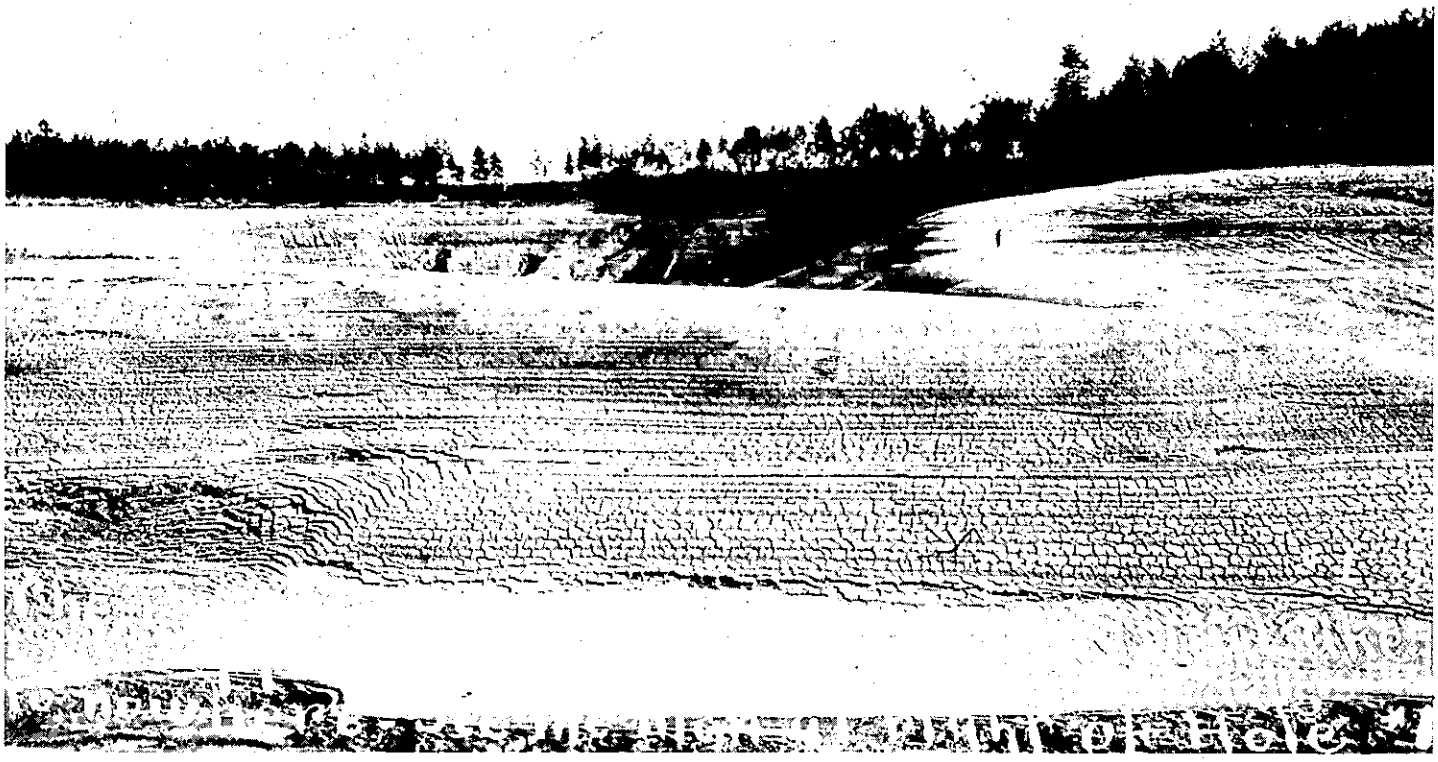

'77::THE LAKESHORE CONVENTION::NSS
ALPENA MICHIGAN
$4.00



Runny Lake. 1½ Mile Long - Gone Dry.
Second occurence in 23 years
Banks 150 ft. high. Showing small Stream below.

ALPENA, Michigan, on Thunder Bay, is fifty miles north of the mouth of Saginaw Bay. When it was surveyed in 1839, no member of the surveying party would accept an offer of the township as full payment for his summer's work. In spite of this discouraging start, Alpena on its hilly site became a flourishing center of lumber and flour mills, tanneries, fisheries, limestone quarries (rivaling those near Rogers City), and cement and paper plants. It has a municipal beach and camp grounds. With a population of 14,682, it is the largest community north of Bay City on the Lake Huron shore.

Michigan Historical Commission

NATIONAL SPELEOLOGICAL SOCIETY

OFFICIAL 1977 GUIDEBOOK ALPENA, MICHIGAN

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THE 1977 N.S.S. CONVENTION, HOSTED BY THE MICHIGAN INTERLAKES GROTTO OF THE NATIONAL SPELEOLOGICAL SOCIETY.

CONVENTION COMMITTEE

William K. Nelson..... Co-chairman
William G. Fritz..... Co-chairman
Aubrey Golden..... Finances
Rane L. Curl..... Sessions
Carol Fritz..... Publications Editor
Judy Nelson..... Registration
Dave Luckins..... Publicity and Campgrounds
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Bob Lambeck..... Transportation
Lois Guest and Bruce Herr..... Name Tags
Nancy Dorset..... Safety and Rescue
Irv. Kuehner..... Field Trips
Harry Sorenson..... Guided Field Trip Leader
Jim Clark..... Facilities

And any and all others who were unintensionally left off this list.

ACKNOWLEDGEMENTS

As is true of all undertakings of this size, there are many people whose participation can be measured in hours instead of weeks, but without whom this convention would never have happened. To all of those people and Kirk MacGregor and Harry Sorenson in particular, we extend our thanks.

We would also like to extend a special thanks to all the landowners who gave us permission to visit their property and to the City of Alpena for making us welcome.

INTRODUCTION

If you ever stopped to wonder why Michigan and not some other state became the home of the automobile industry, you could probably come up with many semi-logical reasons. I have one. I think that Henry Ford knew what the glaciers and pre-historic seas had done to the geologic formation of Michigan and, knowing that, designed and engineered cars so cavers could get to their karst and caves!

The state of Michigan consists of two peninsulas surrounded by four of the five Great Lakes. Our caves and karst are grouped in five main locations throughout the state with over 11,000 lakes and 6,400,000 acres of state parks and national forests in between. This makes Michigan not only interesting geologically, but a great place to take a vacation.

The guidebook was designed with both of these factors in mind. You will find that it has not only an explanation and description of our caves and karst, but self-guided tours arranged so that you can take them as you travel through Michigan on your way to and from the convention in Alpena. There is also a section on recreational and historical features near the tour routes which will be of interest to any of you vacationing in our state.

Many of these features are in either state or national parks. There is a daily use fee as well as a camping fee for most of them. The state park daily use fee is $1.00 with an annual permit for $5.00 for both residents and non-residents. State park and national park camping fees vary. If you plan on camping most of the time, you should consult your road map for either State or National Forest Campgrounds. These are usually considered "primitive" areas, but they are also usually free and relatively unpopulated due to their lack of facilities.

For those of you coming and going by way of Ontario, Canada, Kirk MacGregor has contributed an article-tour on caving in Ontario. Ontario karst, particularily in the Bruce Peninsula where dolomite cliffs rise up to 200 feet above the waters of Georgian Bay (which are still pure enough to drink straight from the lake) is spectacular.

If you do come and go through Canada, please note two things:

1. If you have a CB radio, you must have a Canadian permit which is free. See the June NSS News for the address.
2. You will have to clear customs on entering or leaving the U.S. Custom's officials are hired to enforce the laws of their respective countries and they are thorough. Nine times out of ten you won't be inspected, but you never know when you are going to draw number ten.

The convention area itself is one of contrasts. Alpena is located on the shore of Lake Huron and is surrounded by rolling farmlands, northern bush, and limestone karst. The people are just as varied. Some have welcomed us with open arms and written permission to enter their property; others enforce their No Trespassing signs. Please follow the directions given in the tours and help us keep our landowner relations working smoothly.

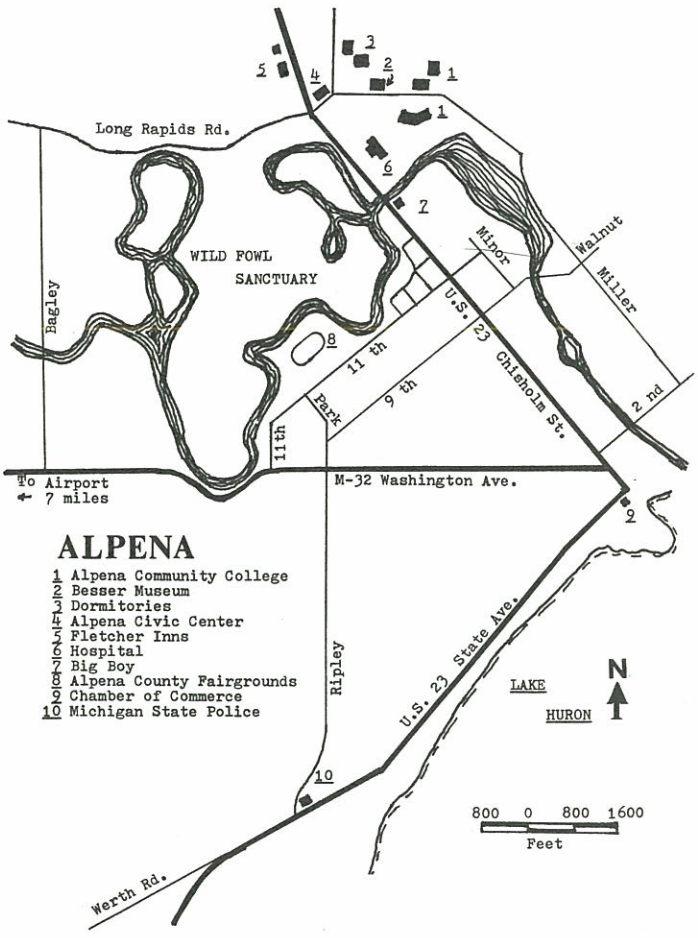
The wildlife in the convention area as well as in most of the northern two-thirds of Michigan is also varied. Black bear are present and in some Rest Areas, very visible. Treat them with respect. More hazardous because of their numbers are the whitetail deer. They are not vicious, but they have a habit of running in front of cars. If you drive at night, watch for them. Hitting one can result in great damage to your vehicle and injury to you.

The convention campground is within the county fairground which is within the Alpena city limits. The fairground is surrounded on three sides by the Thunder Bay River and the Wild Fowl Sanctuary. We have exclusive use of this fenced facility during the convention. This does not exempt us from the local laws. However, the local law isn't going to come looking for any of us without reason. Use of common sense will be appreciated.

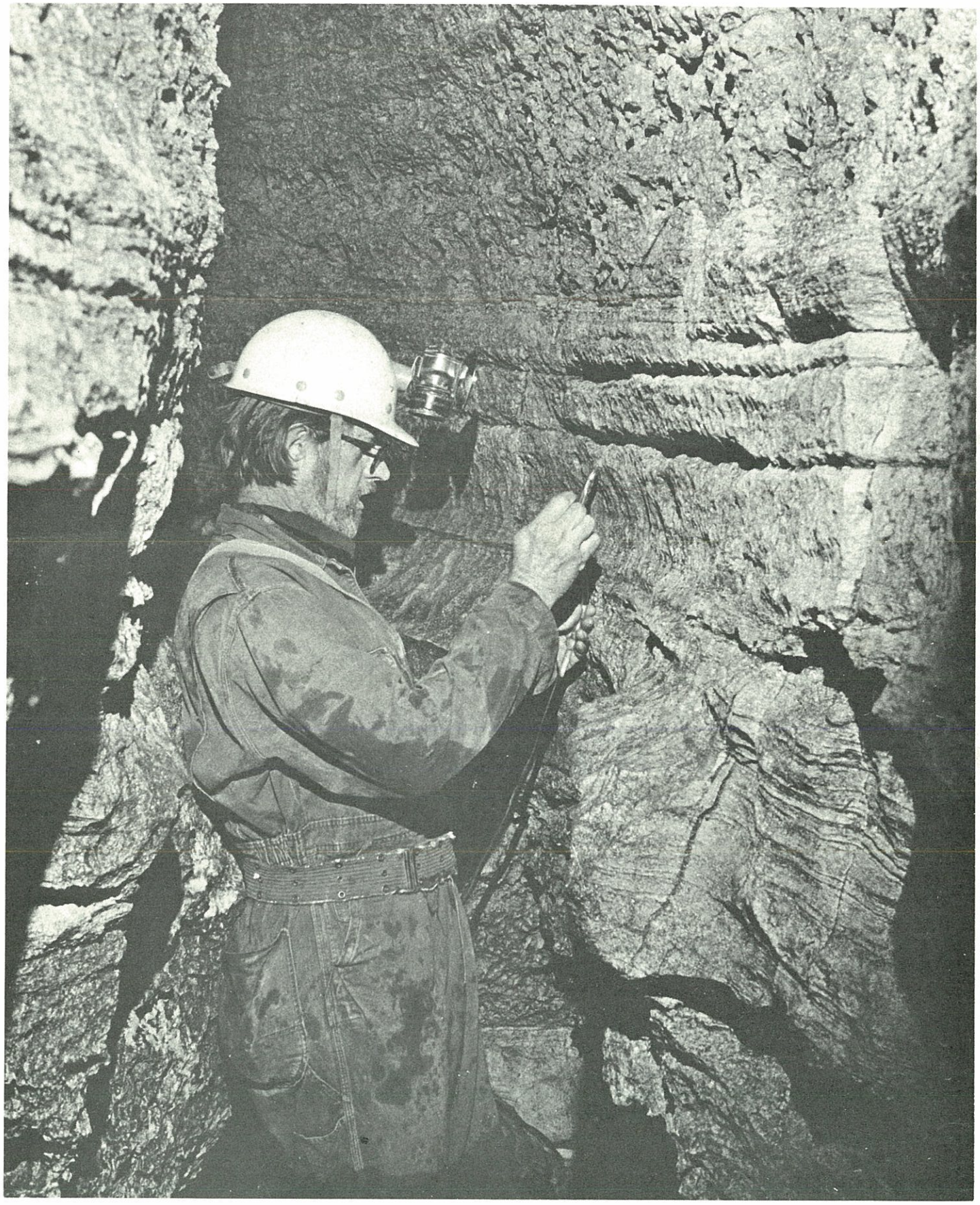
There is a beautiful sand beach within the campground. It was obviously constructed for swimming, but there will NOT be a lifeguard on duty. Swimming will be at your own risk at all times.

Information on such things stores, bars, laundramats, restaurants, etc. will be available either in the program or in a handout included in your convention package or from any of the convention staff.

The Michigan Interlakes Grotto welcomes you as our guests at the 1977 National Speleological Society Convention, July 30-August 6 in Alpena, Michigan.



I. GEOLOGY & HYDROLOGY OF MICHIGAN



FIELD TRIPS

Two guided field trips are planned for the Alpena Lakeshore Convention for your interest and pleasure. The first, on Monday, August 1st, led by geologists Harry O. Sorensen and William A. Walden, will show you the highlights of the geology of the Traverse Group (Devonian) in the Alpena area. We will caravan from the campus parking lot to the Paxton Quarry west of Alpena to take a first-hand look at the Antrim Shale (Devonian) which overlies the Traverse, Traverse, where we will see a profusion of concretions in all sizes up to 18 feet in diameter– the famous kettles of Kettle Point, Ontario– and then proceed down the stratigraphic section as we travel northward from Partridge Point to the Rockport Quarry. This old abandoned quarry is located along the shore on the northern edge of Alpena County. We will witness a proliferation of invertebrate fossils throughout the trip. This is one of the best Devonian fossil collection areas in the Great Lakes area and includes many type localities.

An elaborate guidebook was prepared by the Eastern Section, Geological Society of America and the Michigan Basin Geological Society for a field trip to this area in 1970. It is lavishly illustrated with maps, drawings, stratigraphic columns, and photos of Devonian outcrops and their fossil assemblages which we could not hope to duplicate for this convention guidebook. This book will be made available at cost to field trip participants. Our field trip log which follows will merely supplement this guidebook and direct you to the outcrop localities we hope to visit during the convention.

Serious students of paleontology, paleoecology, and stratigraphy can take this GSA-MBGS compendium of outcrop localities, rock sections, and formal lists, and pursue for themselves such additional field study or collecting as individually desired.

Field trip participants will want to return to Alpena in time to freshen-up and have dinner so that they may participate in the First Michigan Karst Symposium to be held at a time and place to be announced later. An overview of the karst development and hydrology, as a preview of Tuesday's field trip, as well as several other interesting papers on the present state of the art of understanding Michigan's karst development, will be given at this meeting.

The next day, Tuesday, August 2nd, our own geologist, Irv Kuehner, will lead us on a visit to the principle features of karst development in the northeast corner of Northern Lower Michigan. After a quick stop at the Little Ocqueoc River, an area of interesting cave potential, we will make a hurried jaunt over heavily forested high moraine country to the "headwaters" of one of Michigan's main karst systems at Shoepac Lake in the Black Lake State Forest. Here we will see several secondary sinkholes – huge cone shaped depressions in the glacial drift over limestone collapse features at depth – some of which are filled with water. The only historically active collapse in Michigan is visibly happening here at Shoepac Lake. From here we will proceed down-system past more secondary sinks, sink lakes, collapse valleys, a vertical cave, and one of the largest and most spectacular sinkholes known in this part of the country, to an underwater sinkhole in El Cajon Bay that is undoubtably the discharge point for the water from one of Michigan's unique karst systems.

The Michigan Basin is a very shallow intercratonic basin of moderate size situated on the south edge of the Canadian Shield and separated from the Eastern Interior Basin by the Wisconsin and the Kankakee Arches to the west and southwest, and from the Appalachian Geosyncline by the Findlay Arch to the southeast. The Kankakee and Findlay Arches are branches of the Cincinnati Arch, directly to the south. The basin is filled with Precambrian and Lower and Middle Paleozoic sandstones, shales, limestones, dolomites, and evaporites (anhydrite, gypsum, and salt) in gently dipping stratigraphic sequences centered near the city of Midland.

These formations are all nested together like a stack of saucers and outcrop in concentric rings of successively older beds outward from the center of the basin. These rings of outcrops are most notably exposed in the lakeshore areas of Michigan's Lower Peninsula, eastern Upper Peninsula, eastern Wisconsin, northeastern Illinois, northern Indiana and Ohio, and southeastern Ontario (See multicolored centerfold).

⊢ Plate I-1: Rane Curl surveying in Hendrie River Water Cave.

To keep all of this from being too easy for students of geology, four successive periods of continental glaciation swept, gouged, and bulldozed everything that could be torn loose from the sequence of rocks in the Michigan Basin and pushed it all down into Ohio and Indiana. This took place, of course, during the Quaternary, or Late Cenozoic Epoch, from 100,000 to as late as 11,000 years ago. It is generally believed that the predominant areas of ice erosion followed the paths of old pre-glacial drainage ways to scour out the present day Great Lakes and major embayments. The main tongues of ice flowed southward through the western Superior, Green Bay, Michigan, Saginaw, and Erie Basins and spread out laterally upon the intervening land. As the climatic cycle entered a warming period and the last glaciers (Wisconsin) melted off the Great Lakes area, they left a concealing mantle of Upper Michigan sand and Canadian hard rocks -- up to a thousand feet thick – in a revealing pattern of moraines, till plains, outwash plains, eskers, and other glacially related features (See Figure 1). Nearly all of Michigan's rivers, often underfit to an exaggerated degree, were originally the outlets and distributaries for melt water running off the mile thick ice sheets. Poor drainage development, particularly in interlobate areas, left Michigan with a profusion of wetlands and over 11,000 inland lakes. These, along with the surrounding fresh water Great Lakes, make Michigan truly a water wonderland with an interesting variety of related sports and activities.

The diversity of Michigan's biotic assemblages are even more profuse than the vagaries of its Pleistocene glacial deposits as each species sought out its ideal place in the sun to match climatic range, water supply, and particular soil, derived from the sand, clay, gravel or muck deposit, with its own special needs. There are in this state as diverse a collection of biota as found anywhere else in North America; being on the eastern edge of the range of prairie and western species and the western range for eastern species; plus the northern range for many southern plants and the southern extent of many sub-artic plants. You will find in this state everything from cactus plains, isolated disjuncts of prairie grasses and wildflowers, pine forests, mixed hardwoods, dismal swamps, plus string bogs and boreal forests characteristic of sub-artic climates.

The animals that sought out living space in these varied climes are themselves representative of many areas of the continent; from moose to elk, deer, and buffalo; from pine marten, wolverine, and beaver to raccoon and oppossum; from prairie chicken to wild turkey; and from grayling (now extinct) and trout to catfish and all the many species between. Michigan is one of the leading states in licensed small game, big game, and fishing sportsmen who annually harvest a part of this cornucopia of wildlife.

Farming and settlement followed the dictates of the varied geology of this area; from eastern type mixed farming to northern dairy farming, and from corn and hogs to wide expanses of wheat land. The climatically moderated western Michigan fruit belt is world renown.

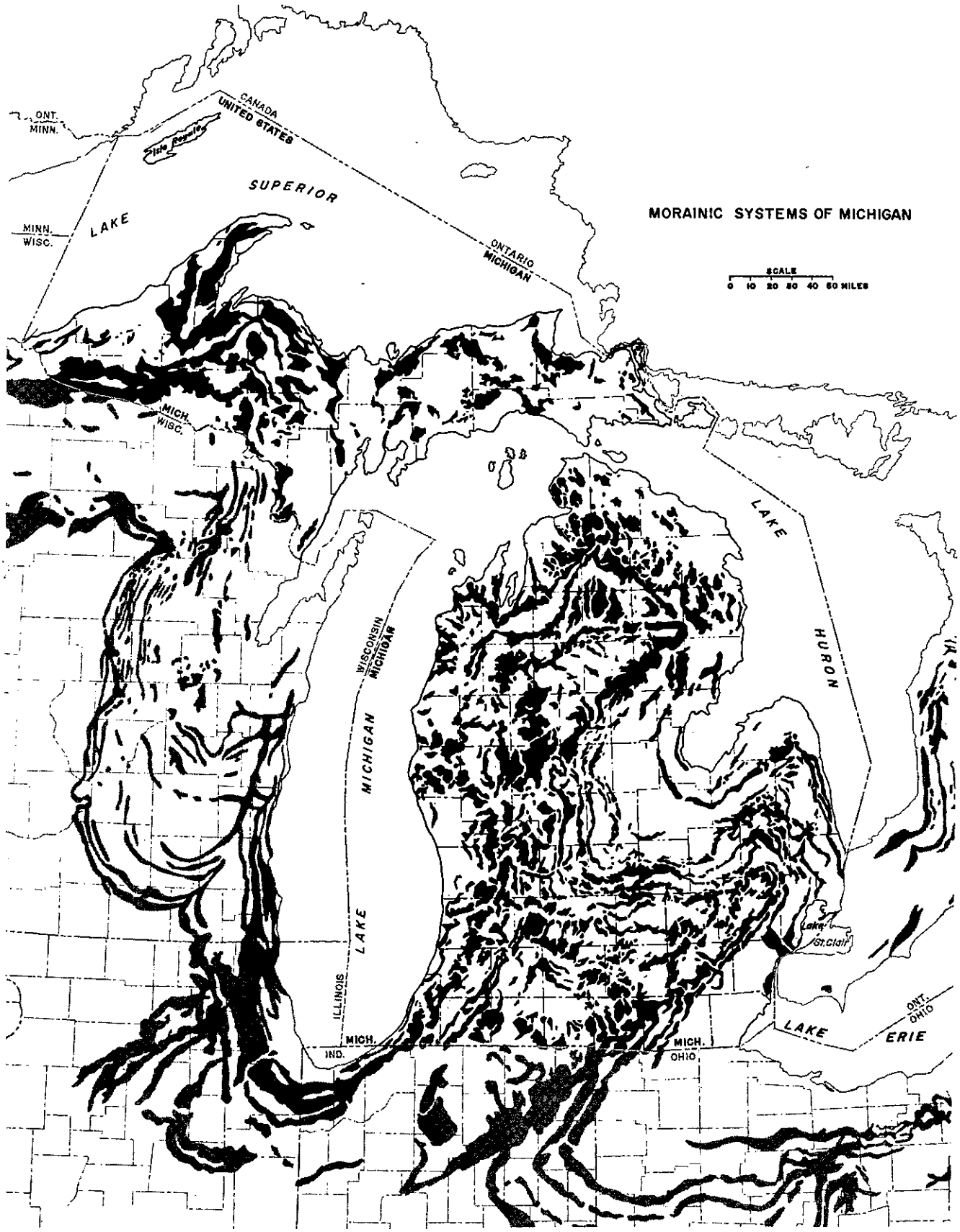
The short growing season of northern Michigan has left that part of the state to the foresters, tourists, and miners while the southern part of the state that most of you just journeyed through is intensively farmed. Southern Michigan's populous manufacturing belt resulted when the fortunate supply of cheap labor from the farms and successive waves of European immigrants were brought together with plentious food and building materials from the farms and northern forests at the crossroads of cheap transportation of bulk raw materials and fuels in a favorable economic climate. Thus, you have Michigan in brief – the Great Lake State – a product of its unique geological, natural, and historic heritage. (I.V.K.)

FIELD TRIP NUMBER 1

HIGHLIGHTS OF GEOLOGY OF THE TRAVERSE GROUP, ALPENA COUNTY MICHIGAN

By: *Harry O. Sorensen and William A. Walden, Economic Geologists, Geology Division, Department of Natural Resources, Lansing, Michigan*

As a supplement to the guidebook "Devonian Strata of Alpena and Presque Isle Counties, Michigan," by George M. Ehlers and Robert V. Kesling, for the Eastern Section, Geological Society of America and the Michigan Basin Geological Society field excursion on May 2-10,



The pattern of moraines left by the retreating Wisconsin glacier clearly reveal the lobes of ice that once covered the Great Lakes Area.

1970, we present a road log for a one day field trip for the National Speleological Society on the 1st of August, 1977. This log also includes a geologic map of the area with the location of seven stops. Also attached is a composite log giving sequence, thickness, and lithologic information on rock units for the Traverse Group in the Alpena area. Page numbers in the log refer to the GSA-MBGS Guidebook.

NOTE: No preparations have been made for a formal lunch stop. It is suggested that each field trip participant bring along prepared lunches or their makings; some munchies, and something to drink. We will eat on the road or, if time permits, a few minutes at one of the stops can be devoted to eating and refreshments.

Mileage

To Stop #1:		Monday, August 1st, 1977
0.00		Start from Alpena Community College parking lot located on the north side of Johnson Road about 0.3 mile east of intersection with US-23 on the north side of city of Alpena. Leave parking lot by auto caravan at 9:00 AM sharp for first stop.
00.3	(00.3)	Junction with US-23. Stop light. Turn left (SE) onto US-23.
01.0	(00.7)	Bridge over Thunder Bay River.
02.1	(01.1)	South Eleventh St. Stop light. Turn right (SW).
02.7	(00.6)	Park St. Turn left (SE) and follow Park St. to intersection with M-32.
03.0	(00.3)	Junction with M-32. Stop light. Turn right (W). Note: Road cut to west exposes Potter Farm Formation. Continue west.
11.0	(08.0)	King Settlement Road. Turn left (S).
11.5	(00.5)	Entrance to Paxton Shale Quarry of Huron Portland Cement Company. Follow lead car to appropriate parking spot in quarry area.
Stop #1		Paxton Quarry. NE Section 30, T31N, R7E. Approximately 55 feet of Antrim Shale exposed in quarry wall. Quarry floor is about 40 feet above Squaw Bay Limestone, the top strata of the Traverse Group. Description of the Antrim Shale and stratigraphic section of the quarry is given on pages 102-103; pictures of the quarry exposures are shown on pages 5 and 6.
To Stop #2:		
00.0		Return to cars and proceed by caravan to entrance to quarry. Turn left (N) on King Settlement Road.
00.5	(00.5)	Junction with M-32. Turn right (E) and proceed on M-32 toward city of Alpena.
06.0	(05.5)	Lake Winyah Road (formerly Four Mile Dam Road). Turn left (N).
08.0	(02.0)	Four Mile Dam on Thunder Bay River.
Stop #2		Four Mile Dam locality, SW and SE Section 7, T31N-R8E. Park near turn of road and go north down the hill to dam. Four Mile Dam Formation bioherm overlapped and flanked by basal beds of Norway Point Formation. Description of formations on pages 80-91; fossils of Four Mile Dam Formation shown pages 25,26,28, and 29, and of Norway Point Formation on page 31; pictures of locality on pages 4, 30, and 33.
To Stop #3:		
00.0		Return to cars and proceed by caravan back to M-32.
02.0	(02.0)	Junction with M-32. Turn left (E) and proceed to Alpena.
05.4	(03.4)	Junction with US-23. Turn half right (SE).
05.6	(00.1)	Turn right (SW) and continue on US-23.
08.2	(02.6)	Blinker light (State Police Post to right in northwest corner of intersection) continue straight ahead on US-23.

STRATIGRAPHIC SECTION AT THE PAXTON QUARRY
HURON PORTLAND CEMENT COMPANY
ALPENA COUNTY, MICHIGAN

Unit		Thickness (feet)	Depth (feet)
Antrim Shale:			
25	Shale; dark gray to black	19'0"	19'0"
24	Limestone; light buff-gray	2'0"	21'0"
23	Shale; dark gray	1'0"	22'0"
22	Limestone; gray, argillaceous	3'0"	25'0"
21	Shale; gray, fairly hard	4'6"	29'6"
20	Limestone; gray, argillaceous, fairly uniform, some fossils	1'0"	30'6"
19	Shale; dark, some calcareous stringers	1'6"	32'0"
18	Limestone; gray, argillaceous	3'6"	35'6"
17	Shale; dark gray with lighter bands and mottlings	5'6"	41'0"
16	Limestone; dark gray, argillaceous	0'6"	41'6"
15	Shale; very dark gray with calcareous stringer at 52', lighter gray in lower 33'	45'0"	86'6"
	Thickness	86'6"	
Squaw Bay Limestone:			
14	Dolomite; gray-buff, dense, fossiliferous with calcareous fossils	2'6"	89'0"
	Thickness	2'6"	
Thunder Bay Limestone:			
13	Limestone; gray, argillaceous, with large corals and bryozoans	2'0"	91'0"
12	Dolomite; buff-gray, fine grained, somewhat fossiliferous	1'6"	92'6"
11	Shale; gray, calcareous, some banding, a few fossils along bedding plains near top	10'0"	102'6"
10	Dolomite; gray, with buff fossil fragments and some shaly partings and thin layers	2'0"	104'6"
	Thickness	15'6"	
Potter Farm Formation:			
9	Shale; gray when dry, dark when wet, some fossils	6'6"	111'0"
8	Alternating argillaceous limestone with crinoidal fragments and calcareous shale	2'6"	113'6"
7	Shale; medium gray, some lighter banding, fairly uniform	6'0"	119'6"
6	Limestone; gray with lighter crinoidal hash	1'6"	121'0"
5	Shale; dark gray, very uniform, few lighter gray bands	18'6"	139'6"
4	Limestone; argillaceous to limy shale, fossiliferous, crinoidal material	1'6"	141'0"
3	Shale; gray, finegrained, uniform no banding	13'0"	154'0"
2	Limestone; gray, argillaceous; fossiliferous, crinoidal hash	1'0"	155'0"
1	Shale; gray, very fine grained, some light gray bands, very uniform	6'0"	161'0"
	Thickness	56'6"	

Figure 2. Hole No. 3 Drilled for the Huron Portland Cement Company at their quarry at Paxton, Alpena County, Michigan. Top at about 648 feet above mean sea level. Hole is located near the southern edge of quarry.

10.4	(02.2)	Partridge Point Road. Turn left (E). McDonald Dairy Company milk and ice cream warehouse on northeast corner. Continue on Partridge Point Road to south side of Partridge Point.
12.5	(02.1)	Dirt road to left (S) leads to Squaw Bay. Park cars and walk about one-quarter mile to shore.
Stop #3		Squaw Bay Formation. Type Locality, SW Section 11, T30N, R8E. Pavement limestone with limestone rubble along shore. Description of formation is on pages 101-102. Fossil of Squaw Bay Formation shown on page 38. Picture of exposure is shown on plate 5, photo #3.
To Stop #4		
00.0		Back to cars. Turn cars around facing east and follow lead car short distance to next stop.
00.3	(00.3)	Park along Partridge Point Road near east end of peninsula. Follow trip leaders to shore of Thunder Bay.
Stop #4		Thunder Bay Limestone. Type Locality, NW and SE section 11, T30N, R8E. Outcrops in small cliff facing Thunder Bay. Description is on pages 100-101; fossils are shown on pages 35,37,38; pictures of formation are on pages 5 and 6.
To Stop #5		
00.0		Return to cars and proceed in caravan to US-23.
01.8	(01.8)	Junction with US-23. Turn right (N) and head for city of Alpena.
04.1	(02.3)	Blinker light. (Police Post in northwest corner of intersection). Proceed straight ahead.
05.7	(01.6)	In city of Alpena. Turn left (NW) and continue on US-23.
05.8	(00.1)	Stop light. North Second Avenue. Turn right (NE).
06.0	(00.2)	Bridge over Thunder Bay River.
06.1	(00.1)	Stop light. East Miller Street. Turn right (SE) and continue on Miller Street for one block.
06.2	(00.1)	Ford Street. Turn left (NE) and continue on Ford Street.
06.7	(00.5)	Stop light. Wessel road to left. Entrance to Huron Portland Cement Plant to right. Turn left (NW) and proceed on Wessel Road.
07.3	(00.6)	Entrance to Huron Portland Cement limestone quarry. Follow lead car to appropriate parking area in quarry.
Stop #5		Limestone quarry of the Huron Portland Cement Company, Section 13, T31N, R8E. Upper Genshaw Formation in lower quarry levels. Newton Creek Limestone and Alpena Limestone in the upper part of the quarry. Description of formation is found on pages 60-80; fossils of Genshaw Formation on pages 17-19 and 22, Newton Creek Formation on Pages 23 and 24, and Alpena Formation on pages 22-25; picture of the quarry on pages 3,4,27, and 30.
To Stop #6:		
00.0		Back to cars and follow lead car to quarry exit on Wessel Road. Proceed back to Ford Street.
00.6	(00.6)	Ford Street. Turn right (SW) and proceed on Ford Street.
00.9	(00.3)	Bosley Street. Turn right (NW) and go for one block.
01.0	(00.1)	North Second Avenue. Turn left (SW) and continue for five blocks.
01.5	(00.5)	Miller Avenue. Turn right (NW) and continue on Miller Avenue.
02.1	(00.6)	Railroad crossing (Road change to Johnson Road) continue on Johnson passing Alpena Community College to Junction with US-23.
03.1	(01.1)	Junction with US-23. Turn right (NW).
03.2	(00.1)	Fletchers Motel to left (W).
03.8	(00.6)	French Road. Turn Half left (NW) continue on French Road.
05.3	(01.5)	French Road turn half right (N) (Lumber Mill on northeast corner of this intersection with Hamilton Road to east). Continue on French Road.
10.7	(05.4)	Road cut exposing almost 30 feet of strata going down hill to the north over an old glacial lake beach ridge. Park along road shoulder.
Stop #6		Killians Member Type Locality, NE and SE Section 8, T32N, R8E. Description of member is described under Genshaw Formation on pages 60-69; fossils of the Killians Member are under Genshaw Formation on pages 17, 18, 21, and 22; picture of this exposure is on plate 3, photo #2.
To Stop #7:		
00.0		Back to cars and continue in caravan to next stop.
00.5	(00.5)	Long Lake Road. Turn right (E), continue on Long Lake Road to intersection with US-23.
03.9	(03.4)	Junction with US-23. Turn left (NE) and continue on US-23.
06.5	(02.6)	Rockport Quarry Road. Turn right (E). Texaco gas station in northeast corner.
09.8	(03.3)	Entrance to abandoned Rockport Quarry. Follow lead car to appropriate parking area.
Stop #7		Rockport Quarry, NW Section 6. T32N, R9E. Type Locality for the Rockport Quarry Limestone. Bell Shale in drainage ditch, Rockport Quarry Limestone in main quarry capped by basal beds of the Ferron Point Formation. Description of on pages 40-56; fossils of Bell Shale on pages 13-15; Rockport Quarry on page 15, Ferron Point pages 16-17; pictures of quarry and its exposures on pages 1,2,3,19, and 20 of the GSA-MBGS guidebook.

The Rockport Quarry stop will conclude our geological field. trip and members of the party will be free to leave for Alpena at their own discretion.

NOTE: Field stops may have to be altered to accomodate work schedules, blasting times, and official requirements of the Huron Portland Cement Company for group visits to the Paxton Shale Quarry and the Limestone quarry in Alpena. In addition, stops 2-5 may be reduced to alternate status depending on time and progress of the trip schedule.

STRATIGRAPHIC SECTION AT THE HURON PORTLAND CEMENT COMPANY QUARRY ALPENA COUNTY, MICHIGAN

Unit		Thickness (feet)	Depth (feet)
Four Mile Dam Formation: (stripped from top of quarry)			
39	Mudstone; bluish gray, calcareous, with occasional patches (Dock Street Clay)	7	7
Alpena Limestone: (Top of quarried section)			
38	Limestone; white, light gray or light brown, containing bioherms s	57	64
37	Shale; bluish gray, highly calcareous, fossiliferous	1	65
36	Limestone; white to light gray with massive shale; black, bituminous	20 1	85 86
	Thickness	79	
Newton Creed Limestone:			
35	Limestone; light buff-gray, odor, finegrained, petroliferous	10	96
	Thickness	10	
Genshaw Formation (Upper): (Bottom of quarried section)			
34	Limestone; gray, fossiliferous, becoming thin-bedded and banded near top	25	121
	Thickness	25	
Killians Limestone Member: (Upper part exposed in sump in quarry floor)			
33	Limestone; black, highly fossiliferous with many white corals (Hexagonaria)	4	135
32	Limestone; very dark gray, fossiliferous	8	143
	Thickness	22	
Genshaw Formation (Lower):			
31	Shale; brown to gray, grading upward from argillaceous to limy	22	165
30	Limestone; gray, argillaceous, highly fossiliferous with many large Hexagonaria	28	193
29	Shale; gray, limy, fossiliferous	2	195
28	Limestone; gray, argillaceous, highly fossiliferous	18	213
	Thickness	70	
Ferron Point Formation:			
27	Shale, light bluish gray, highly fossiliferous zones 6-9' below top containing Chonetes	30	243
26	Limestone and shaly limestone layers; highly fossiliferous with corals, bryozoa, crinoid columns, and brachiopoda da (Atrypa)	16	259
25	Shale; gray, poker-chip partings	5	264
24	Limestone; light gray, containing irregular limy shales, highly fossiliferous fossiliferous	10	274
23	Shale; medium gray, some poker-chip partings, fossiliferous	7	281
	Thickness	68	
Rockport Quarry Limestone:			
22	Limestone; gray to brownish-gray, less fossiliferous than underlying unit	14	295
21	Limestone; brownish-gray to gray, Fossiliferous bands with large corals, and stromataporoids (Cystiphyllum)	28	323
	Thickness	42	
Bell Shale:			
20	Shale; gray to dark gray, soft, fairly uniform	70	393
19	Shale; brownish-gray, upper part containing crinoidal hash	1	394
	Thickness	71	
	Total Traverse Group Thickness	394	
Rogers City Limestone:			
18	Limestone; grayish-brown, finegrained, finely crystalline, some fossils and styolites, fairly uniform	19	413
17	Core missing	15	428
16	Limestone; brownish-gray but lighter than underlying unit, some fossils	25	453
15	Limestone; dolomitic, warm-gray, finely crystalline, fairly good acid reaction	27	480
	Thickness	86	
Dundee Limestone:			
14	Limestone; dolomitic; brown, gray, some banding and mottling	27	507
13	Dolomite; gray and brownish, thin bands of chert in upper foot and scattered irregular masses of chert in lower 11 feet	19	526
12	Limestone; dolomite, grayish-brown, slightly banded, finegrained, corals in lower 6 feet	76	602
11	Limestone; buff, even-grained, slightly banded, uniform	18	620
10	Dolomite; brownish-gray, finegrained, slightly banded near top, some gypsum at base	8	628
	Thickness	148	
Detroit River Group:			
9	Dolomite; light buff gray, considerable anhydrite in thin bands	4	632
8	Dolomite; buff-gray, finegrained, localized anhydrite in thin layers and partings	17	649
7	Dolomite; gray, with much gypsum in bands and fillings	4	653
6	Dolomite to dolomitic limestone; buff to brown, finegrained, with anhydrite crystals and fillings, some faint banding	13	666
5	Limestone; buff, slightly banded, with gypsum fillings	2	668
4	Dolomite; warm-gray, finegrained, slightly banded with gray gypsum (selenite) partings near top	5	673
3	Limestone; gray, finegrained, slight banding, some thin gypsifirous partings	2	675
2	dolomite; buff, finegrained, banded with gray and brown, with some gypsum	5	680
1	Limestone; gray to brownish-gray, finegrained, finely and irregularly banded (possibly with dolomite)	4	684
	Thickness	56	
	Grand Total Thickness	684	684

Figure 3. Composite log compiled from sections exposed in wall of quarry and core drilling at the Huron Portland Cement Company Quarry at Alpena, Section 13, T31N, R8E, Alpena County, Michigan. The top is about 630 feet above mean sea level.

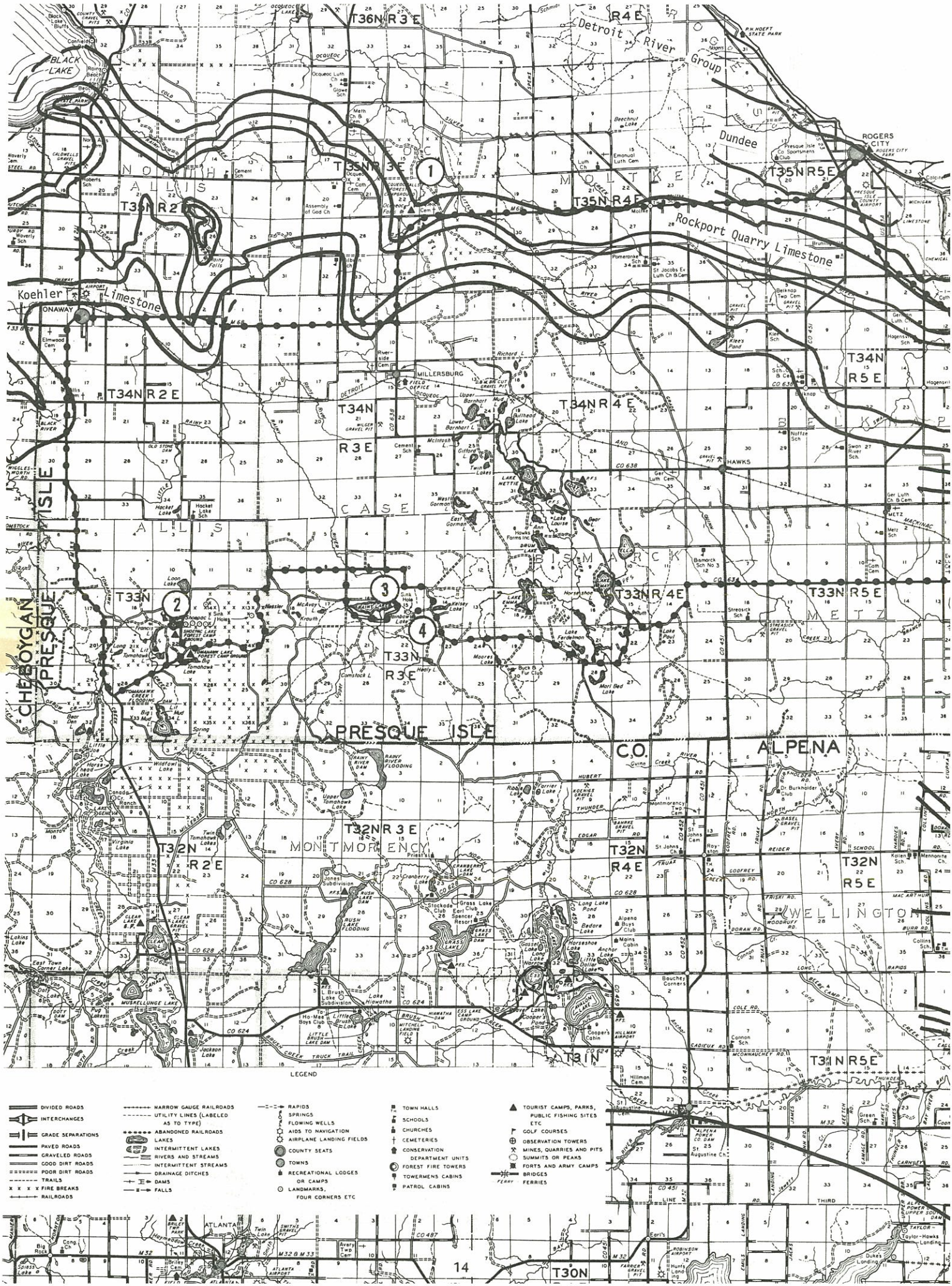
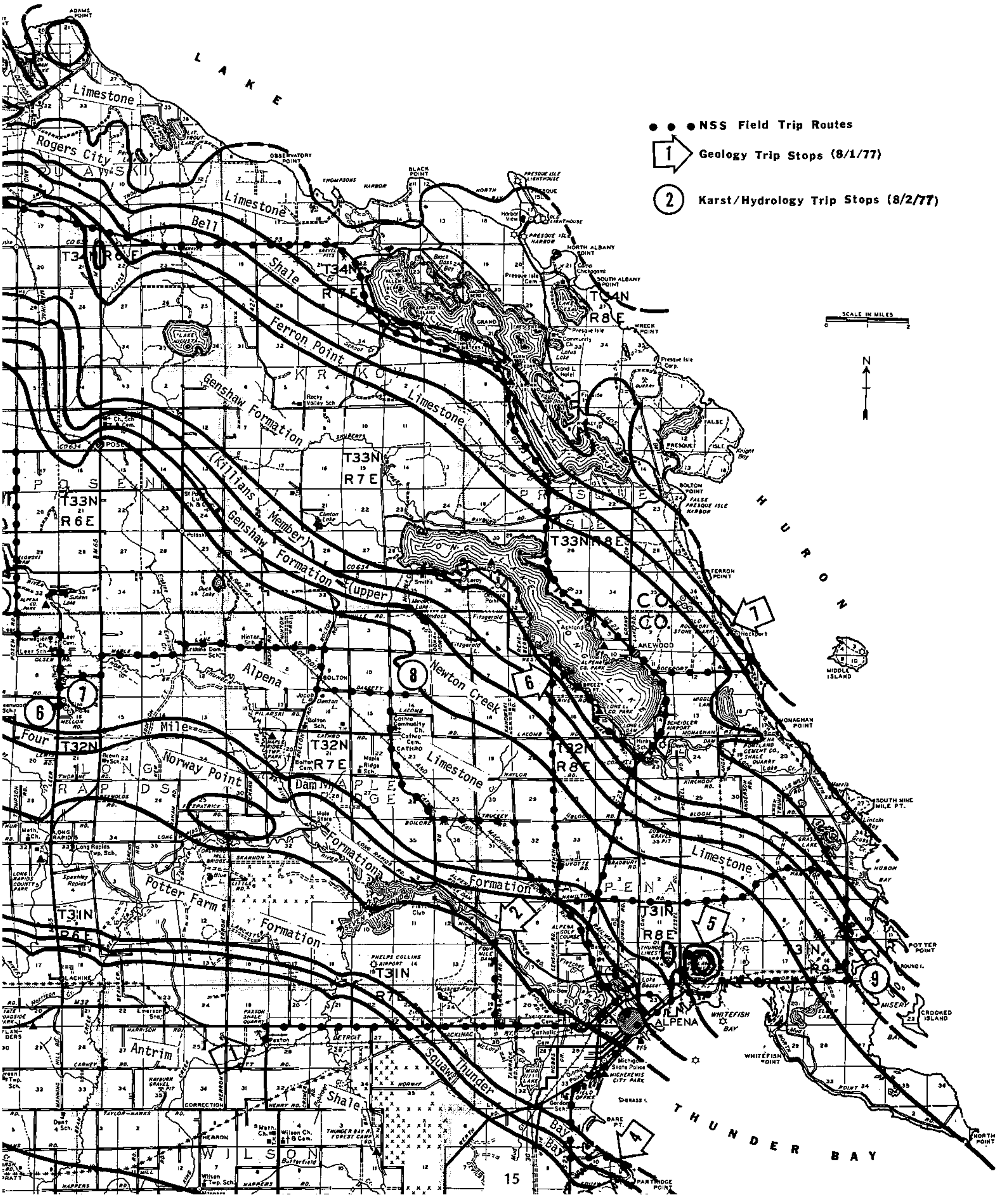

T36N R3E
R4E
Detroit River Group
Dundee
ROGERS CITY
T35N R5E
T35N R4E
T35N R3E
T35N R2E
Rockport Quarry Limestone
Koehler Limestone
ONAWAY
MILLERSBURG
T34N R2E
T34N R3E
T34N R4E
T34N R5E
HAWKS
T33N R2E
T33N R3E
T33N R4E
T33N R5E
METZ
ALPENA
C.O.
T32N R3E
MONTMORENCY
T32N R2E
T32N R4E
T32N R5E
WELLINGTON
T31N R5E
T30N
CHEBOYGAN
PRESQUE ISLE
ALLIS
CASE
BISMARCK
BELKNAP
LEGEND
DIVIDED ROADS
INTERCHANGES
GRADE SEPARATIONS
PAVED ROADS
GRAVELED ROADS
GOOD DIRT ROADS
POOR DIRT ROADS
TRAILS
FIRE BREAKS
RAILROADS
NARROW GAUGE RAILROADS
UTILITY LINES (LABELED AS TO TYPE)
ABANDONED RAILROADS
LAKES
INTERMITTENT LAKES
RIVERS AND STREAMS
INTERMITTENT STREAMS
DRAINAGE DITCHES
DAMS
FALLS
RAPIDS
SPRINGS
FLOWING WELLS
AIDS TO NAVIGATION
AIRPLANE LANDING FIELDS
COUNTY SEATS
TOWNS
RECREATIONAL LODGES OR CAMPS
LANDMARKS, FOUR CORNERS ETC
TOWN HALLS
SCHOOLS
CHURCHES
CEMETERIES
CONSERVATION DEPARTMENT UNITS
FOREST FIRE TOWERS
TOWERMENS CABINS
PATROL CABINS
TOURIST CAMPS, PARKS, PUBLIC FISHING SITES ETC
GOLF COURSES
OBSERVATION TOWERS
MINES, QUARRIES AND PITS
SUMMITS OR PEAKS
FORTS AND ARMY CAMPS
BRIDGES
FERRIES

Figure 4: Geology of the Devonian Traverse Group of Northeastern Lower Michigan showing the routes and stops of the 1977 National Speleological Society Geology and Karst/Hydrology Field Trips (Geology after Ehlers and Kesling, 1970).



FIELD TRIP NUMBER 2

HYDROLOGY AND DEVELOPMENT OF NORTHEASTERN LOWER MICHIGAN KARST

By: *Irvin V. Kuehner, Geologist*
NSS 16326 Member Michigan Interlakes Grotto
Regional Geologist, Michigan Department of Natural Resources, Region III Headquarters, Lansing, Michigan

The Michigan Interlakes Grotto has been making intermittent attempts to locate and map myriad karst features developed in the Traverse Formation across the top of Northern Lower Michigan, and to fathom their hydrology and geomorphology, for the past four years. Previous karst studies in this area consisted of a few descriptive paragraphs and brief mention.

At first, we thought we might be dealing with an incipient karst, dissolved from limestone beds since the Wisconsin glaciers retreated from this part of the state about 11,000 years ago. But as we gain additional knowledge and as we add to our store of observable facts, particularly recently discovered karst development extending below the surface of Lake Michigan on the side of Little Traverse Bay, we have had to alter our thinking. We have lately come to understand that karst features are prevalent throughout the Traverse Group and that they were probably developed in pre-glacial and/or inter-glacial times. The sub lake level karst was most likely developed during the low level Lake Stanley and Lake Chippewa stages which were at least 400 feet below present lake levels.

Unfortunately, the Traverse Group is, for the most part, heavily mantled with glacial drift, particularily in its western extent. This same glacial drift has filled and plugged nearly all of the existing karst systems. Minor subsequent development, severely retarded by the drift mantle and extensive plugging, has produced the paucity of Holocene and recent karst features we are now using in trying to figure out the extent of cave formation and karst development. The potential for cave formation in Alpena, Presque Isle, and Montmorency counties is fairly good but, to date, the Mammoth Cave of Michigan has eluded our casual exploration methods. From here on it will take the combined best efforts of geologists, geophysicists, geomorphologists, hydrologists, and a lot of luck to come up with the big cave in Northern Lower Michigan.

Following up on old printed accounts and rumors from residents and former residents has brought us into contact with many interesting people and produced some valued and lasting friendships in the bargain. We would not want to abandon this exploration method nor the benefits derived therefrom.

Michigan has five principle karst areas; the Devonian Traverse Group of limestones across Northern Lower Michigan discussed here; the broad band of Silurian dolomites and limestones in the Eastern Upper Peninsula – the site for Hendrie River Water Cave and Kochab Cave discussed elsewhere in this volume by George Wood, and the Silurian limestone area of Monroe County in southeastern Michigan, covered by John Moses. The gypsum karst in the Mississippian Michigan Formation in Central Lower Michigan has been written up by Allan Ostrander. Pre-convention or post convention field trips to any of these areas not covered by formal convention field trips may be experienced by all those cavers who have a compelling interest to visit these unique karst areas. Assistance in locating them will be gladly proferred by the field trip chairman or the officers and members of the Michigan Interlakes Grotto.

NOTE: No preparations have been made for a formal lunch stop. It is suggested that each participant bring along prepared lunches or their makings, something to munch on, and something to drink. Because of the distance we will be trying to cover today, we may have to eat on the run. However, we will try to stop in some interesting place to partake of sustenance and refreshments.

To Stop #1	Mileage	
00.0		Tuesday, August 2nd, 2977 Start from Alpena Community College parking lot located on the north side of Johnson Road about 0.3 mile east of the intersection with US-23. Leave parking lot by auto caravan promptly at 9:00 AM for the first stop. Jessie Besser Museum, site of several convention activities on the right. Alpena County Sheriff Dept. and Alpena Community Hospital on the left. Alpena Civic Center on the north corner.
00.3	(00.3)	Junction US-23. Stop light. Turn right (NW) onto US-23. Keep caravan together please. You will be travelling from here to Rogers City on ancient flat to gently sloping Nippising lakebeds deposited 3,000-plus years ago. The route crosses and recrosses old beach ridges that are mainly concealed in the dense thickets of cedar and mixed hardwoods. The soil is sandy and generally poor. Where it is poorly drained, dense cedar swamps – favorite wintering yards for the whitetailed deer – develop.
05.6	(05.3)	Devil's Lake on right. This lake is karst controlled. On occasion – the last time in 1968 – the plug gets pulled and Devil's Lake is unexpectedly and completely drained, only to be refilled again when sediment replugs the unknown outlet. The small stream, Long Lake Creek, crossing the road connects Devil's Lake and Long Lake. It reverses direction of flow at times, depending on the imbalances of the hydrologic system.
07.4	(01.8)	Long Lake on left. Although hydrographic charts show no sharp depressions or holes on the bottom of Long Lake, the lake is thought to be karst controlled because of its occasional and unexpected changes in water level. The lake may very likely be filling a graben, down-thrown fault block. The whole south shore of Long Lake, running for its full length and beyond, is tilted towards the graben, an occurrence repeated along the basinward side of several other major karst features in Northeastern Lower Michigan. A string of small linear lakes (Fitzgerald, Mindak, and Trapp) and large open bedrock cracks delineate the southeastern edge of this tilted block. A NW-SE tending surface fault, not too common in this drift covered territory, is reported along the southwest side of Trapp Lake.
08.1	(00.5)	Rockport Road on right. Three miles to old abandoned Rockport Quarry. Continue straight ahead.
08.6	(01.2)	Grand Lake Road. Presque Isle (limestone) Quarry seven miles to north. Continue straight ahead.
09.9	(01.3)	Presque Isle/Alpena County line.
12.7	(02.8)	Grand Lake on right for next 8 miles. We have and are now travelling on the old Algonquin (8,000 years BP) lake bed. Nipissing wave cut beaches below highway on right.
17.1	(04.4)	Genshaw limestone (Traverse Group) in roadcut on left. We have to call attention to all of our roadcut outcrops in the Lower Peninsula of Michigan. We have darn few of them. Practically everything is drift covered.

21.5	(04.4)	County Highway 638 to Presque Isle and Presque Isle Harbor 5 miles to the east. The picturesque harbor and lighthouse make an interesting side trip. Continue straight ahead.
27.7	(02.1)	Junction with M-65 to Posen, one of Michigan's main karst areas. We will go past Posen on our return trip this afternoon. Continue ahead.
29.8	(02.1)	Cross Swan Creek. Swan Creek Falls, one of the four waterfalls in the Southern Peninsula of Michigan, 50 yards in woods on right.
33.7	(03.9)	Business US-23. Turn right.
34.4	(00.7)	Quarry View. The Rogers City Quarry (US Steel Corporation) is said to be the largest limestone quarry in the world. The quarry has its own lake port at Calcite. Rogers City limestone from this quarry and iron ore from Upper Michigan, Wisconsin, and Minnesota, bulk shipped to lower lake ports, furnishes a large part of the nation's steel. This is, of course, a working quarry and very difficult to get into during working hours. Rumor has it that they have unearthed at least 40 drift filled sinkholes in their quarrying operations. We have not been able to confirm this.
35.4	(01.0)	Enter Rogers City.
35.5	(01.1)	Cross Quarry tunnel beneath road to newly opened quarry on left. **NOTE:** When Paul Johnson and I drove this route last January to make up this road log, there were snow banks 8-10 feet high along this road, all the lakes and streams were frozen over, Lake Huron was frozen all the way to Ontario – the first time in many years – the temperature was -4 degrees F., and the wind was gusting up to 30 mph. Visibility was zero at times. Snowmobiles were zipping all over the place and we couldn't find a restaurant open to get a cup of coffee at noon on Sunday. We also got horribly stuck in the snow twice. This note was included here to let you know how much field trip committees suffer to put things together for you. By the way, the sun was shining and it was a positively beautiful day!
36.7	(01.2)	Turn left on Erie Street. (M-68)
37.9	(01.2)	Cross US-23.
41.8	(03.9)	Climb up off Alonquin lake plain. Late glacial readvance carved many drumlin-like features into this glacial material.
47.6	(05.8)	Cross Little Ocqueoc River.
48.3	(00.7)	Turn right on Silver Creek Road.
48.8	(00.5)	Follow lead car about a half mile into the forest. Park close to the side of road to let traffic pass.

Stop #1

Down the hill to the right the Little Ocqueoc River disappears into a mass of broken Rockport quarry limestone and abandons its old surface watercourse. Water can be heard running underground for quite some distance. Members of the Michigan Interlakes Grotto have been digging in this area for several years trying to find creditable cave. A small cave at the end of a reentrant, has been pushed for 32 feet before the crawl space became too narrow for our smallest member to proceed. The area still has possibilities for cave development and will be explored again during the dry, low water cycle coming up this year. The water of the Little Ocqueoc River resurges at a small rise beneath the bottom of the hill where it travels a short distance before joining the Ocqueoc River.

NOTE: Those who have the time and are not travelling with the caravan may wish to visit oqueoc Falls campground 0.5 mile to the west.

Plate I-2: Remnant of Ocqueoc Cave on the Little Ocqueoc River.

To Stop #2		
00.0	(00.0)	Turn cars around and return to M-68. Turn right on M-68 and follow a broad curve to the left.
04.0	(04.0)	Follow M-68 to right towards Onaway.
05.0	(01.0)	Cross Ocqueoc River.
09.5	(04.5)	Cross Rainy River.
12.5	(03.0)	Enter Onaway.
13.7	(01.2)	Turn left on M-33 and proceed south. This is high moraine country and the scene of some of Michigan's most beautiful pine and mixed hardwood forests; terrific whitetail deer country; and has many back roads that are perfect for ATV crusing. The only elk herd east of the Mississippi River is trying to reestablish itself in this area. The Polar-Equator Trail (non-motorized) crosses and recrosses our route for the next several miles.
23.5	(09.8)	Turn left on Tomahawk Lake Road.
24.9	(01.4)	Fork, bear right. Little Tomahawk Lake, down the road a short distance to the left, is a waterfilled secondary sinkhole.
25.4	(00.5)	Big Tomahawk Lake on right.
25.7	(00.3)	Fork, bear left to Shoepac Lake State Forest Campground. Park off the road so as not to impede traffic. Proceed on foot to the divide between Shoepac Lake and the first sinkhole. This lake, as well as other lakes in this immediate vicinity, are water filled secondary sinkholes. The hydrographs of the bottom of these lakes look like the contour map of the string of four empty sinkholes to the east. The only known active karst development is taking place in this area. Note the precipitous

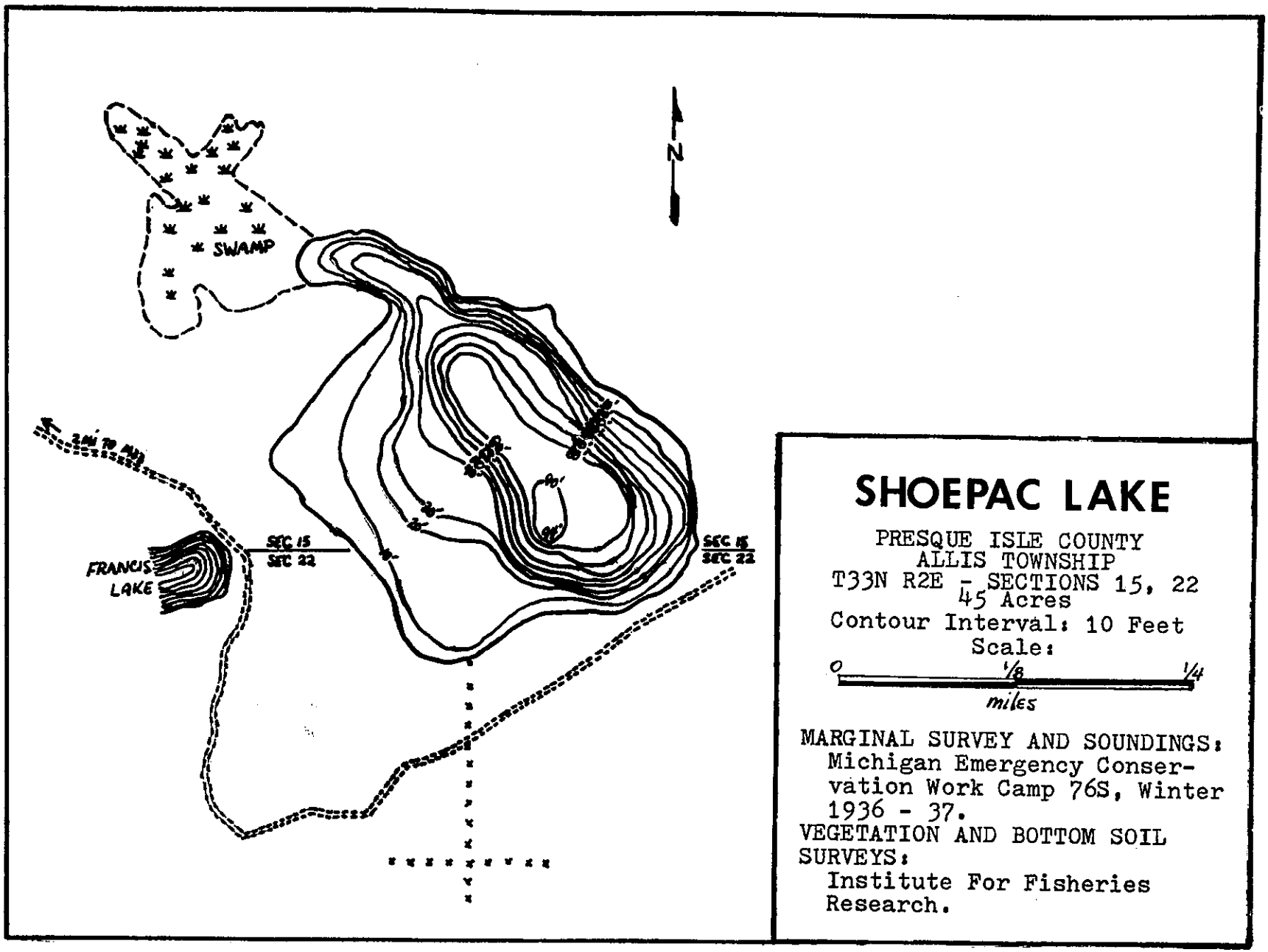


Figure 5: Hydrograph of the bottom of Shoepac Lake. Note the many secondary sinkholes making up this collapse basin.

newly eroded bank on the east end of Shoepac Lake. Slumpage into the underwater sinkhole is constantly occurring. On the southeast side of Shoepac Lake, at the old campground, a small sink developed in 1965. Several truckloads of sand were used to fill this collapse area. The glacial drift is approximately 95 feet thick here. You will note the lake level of Shoepac Lake is 90 feet above the dry bottom of the next sinkhole to the east. An hydrologic curiosity, to be sure.

NOTE: A pleasant path goes all the way around the four sinkholes to the east and returns to Shoepac Lake. Convention field-trippers check with you leader to see if we have time to partake of this pleasant interlude.

The Department of Natural Resources Forestry Division is trying to reduce vehicular traffic to this area in an attempt to save the sinkholes. Motorcyclists have wreaked much havoc in the fourth sink and have created a serious erosion problem.

Return to Tomahawk Lake Road.

To Stop #3

00.0	(00.0)	Turn left on Tomahawk Lake Road (County Rd 634) and proceed eastward through Black Lake State Forest to Rainy Lake.
00.1	(00.1)	Entrance to Tomahawk Lake Campground on right. Proceed straight ahead.
01.9	(01.8)	Fork, bear left. Right fork goes south to Canadian Lake Tower.
03.9	(02.0)	T-intersection. Turn right and follow County Road 634 as it curves to left.
04.7	(00.8)	T-intersection. Turn right.
06.7	(02.0)	Intersection. Turn right on Rainy Lake Road. You may have noticed the rows of No Trespassing signs on both sides of the road as soon as we left the state forest. Northeastern Lower Michigan is known as Hunt Club Territory. Back in the 1920's, 30's, and 40's when all of this desecrated burned-over forest land was going begging for tax title, and when the state was glad to get rid of it for a few dollars per acre, much of it was grabbed up and accumulated by southern Michigan, Ohio, and Indiana deer hunters. These are now maintained as private clubs for members and guests. The deer hunting prospects are excellent at the present time. Maturing forests, unless they are systematically harvested, will destroy the second growth habitat and diminish the herd. Partridge and woodcock are also popular hunting targets in this area in the Fall.
07.5	(00.8)	Intersection with North Shore Drive. Proceed straight ahead.
07.7	(00.2)	Rainy Lake.
09.5	(01.8)	Follow lead car around South Shore Drive to public access on northeast corner of lake. Park close along side the road so as not to impede traffic.

Stop #3

Rainy Lake is collapse valley made up of a series of secondary sinkholes of various size and depth that have coalesced into a single lake basin. Rainy Lake is karst controlled and has been known on three occasions, at least, to have drained partially or completely. We have pictures and accounts of the 1927 draining which show it completely dry and resembling a badlands canyon. In 1955, the lake level unexpectedly dropped 4 or 5 feet. When enough sediment replugs the karst system, the lake refills.

See pictures on inside front cover of guidebook showing Rainy Lake when it was unexpectedly drained in 1927. Similar occurrences in 1904 and 1955 are known.

To Stop #4

Return to Rainey Lake Road.

00.0	(00.0)	Head north on Rainy Lake Road. Keep caravan together please.
01.1	(01.1)	Turn right on County Road 634.
01.6	(01.5)	Follow road to right.
03.1	(00.5)	Follow road to left.
03.6	(00.5)	Turn right and follow winding road uphill.
04.2	(00.6)	Entrance to Rainy Lake Ranch. This is a private resort and hunt club. They do not welcome drop in visitors. Note the hostile signs at the entrance and along the entrance road. Please, ask at the convention desk to ascertain whether permission to visit this site has been secured by the field trip organizers. Do not enter upon this property without securing prior permission.
00.5	(04.7)	Rainbow Lake Lodge.

Stop #4

Rainbow Lake Sinks. This is a similar arrangement of secondary sinkholes with two of them dry in close proximity to a third water-filled sink. Here the dam or saddle between is even narrower than at Shoepac Lake. There are small lakes at the bottom of the two so-called dry sinks but the 90 foot difference in water levels is again apparent. Another hydrologic puzzle. Please note the prominent leaks in the "dam".

To Stop #5

Return to County Road 634.

00.0	(00.0)	Turn right on County Road 634.
00.2	(00.2)	Fork, bear right. Road on left goes to Kelsey Lake, a water filled secondary sinkhole.
00.9	(00.7)	Fork, bear left and continue on County Road 634.
01.9	(01.0)	Note cedar swamps on right and left. Areas similar to this are preferred winter deer yards and are the determining factor in the size of the deer herd.
04.1	(02.2)	Fork, proceed straight ahead on County Road 634.
04.4	(00.3)	Lake Ferdelman on left. This lake and Lake May, Lake Emma, Horseshoe Lake, Lake Ruth, and other lakes in the area are water filled secondary sinkholes.
05.1	(00.7)	Road turns to the left.
06.4	(01.3)	Road turns sharply to right. Stay on County Road 634 which proceeds generally east and north.
08.9	(02.5)	Turn right.
09.9	(01.0)	Cross County Road 451. Please close-up caravan.
17.0	(07.1)	Turn right on Leer Road.
19.0	(02.0)	Turn left on Thunder Bay Highway.
19.6	(00.6)	Entrance to Stanley Sobek farm.
20.1	(00.5)	Proceed between barns to right and park in pasture before you get to the wheat field. Continue on foot to swallow hole and cone-shaped entrance to Bottleneck Sink.

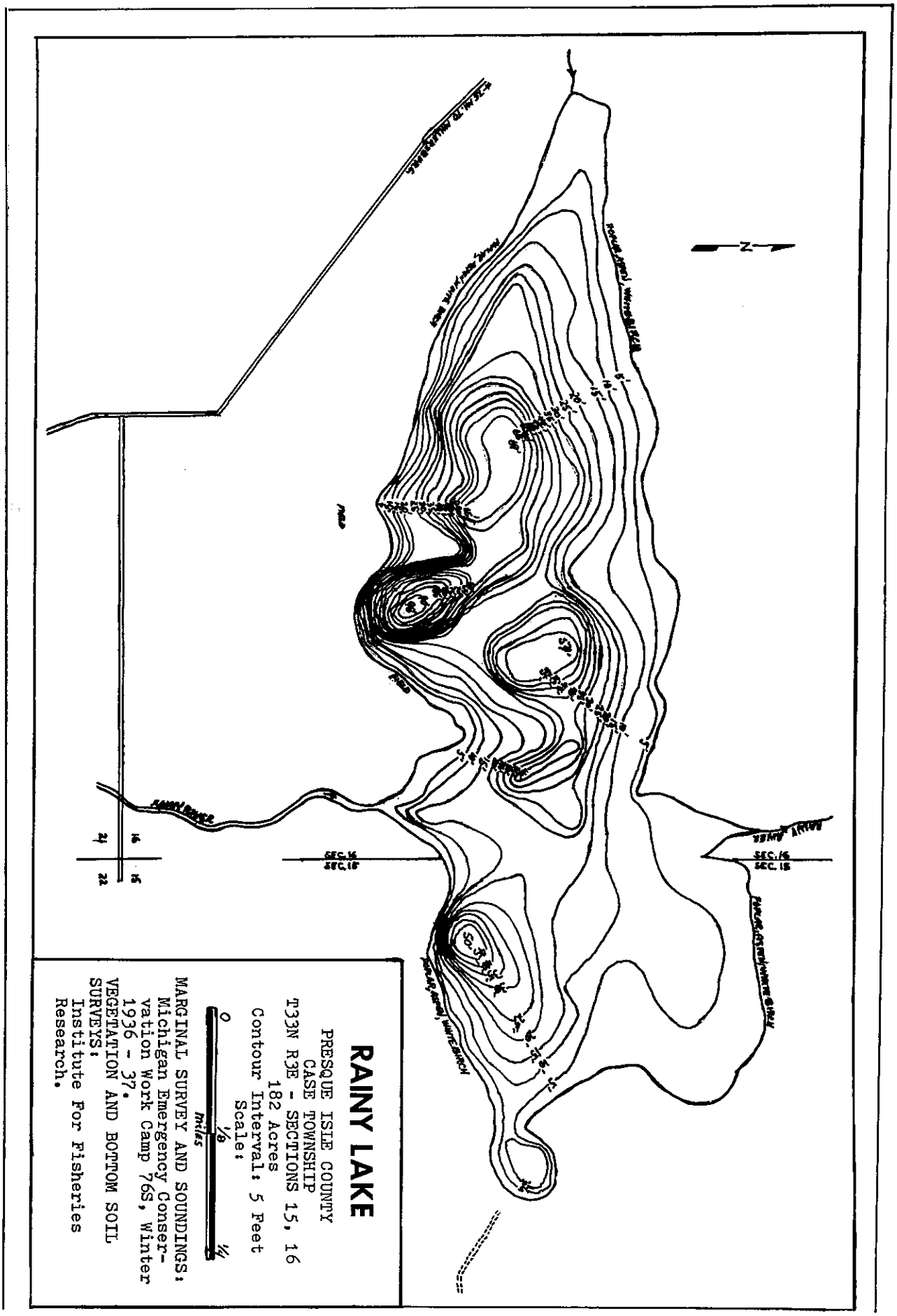


Figure 6: Hydrograph of the bottom of Rainey Lake. Note the sink holes that coalesce to make up this lake basin.

Plate I-3: Overall scene showing the site of the swallow hole and Bottleneck Sink. Note two circles in field in upper right of picture. Are these uncollapsed sinkholes? They are the correct diameter. As soon as practicable we will have George Henry run an electrical resistivity line across these strange features to determine what is underneath.

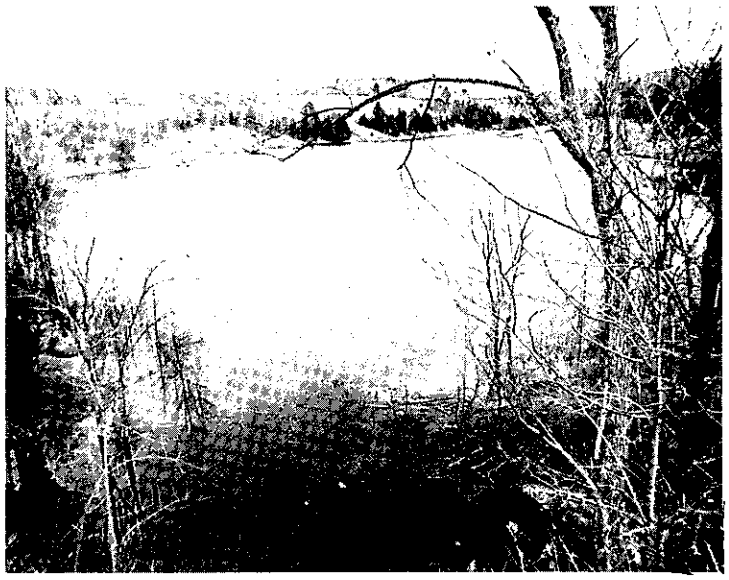
Stop #5

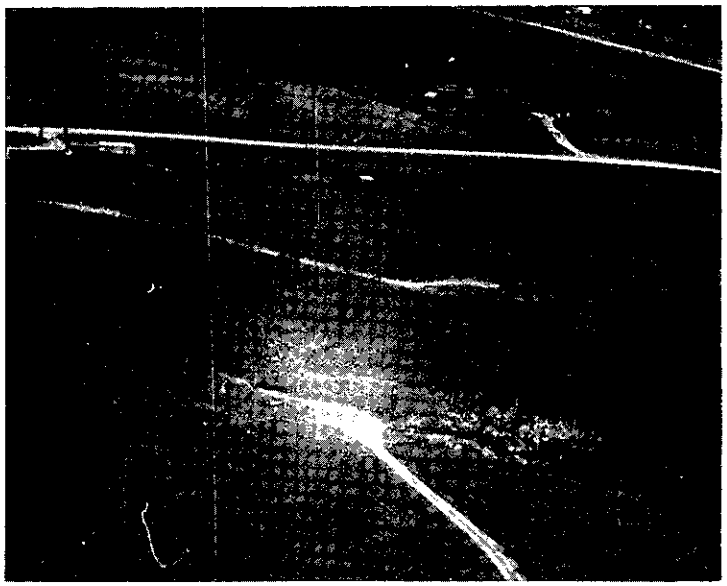
Bottleneck Sink. The stream enters the swallow hole in end of the short collapse valley, travels 200 feet underground and tumbles into Bottleneck Sink in an 80 foot waterfall. If the stream is running this time of year, you will be able to hear the crashing of water. The water enters the broken rubble at the bottom of the sink and disappears. There are no visible leads off from the bottom of the sink although there must be some channels beneath the rubble piles. There are no formations in the cave. Individual members of Michigan Interlakes Grotto have entered Bottleneck Sink on a few occasions. Former NSS President Rand Curl yo-yoed a television crew into the sink for the Michigan Outdoors program in 1970. The cone shaped entry makes descent into th mistake
the sink very difficult. The edges are extremely unstable and, depending on the flow rate of water, you might have to descend into the waterfall. Entry should only be attempted by experienced vertical cavers. The NSS Vertical Section may hold some activities here but you should check at registration desk for information. Bottleneck Sink is on private property. Do not attempt to visit this sink without prior permission of the land owner. Mr. Sobek will not grant permission to enter the sink unless the officers of the Michigan Interlakes Grotto can assure him that the caver is an experienced and certified NSS vertical caver.

To Stop #6

00.0	(00.0)	Return to Thunder Bay Highway. Turn left (west) on Thunder Bay Highway.
00.6	(00.6)	Turn left on Leer Road.
00.7	(00.1)	Collapse valley and small sinkhole on west side of road. Local people tell us that this used to be an entrance to a small cave that ran off to the southeast beneath the road. Road fill supposedly covered up the entrance to the cave. Unconfirmed.
01.5	(00.8)	Historic Elowski Mill on right. One mile to the west is a mile long collapse valley.
02.1	(00.6)	Former gift shop and visitors center at foot of Mystery Valley.

Park cars close beside road and follow the trip leader on foot to the foot of the valley.





Plates I-4, 5, 6: Scenes of Mystery Valley both dry, during the summer and fall, and partially filled with water in the early spring.

Stop #6

Mystery Valley is a large karst collapse area that runs about one mile to the east. There is a sinkhole on the west end of the Valley. During logging days when it was essential to be able to float logs down area rivers to the saw mills at Alpena, this sink caused problems. Spring floods on the Thunder Bay River, which crosses the valley, would be diverted into Mystery Valley where the water would disappear down the sink. Legends abound about logs and loggers being carried down the maelstrom in the sink, later to triumphantly reappear in Thunder Bay or Misery Bay on Lake Huron. They make nice stories, especially appealing to the cavers looking for a big cave in this area, but they are pure poppycock. The spring flood entering the sink became intolerable. In 1899, a dam was built across the middle of the valley, thereby creating Sunken Lake, and preventing Thunder Bay

Plate I-7: Typical earth crack north of El Cajon Bay.

River water from entering the western part of Mystery Valley. The day was saved! However, Mystery Valley partially fills with water nearly every spring only to be slowly drained out through the sinkhole by early summer. It is a very picturesque valley, with or without water, in all seasons of the year. Drought conditions this year prevented the annual fill up.

Fletcher Park, surrounding most of Sunken Lake is the "official" campground for the Michigan Interlakes Grotto when we are working or "caving" in this area. It is a very pleasant place to camp. We are well known to the park management as the first campers to arrive in the Spring and the last campers to leave in the Fall. We have been snowed on many times.

There are some pleasant hiking trails in Fletcher Park. Several will lead you to the large bedrock cracks on the south side of Mystery Valley. Do not use these trails to enter the valley from the back no matter what they tell you at the park! The owner of Mystery Valley is very particular. He welcomes visitors, but only if they stop at his trailor first. He keeps several German Shepard watchdogs and a shotgun, but is very friendly if approached properly.

The stone building on the west end of the valley where we entered was erected by Arthur Poch when he attempted to commercialize Mystery Valley several years ago. Arthur Poch was the first man to enter Bottleneck Sink. He entered during early Spring when the cave was still filled with icicles and came out reporting that the sink was full of formations. This, of course, is not true.

Return to cars.

To Stop #7

00.0	(00.0)	Continue south on Leer Road.
01.0	(01.0)	Settlement of Leer. Turn left on Carr Road.
02.0	(01.0)	Leer Church. Entrance to Fletcher Park on left. Turn right on Leer Road again. Alpena and Presque Isle Counties were settled predominantly by Polish immigrants during the early part of this century. The Leer and Long Rapids areas were, however, settled mostly by Norwegians. Leer Church is a Norwegian Lutheran Church. This is in the heart of sinkhole country. The people here are very concerned about these karst features and the possibility of groundwater contamination that might result from using them indiscriminately as dumps.
03.0	(01.0)	Maple Lane Sink. This is a nice size sinkhole with vertical rock walls. In the past, there was a lot of dumping into this sink.
03.2	(02.0)	Sinkholes in fields on the right and left for the next half mile.
03.9	(00.7)	Stop along road and receive instructions from your trip leader. This is posted private property. If you enter this property and are ordered off, leave immediately or you will be subject to arrest. We could not secure permission to enter upon this property and you should not attempt to do so without such permission.

Stop #7

This string of sinkholes, beginning near the road and running for a quarter mile to the SSE, are known as the Four Holes, or the Dehring Sinks after their owner, Louis Dehring. The fourth, or east sink, is very spectacular and is believed to be the largest sinkhole in this quadrant of the country. It is about 350 feet in diameter and probably 100 feet deep. It has 80 foot vertical rock walls around most of its diameter, and can be easily entered by experienced free-climbing cavers. Eternally frozen ground at the bottom of this sink may be Michigan's only perma-frost. The large cedar log in the bottom of the sink was cut by a Norwegian lad in 1899. It fell the wrong way into the sink, which was two-thirds filled with water at that time. It is reported to us by oldtimers in the area that the fourth sink contained water until Sunken Lake Dam was built. When Sunken Lake filled up behind the dam, the water drained out of the fourth Dehring Sink. We haven't been able to figure out this hydrologic relationship and whether the two instances are interconnected. Anyone have any theories? During spring run-off, an

intermittant stream tumbles over the north side of the first sink and plunges to the bottom. The water immediately disappears into the rubble in the bottom of the sink. There are no known caves, holes, or cracks leading off from any of these sinks. The ground surface has many cracks, suspicious depressions, and swallow holes.
Reenter cars.

To Stop #8

00.0	(00.0)	Turn cars around and head north.
00.6	(00.6)	Turn right on Maple Lane Road.
01.2	(00.6)	Turn right into lane by old orchard and proceed past barn on the right to southeast corner of hay field. Leave cars and proceed across electric fence and through gate. Beware of fence. If there are cattle in the field, it will be charged. This again is private property. Please ask permission of the owner before entering.

Stop #8

This collapse area and intermittent swallow hole on the Harvey Hasen farm was reported to us by his son, John, who is very interested in the karst development in this area, particularly on their farm. A party of Michigan Interlakes Grotto cavers tried to dig into this suspected cave last summer without success
Last November, George Henry and I ran an electrical resistivity survey over this depressed area. The water table and bedrock surface could be easily interpreted from the data collected. George interprets the fall-off of resistivity over this collapse area as indicative that there is not an air filled cavern beneath this location. He believes it to be an indication of wet, drift-filled, honeycombed rock. Poof! There went our first scientifically located cave.

To Stop #9

Return to Maple Lane.

00.0	(00.0)	Turn right. Note the potato fields for next several miles. This marginal farmland produces wonderful potatoe crops making posen the Potato Capital of Michigan.
00.4	(00.4)	Turn left on M-65. Posen is 5 miles due north. A hepatitis out break in Posen in 1969 was directly related to water supplies secured from the local karst system.
00.9	(00.5)	Turn left on Maple Lane Road. The Posen area seems to be the topographic high point and is the hydrologic divide for this part of northeastern lower Michigan.
02.9	(02.0)	Turn left on Ohlrich Road.
03.2	(00.3)	Turn right on Maple Lane Road.
04.2	(01.0)	Jog right and left and remain on Maple Lane Road.
06.7	(02.5)	Turn right on Bolton Road.
07.3	(00.8)	Settlement of Bolton.
07.5	(00.2)	Stop. Cross Cathro Road and proceed straight ahead.
07.6	(00.1)	Turn right into dump.

Stop #9

Maple Ridge Township Dump. This is not our lunch stop! This shows you the extreme treatment of sinkholes in this part of Michigan. Effluent from this garbage and trash is probably pumped up in domestic water wells in the Long Lake and northern Alpena areas within a matter of hours. We have tried for years to stop this degradation. but it is probable that no relief will come until the DNR Resource Recovery Division and the Alpena County Commission can agree on a site for a couty sanitary landfill. This is a senseless perennial negotiation that has got to come to a head before long. The trash here is continually sinking. Does that mean that this karst feature is actively enlarging, perhaps assisted by added acidic waste and its effluent?
Return to Daggett Road.

To Stop #10

00.0	(00.0)	Turn left on Daggett Road.
00.1	(00.1)	Turn left on Cathro Road.
01.4	(01.3)	Pass through settlement of Cathro.
03.4	(02.0)	Turn left on Boilore Road.
05.4	(02.0)	Turn right on Truckey Road and follow it as it bears to the southeast and parellels the Detroit and Mackinac Railroad track.
07.5	(02.1)	Turn half left on Hamilton Road.
08.4	(00.9)	Cross US-23.
09.5	(01.1)	Cross Long Lake Road.
15.0	(05.5)	Turn right on North Point Road.
16.5	(01.5)	Hook a left.
16.8	(00.3)	Intersection with South Indian Dr. Bear left.
17.3	(00.5)	Proceed east to point where utility line crosses road. Follow trail to right into woods. Where trail crosses unnamed creek 1,000 feet forest, bear left and follow indistinct trail to crude duck blind at edge of Bay. If bay is dry, proceed to edge of the Big Hole.

Stop #10

This last stop of the field trip is to see the Big Hole of El Cajon Bay. The water level is down a couple feet in Lake Huron this year so we can practically walk out to the sinkhole. However, you will have to cross private property to get to the Bay. Do not trespass on private property unless you receive permission from the owner. Permission is being sought for convention field trippers.
El Cajon Bay, a shallow area of Misery Bay, contains two sinkholes. The Bay itself may be a shallow graben. Characteristic bedrock cracks run along the west side.
The Big Hole is about 200 feet in diameter and 80 feet deep. Two large springs enter on opposite sides near the bottom. There is ten feet of fine light silt on the bottom which is easily stirred-up spoiling underwater visibility. No member of the Michigan Interlakes Grotto has been in this sinkhole although many of us have canoed over it several times. Our underwater information comes from non-cavers who were evaluating this feature a couple years ago for inclusion in a proposed Thunder Bay Underwater Historic Park.
Plans were to have an oil-drum raft trolleyed across the Big Hole for conventioneering cave divers, but because of the low water this plan has been abandoned. We would like to hear from any cave divers who enter the Big Hole. We are seeking better information on depth, diameter, size, and shape of the springs and their discharge rate. We would also like to know if the springs can be pushed.
The second sinkhole in El Cajon Bay is a hundred yards SE of The Big Hole and is merely a cone-shaped depression about 150 feet in diameter and 30 feet deep. There are seven other bedrock springs in other parts of the bay.
Return to Cars.

Return Trip

00.0	(00.0)	You can return to the Alpena Community College campus by following these directions.
00.3	(00.3)	Turn right on North Point Road.
03.5	(03.2)	Large overburden tailing piles from Huron Portland Cement Company Quarry.
03.8	(00.5)	Large limestone quarry on right.
03.9	(00.1)	Cement plant.
04.1	(00.3)	Turn left on Wessell Road. (No street sign)
04.5	(00.3)	Stop Light at Ford Road. Turn left.
04.7	(00.2)	Turn right on Hueber Road.
05.0	(00.3)	Bear left on Adams Street.
05.2	(00.2)	Jog right and cross Long Lake Road proceeding straight ahead on Walnut Street.
05.5	(00.3)	Turn right on West Miller Street. Miller is a one way street going west and merges with oncoming Oldfield Street which in turn becomes Johnson Road when you cross the railroad Tracks. Thunder Bay River impoundment on left.
05.9	(00.4)	Besser plant on right. Jessie Besser invented the cement block manufacturing machine and it has been produced for national and international marketing at this plant since 1904. The late Jessie Besser financed and endowed the Jessie Besser Museum.
06.0	(00.1)	Important archeological site on the left along bank of the river. Large cache of copper and stone artifacts unearthed at this site. They are on display at the Besser Museum.
06.4	(00.4)	Alpena Community College. We have enjoyed showing you some of the major karst features in Northeastern Lower Michigan. We hope you will come back to this part of Michigan with us again, someday, to help us figure it all out. Have a nice convention.

Plate I-9: Aerial photo of El Cajon Bay clearly shows the two sink holes. This photo was taken during a low water cycle such as is now occuring. Note the small stream of water issuing from The Big Hole and finding its way to Misery Bay. This is discharge from the two springs at the bottom of the sink.

A SELF—GUIDED TOUR
OF GEOLOGIC POINTS OF INTEREST

By George Wood

The following is quite long for a single-day trip, but works very well as a pre- or post-convention tour. By eliminating Kitchitikipi (Big Spring) or by the judicious use of a road map, most of the points of interest can be visited in a single day.

Mileage Between Points	Cumulative Mileage	
0.0	0.0	Cheboygan and Ostego county line going north on I-75.
5.0	5.0	Entering Sturgeon River valley. The valley is broad because the Sturgeon River once carried large amounts of glacial meltwater south to the Broadman River and to Grand Traverse Bay. During Glacial Lake Algonquin times (11,000 B.C.), the Sturgeon River reversed its flow to the north.
11.6	16.6	Renewed downcutting has formed the present river valley, leaving the old one as a flat, broad terrace.
9.0	25.6	Turn off for Side Trip A. See end of tour for details.
14.5	40.1	The hills are moraines or mounds of clay, sand, and rock that were deposited by the Wisconsin Glaciation.
6.2	46.3	The bed of glacial Lake Algonquin. The sharp change in slope indicates where the shore of the lake used to be.
3.9	50.2	Gently rolling, very low hills with some swampland. The kind of terrain left by a glacier in rapid retreat. This is still Lake Algonquin bottom.
4.8	55.0	The Cheboygan moraine. On its northern side is the terrace left by Lake Nipissing (4,000 BC).
2.2	57.2	Fort Michilimackinac is on the left. The fort was built by the French to protect the trade routes through the straits. In 1761, it was occupied by the British when France surrendered her North American empire. In 1763, the British garrison was killed or taken prisoner during the Pontiac uprising caused by British maltreatment of the Indians. The fort was abandoned during the Revolutionary War because it was too hard to defend.
0.1	57.3	The Straits of Mackinac are a flooded river valley caused in part by collapse of the underlying Salina Formation and erosion during lower lake levels. Now mostly limestone and dolomite, the Salina Formation of the Upper Silurian Period once had tremendous salt beds. The collapse occurred during the Middle Devonian Period and was caused by leaching which lowered the area of the Straits and fractured more than 600 feet of overlying rock. The cavern must have been enormous!
3.9	61.2	At the north end of the Mackinac Bridge and to your right is Mackinac Island. It has many sea stacks, sea caves, and terraces left by Lakes Algonquin and Nipissing, and Fort Mackinac. The Indians reserved the island for hunting and religious use in an area where good soil was scarce. It is now totally tourist oriented but still beautiful.
1.9	63.1	St. Ignace, mission and trading post, is the oldest continuously occupied town in Michigan. Mackinac County is underlain by limestone and dolomite of Devonian, Silurian, and Ordovician Age. Major solution cavities exist at depth in the Burnt Bluff Formation, the Manistique dolomite, and the Engadine dolomite. These cavities are under artesian conditions and at depths below current lake levels. Many were formed when the lakes were 80 feet lower than the present level.
2.8	65.9	Castle Rock is formed in Mackinac breccia. The Mackinac Formation was shattered by the collapse of the Salina Formation. Some sections, such as Castle Rock, were later recemented together more tightly than others. Weathering of the surrounding rock leaves pinnacles of this type. They can also be found on Mackinac Island.
3.8	69.7	Exit from I-75 onto M-123 North.
22.9	92.6	Trout Lake. If you do not wish to see Lake Superior and Tahquamenon falls, turn left onto H-40 to reach Fiborn Quarry and proceed to mile 310.8 in log for directions.
32.6	124.6	Whitefish Bay and Lake Superior lie just north of Paradise. Take the 10 mile drive to Whitefish Point if you want to see them.
1.0	125.6	Turn left, north of Paradise, to stay on M-123.
10.7	136.3	Entrance to Lower Tahquamenon Falls.
3.6	139.9	Entrance to Upper Tahquamenon Falls. These forty foot falls and the smaller lower ones are caused by the land upstream rising faster than that downstream. The entire Michigan Basin is rebounding after having been depressed by the weight of the ice during Wisconsin Glaciation.

Plate I-13: The natural bridges entrance to Hendrie River Water Cave.

Plate I-14: Dye tracing the stream in Hendrie River Water Cave.

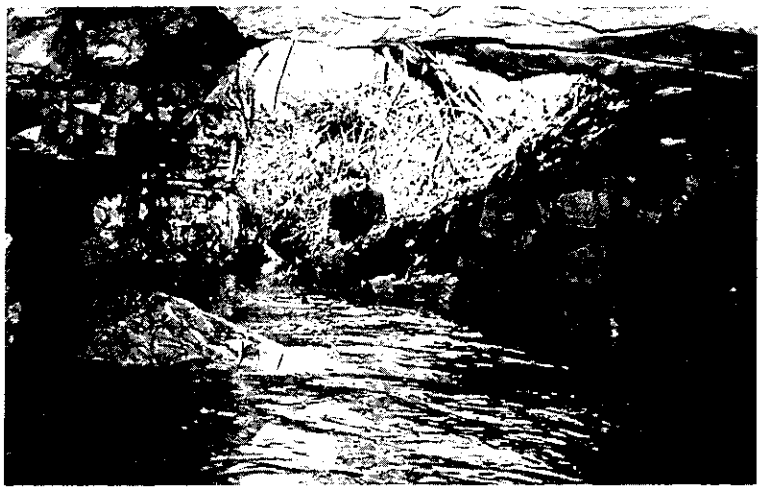


Plate I-15: Hendrie River Water Cave is aptly named.

Plate I-16: Kochab Cave has less water, but more mud than neighboring Hendrie River Water Cave.

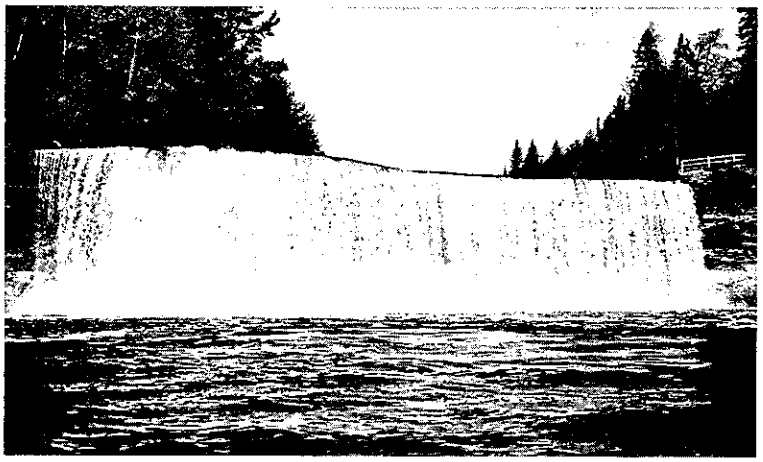
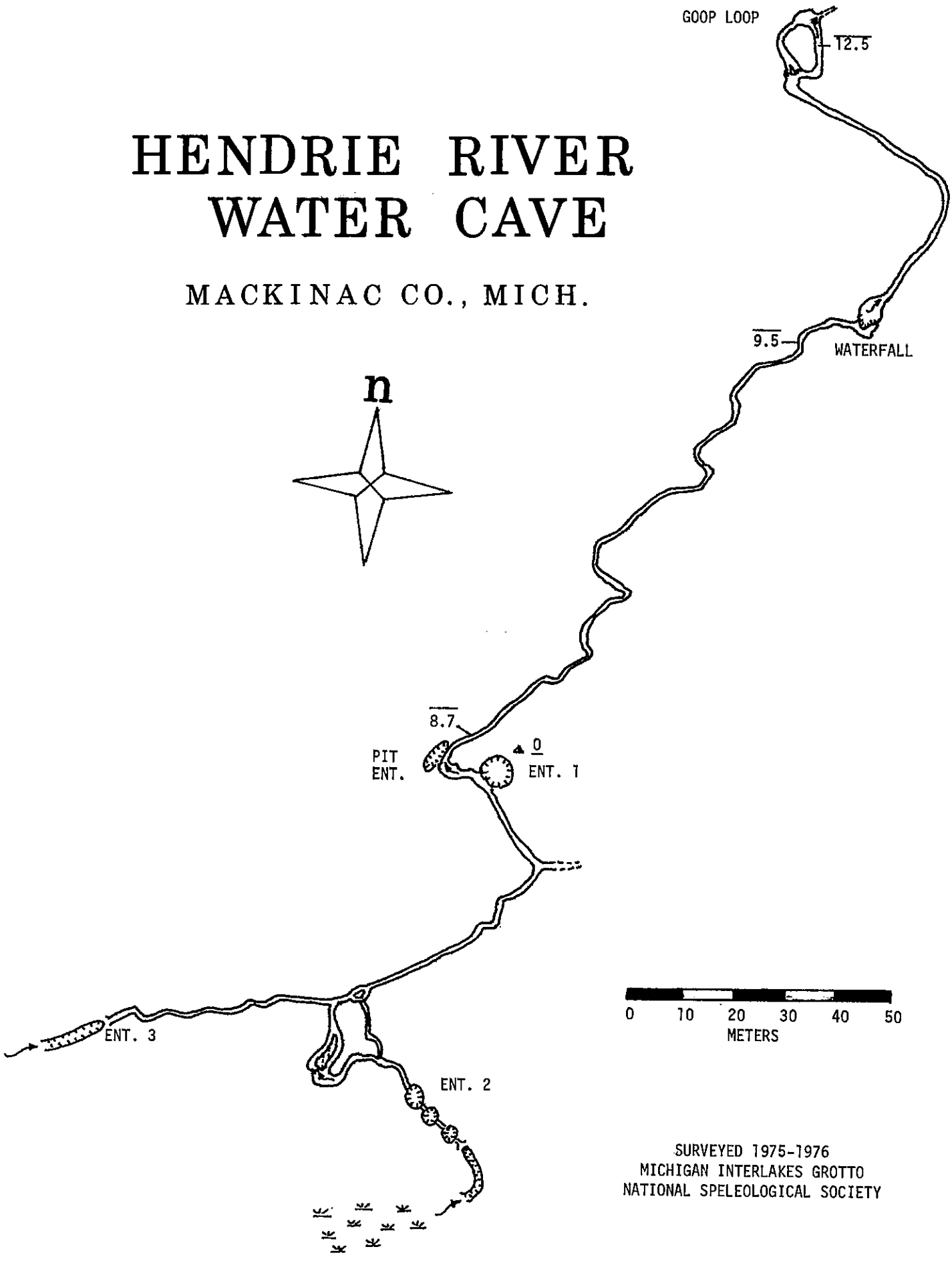


Plate I-17: Tahquamenon Falls in the Upper Peninsula.

Plate I-18: Kitchitikipi, Michigan's largest spring.

HENDRIE RIVER WATER CAVE

MACKINAC CO., MICH.



SURVEYED 1975-1976
MICHIGAN INTERLAKES GROTTO
NATIONAL SPELEOLOGICAL SOCIETY

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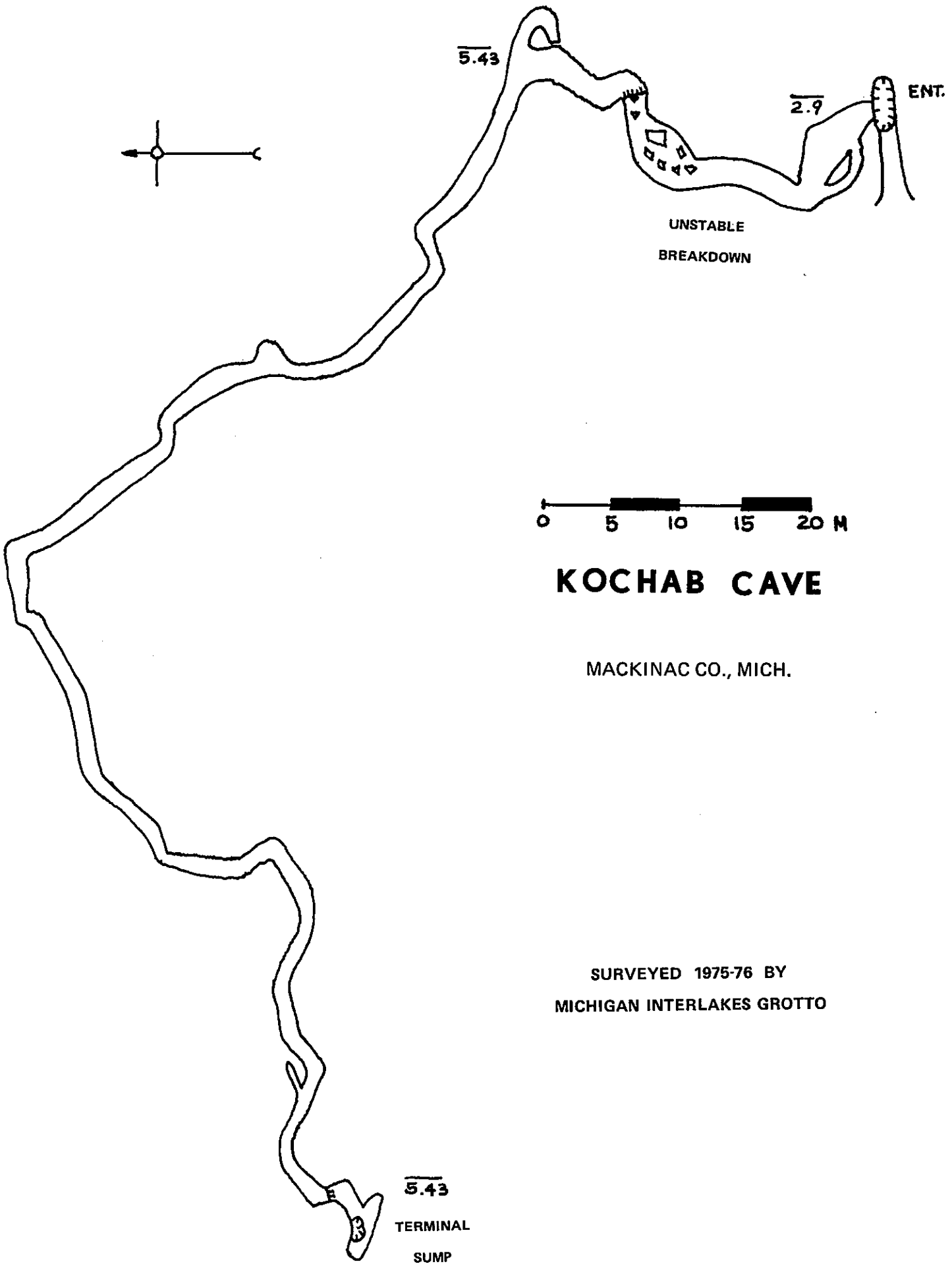
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MACKINAC CO., MICH.
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TERMINAL
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23.1	163.0	Newberry, the seat of Luce County and the largest town for many miles around. Like the rest of the eastern half of the northern peninsula, this area is largely flat with a few morraines. Lake beaches, bars, and dunes can occasionally be spotted throughout Mackinac and Luce Counties, most of which were covered by Lakes Algonquin and Nipissing.
3.0	166.0	Turn right onto M-28.
3.0	169.0	Turn left onto M-117.
14.0	183.0	Turn right onto U.S. 2. The reason you see so many small trees in this area is that Michigan was completely lumbered off in the late 1800's and early 1900's.
6.2	189.2	Turn left to reach Gould City.
33.9	223.1	Manistique. Continue on U.S. 2 until it makes a sharp left. At this point, going straight ahead will put you on M-94.
4.7	227.8	Turn right onto M-149 and follow it to Big Spring Park.
8.0	235.8	Big Spring, or Kitchitikipi, is a large rise. A small, hand powered barge allows visitors to view the bottom and its boiling springs It has a flow of 30-40 C.F.S. and water analysis shows it to be high is SO_4^2 and CO_3^2. It is formed in the Cataract and Burnt Bluff Formations of Lower Silurian Age. They are limestone and dolomite. The Cataract Formation also has shale and gypsum. Reverse directions and travel south to M-149.
8.0	243.8	Turn left onto M-94.
4.7	248.5	Continue straight onto U.S. 2.
40.1	288.6	Turn left onto M-117.
1.6	290.2	Turn right on H-40.
20.6	310.8	Entrance to Fiborn Quarry. The Fiborn member of the Burnt Bluff Formation, part of the Niagaran series of Middle Silurian Age, was quarried here. Fiborn limestone is exceptionally pure and was used in manufacturing calcium carbide and refining iron. There are several small caves located on the quarry sides. Hendrie River Water Cave and Kochab Cave are not far away.
8.0	318.8	Trout Lake. Turn south onto M-123.
22.9	341.7	Enter I-75 South.
12.4	354.1	Exit I-75 to U.S. 23 East and follow it to Alpena.

SIDE TRIP A

9.0	25.6	Exit I-75 North to M-68 East.
Approx. 7 miles.		Turn left onto M-33. Near Legrand, M-33 crosses a seven mile long esker. Eskers are deposits of sand and gravel left by streams running at the bottom of a glacier. They are usually long, sinuous mounds with steep sides, and narrow in width. Generally, flat, swampy areas lie on either side of them.
Approx. 2 miles.		Proceed north about two miles on M-33. The highway passes through a field of drumlins. Drumlins are glacial deposits of unknown origin. They occur in relatively few areas and always in swarms. they are generally elongated with the long axis subparallel. While in the area stop at Mullett Lake to see the terrace left during the Lake Nipissing period.
		Continue north on M-23 to M-27. Turn right on M-27 and follow it to U.S. 23. Turn left on U.S. 23 and follow it north. Much of U.S. 23 is built on a beach terrace left on the Cheboyan moraine by Lake Nipissing.

GYPSUM KARST AND RELATED FEATURES IN THE MICHIGAN BASIN

by: R. C. Elowski, Geologist
A. G. Ostrander, Geologist

Introduction

In the fall of 1976, Mr. Neal Garceau, Manager of the Grand Rapids Gypsum Company, was contacted by the authors in regards to possible karst features in the Grand Rapids area. During the course of the conversation, it was learned that during normal mining operations, a cavern had been discovered in the gypsum seam which they were currently working. This resulted in several field trips to the mine and the following study of the cavern and related gypsum karst features in Michigan.

History of Michigan Gypsum

In 1827, gypsum was discovered along Plaster Creek in the southwestern part of Grand Rapids in western lower Michigan. The first mill was built on Plaster Creek in 1841 near the crossing of the Grandville Road. Most of the gypsum was ground into land plaster. Ten years later, 60 tons were produced daily. In 1843, gypsum was discovered on the north side of Grand River, and in 1849, a mill was built near the site of the Eagle Mill No. 1 of the Grand River Plaster Company (now the Grand Rapids Gypsum Company). A second mill, the Eagle Mill No. 2, was erected on neighboring property in 1869. By 1890, Michigan was one of the leading producers of gypsum and for the last 40 years has ranked second among the states in domestic production.

Currently, the Grand Rapids Gypsum Company is operating an underground mine on Butterworth Highway, west of Grand Rapids. They are using the room and pillar technique of mining. The Gypsum Seam No. 2, in which the cave is located, has just been mined out under their property. They are currently opening a second working level in Seam No. 4 (see Figure 1).

In 1838, Bela Hubbard, along with Dr. Douglass Houghton, discovered gypsum in the mouth of the Aus Gres River in Arenac County on the west side of Saginaw Bay. In 1862, the first mill was constructed at Alabaster, Michigan. Major mining in the Bay area at Alabaster began in the 1860's, and has since become the most important gypsum mining area in Michigan.

Most of the gypsum ore is processed in Grand Rapids, National City near Alabaster, and in Detroit. It is used in plaster board, lath, and plaster. The uncalcined (non-heated ores) gypsum is used as a cement retarder.

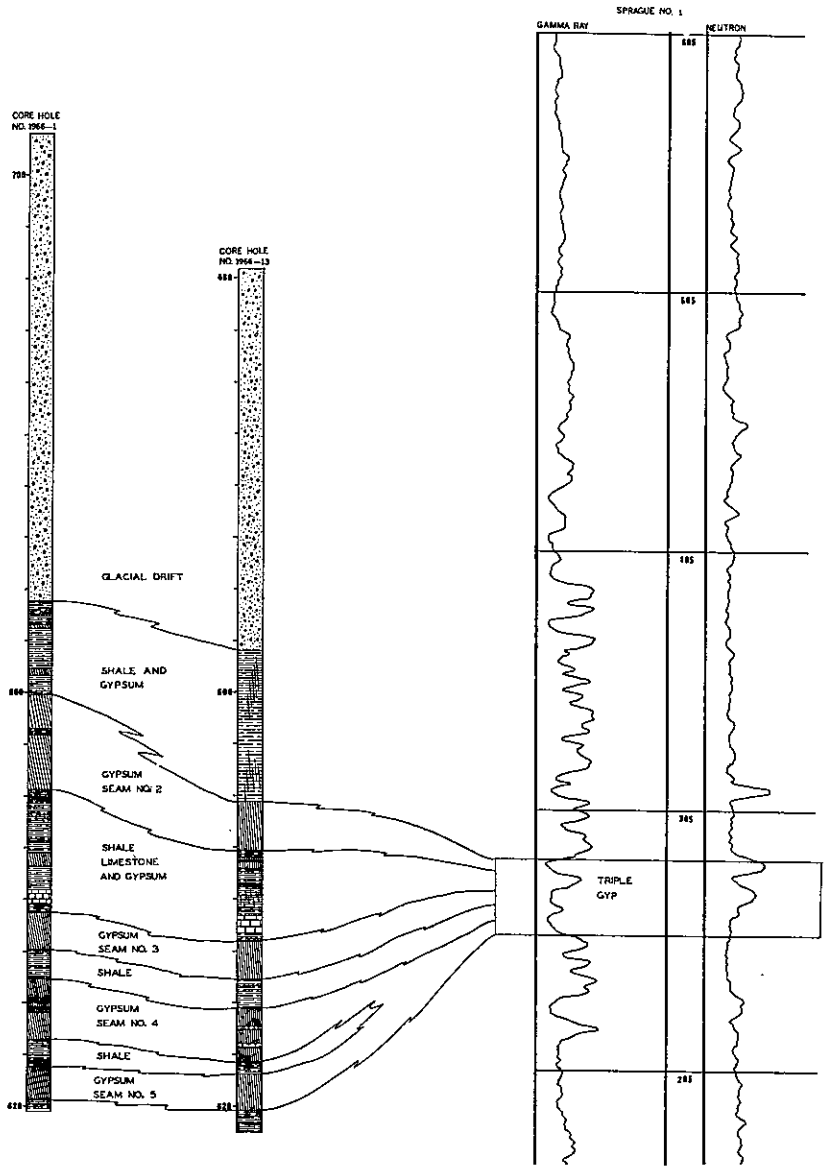


Figure 1: This cross-section shows the subsurface Gypsum seams which are being mined by the Grand Rapids Gypsum Co.. The Gypsum is labled on the left in the two core borings preformed by the above mentioned company. The Gypsum seams are correlated to the mechanical logs of an exploratory oil test well in Boston Township of Ionia County. The mechanical logs are on the right side of the cross-section. The Triple Gyp zone of the exploratory oil test well Sprague No. 1, which the Gypsum seams in the mine correlate to, are in the boxed section of the mechanical logs. Note the vertical scale of the core borings is not the same as that of the exploratory oil test well mechanical logs. The footages used on the cross-section are elevations above sea level.

Description of Michigan Formation

The cave and mine are in gypsum beds in the stratigraphic section known by geologists as the "Michigan Formation". The formation consists of a series of shale, dolomite, gypsum, limestone, and sandstone beds which outcrop below the glacial drift over a large part of the Lower Peninsula of Michigan (see Figure 2). These beds are of late Mississippian Age.

During the drilling of numerous petroleum test wells through the Michigan Formation in this area, it became apparent that certain rock layers within the formation were easily correlatable from one well to the next by sample descriptions and electric log configurations. These layers were given informal names by the drillers; such as "Pencil Gyp", "Triple Gyp", "Brown Lime", etc. In Figure 1, two test borings by the Grand Rapids gypsum Company are correlated to a gamma ray-neutron log from the correlation that gypsum seams 2, 3, and 4 of the test borings are equivalent to the "Triple Gyp" section of the electric logs.

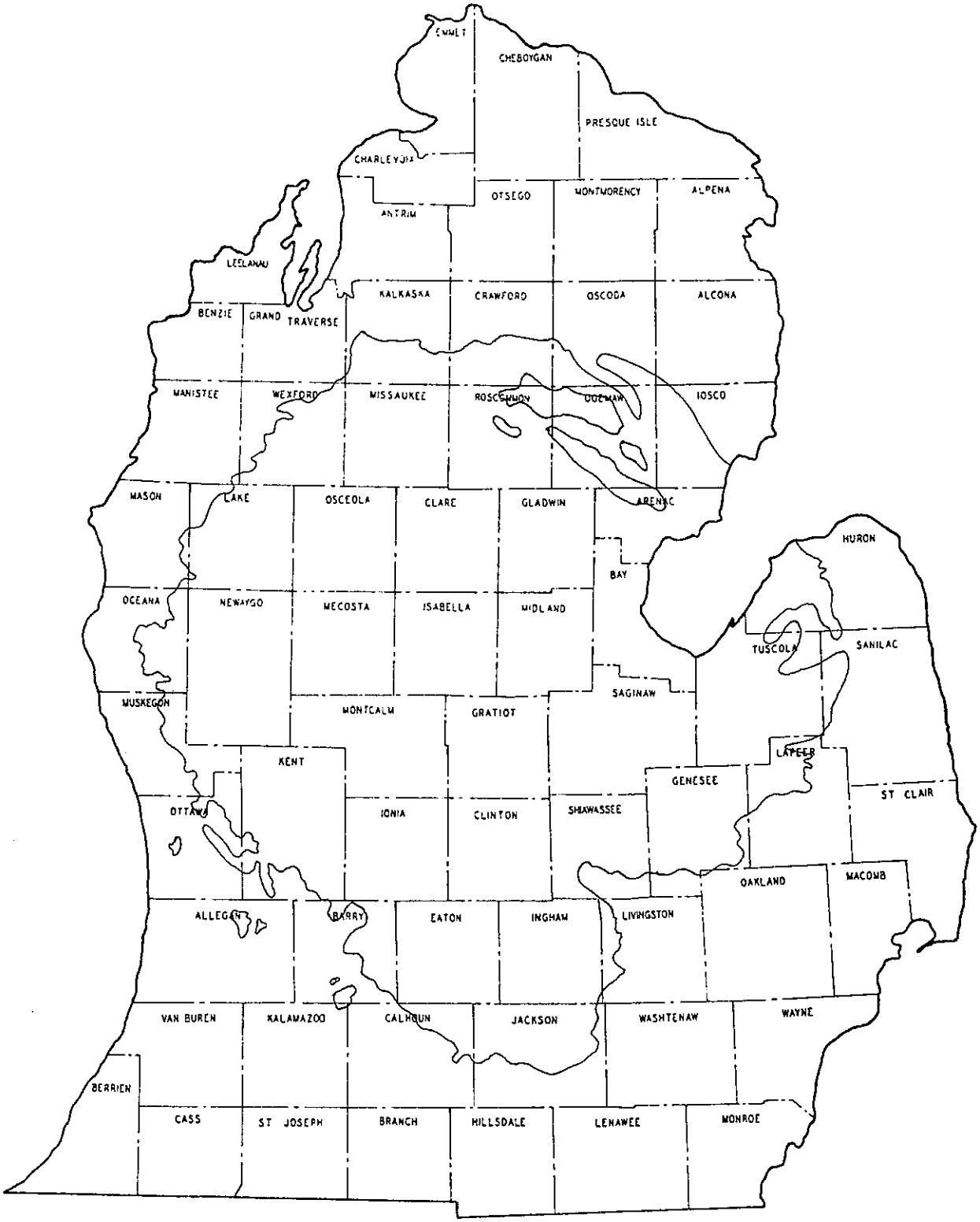


Figure 2: Map of southern Michigan showing extent of Michigan Formation beneath glacial drift. Outline is the zero thickness line where the formation pinches out from its thickest section in about the center of Missaukee County.

Pellerito Cave Description and Possible Theory of Formation

The cavern in the Grand Rapids Gypsum Company mine was discovered on the weekend of July 4, 1976, during normal mining operations. Bore holes for explosives were being drilled into the mine walls. After drilling a two-inch hole for seven feet, no resistance to the auger was encountered. When the auger was removed, confined air under pressure was reported escaping from the hole for twenty-eight hours. The mine wall was then pushed in, exposing a 100 meter cavern. The first person to enter the cavern was mine foreman Russell Pellerito, after whom the cave was named. He reported the air to be very thin as he and his crew proceeded toward the far end of the cavern.

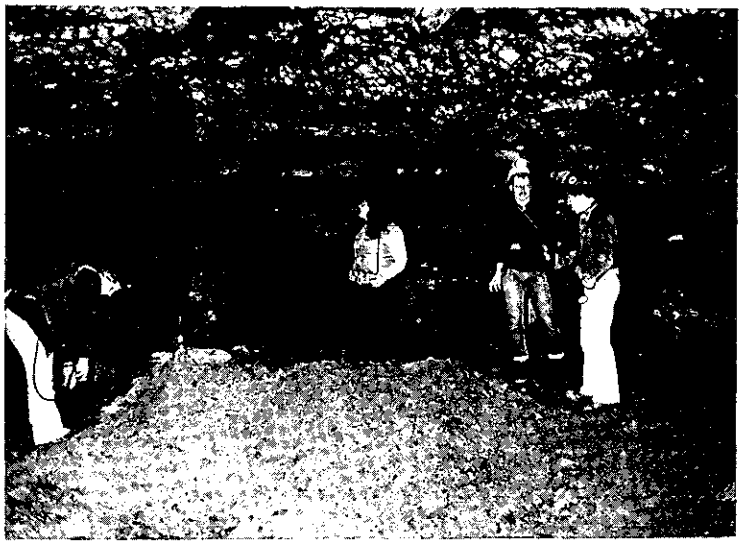


Plate I-9: Russ Pellerito (light pants), first person in Pellerito Gypsum Cave, and visitors.

Subsequent trips to the cavern by the authors and members of the Michigan Interlakes Grotto of the National Speleological Society resulted in a survey and map (Figure 3) of Pellerito Cave.

The cave can only be entered from the mine. It trends in a southerly direction about one quarter mile southwest of the mine entrance. The survey was started at the farthest end of the cave and terminated at a survey station in the mine (see Figure 3). While examining the cave, it was noted that sand, of possible glacial origin, was present in the far end. The presence of this sand would indicate that at one time the cave was opened to the drift; the drift being a possible source of the water which carved the cave. This entrance, now sealed, probably collapsed as the relatively soluble gypsum was dissolved away from under a sequence of gray-green shale and dolomite of the Michigan Formation. There is little or no evidence as to where the water drained, but the cave floor is covered with large amounts of shaley debris sloughed off the ceiling, which may be blocking the drain. At the time of the survey, there were some pools of standing water, particularily at survey station #8 (see Figure 3), but no flowing water and only traces of dripping water in the cave itself.

The cave walls grade upward from a white massive gypsum to a pink nodular gypsum to a roof of interbedded gray-green shale and dolomite. The cave walls are marvelously fluted due to flowing water (Plate 1). All characteristics indicate that at one time large amounts of water moved through this area, possibly at a fairly high velocity (Plate 2).

Other Karst Features in the Grand Rapids Area and Iosco County

Other than Pellerito Cave, which can only be entered from inside the mine, karst features in the area consist of secondary sink holes. In Figure 4, the main office of the mine has been circled. West of the circled area on the map, near the intersection of Collingdale Avenue and O'Brien Street, a closed depression is indicated by the contour lines. This depression is thought to be a sink hole caused by solution and collapse of underlying gypsum beds. Because the extent of the abandoned and unused portions of the mines in the area is not

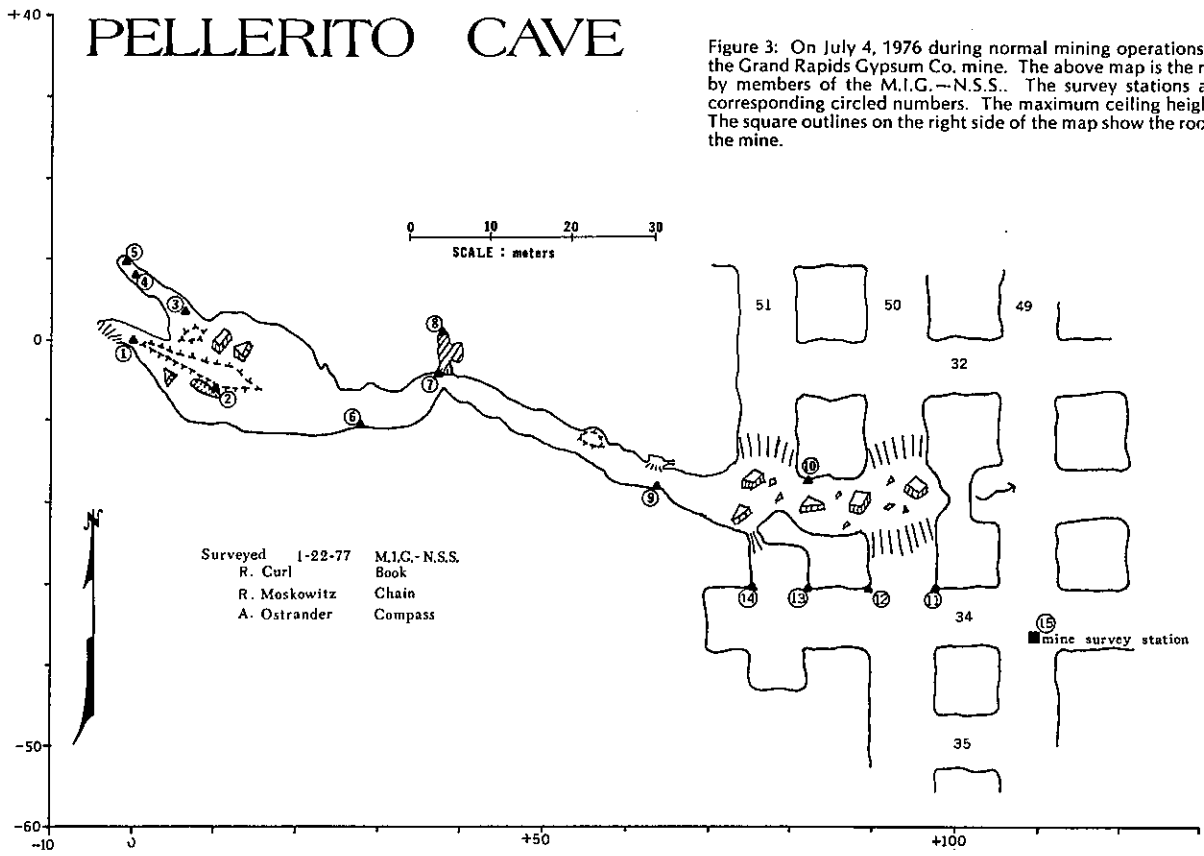
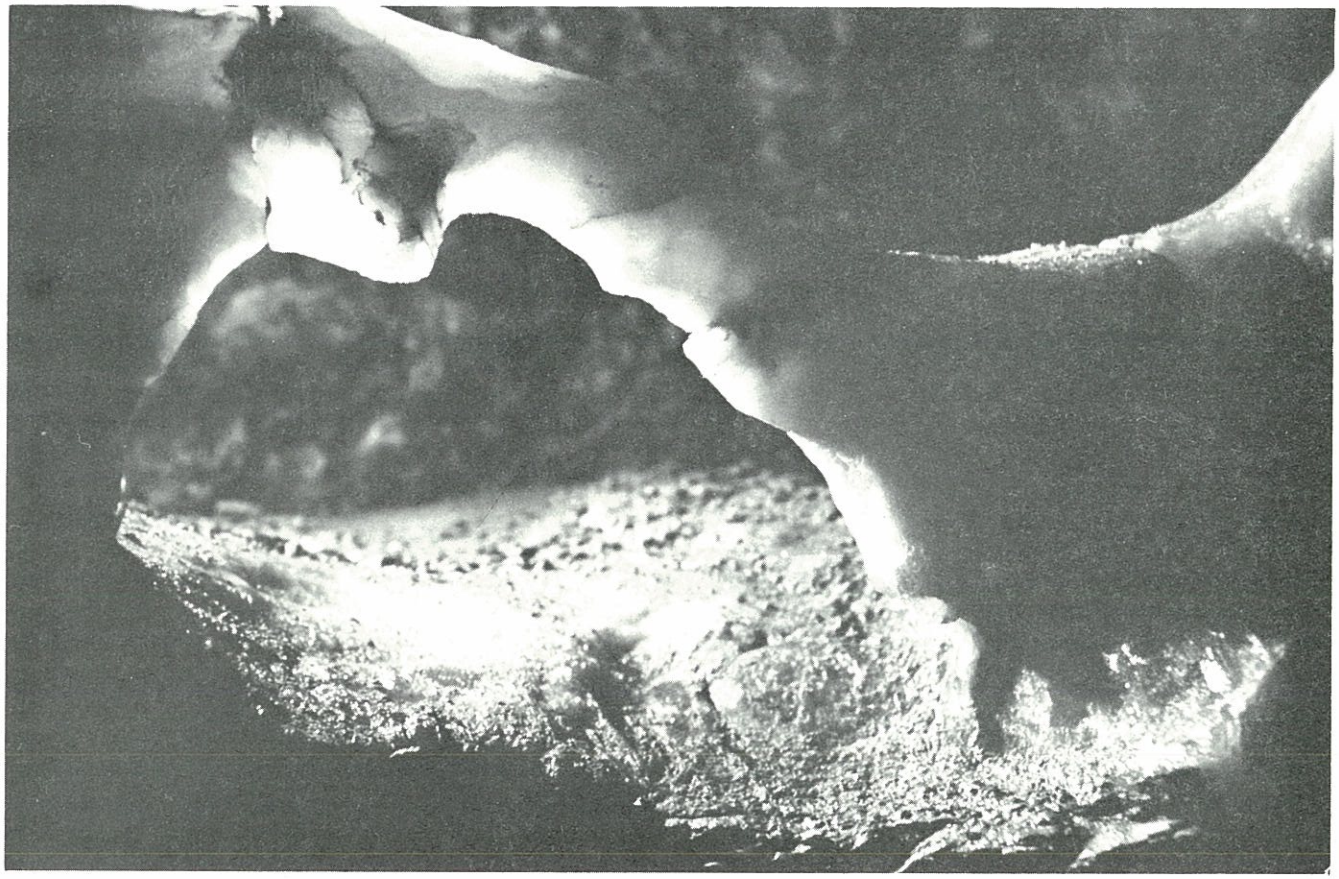


Figure 3: On July 4, 1976 during normal mining operations a cavern was discovered in the Grand Rapids Gypsum Co. mine. The above map is the result of a survey preformed by members of the M.I.G.—N.S.S.. The survey stations are the black triangles with corresponding circled numbers. The maximum ceiling height is an estimated 3 meters. The square outlines on the right side of the map show the room and pillar arrangement of the mine.



Plates I-10, 11: The above pictures show the fluted nature of the cavern walls due to water solution.

Plate I-12: The above picture is a waterfall in the Grand Rapids Gypsum Mine. This is located some distance from the cavern in the mine. This shows the high volume of groundwater that is moving in this area. This activity dissolves gypsum and causes subsurface cavities.

fully known, it can not be stated with certainty that the above-mentioned sink hole, as well as other depressions in the area, are natural karst features. The authors have heard rumors of problems with collapsed streets in this area, possibly due to gypsum solution activity. In any event, the existence of the cave itself would indicate the existence of at least some natural karst beneath the glacial drift in the Grand Rapids area.

Other known gypsum related karst in the state is prominently exhibited on the Elmer A. White and neighboring farms near the intersection of Hattis and Dyer Roads in Section 32 of Burleight Township of Iosco County. (see Figure 5).

On these properties, a linear string of collapse features consisting of several sink holes and sink valleys–some dry and some water filled–can be observed. The most recent collapse was reported on the White farm in early spring of 1968. Strong water currents at depth were related by ice cutters working the largest of the sink lakes in the early 1930's. Many other depressions, closed topographic lows, and internal drainage features indicate that this area in eastern Michigan is the locale for many other active karst systems awaiting investigation.

The karst areas of Iosco County are due to gypsum solution of the same formation as in Grand Rapids, which is the Michigan Formation of upper Mississippian Age. The Michigan Formation dips gently at the estimated rate of 35 feet per mile in a southwesterly direction, the opposite direction of the same formation in Grand Rapids. This is due to the saucer-type deposition of rock layers in the Michigan Basin.

The gypsum beds of the Michigan Formation can be seen at three separate locations in Iosco County. One is the open pit quarry four miles southwest of National City, operated by the Michigan Gypsum Company. Another is operated by National Gypsum Company and is located eight miles west of Tawas City. The third is operated by United States Gypsum Company which is west of Alabaster, Michigan.

Visiting Michigan's Gypsum Karst

No formal field trips to Pellerito Cave or the Iosco County sink hole areas have been planned for the convention. Pellerito Cave cannot be visited while the mine is operating as the only usable entrance to the mine is also heavily utilized by mining equipment removing gypsum ore to the plasterboard plant. Visitors must be accompanied by mine personnel and must be wearing required safety equipment.

Anyone having a compelling reason for visiting Pellerito Cave may make his wishes known to the authors or the field trip chairman. Arrangements to make a post convention visit to the cave may be attempted if there is sufficient interest shown. In the interest of good cavern/mine owner relations, we would not recommend attempting individual arrangements. The mine entrance is gated and locked when not in operation.

You may make your own arrangements to visit the gypsum karst area in Iosco County. Road maps of Iosco County will be available from the field trip chairman. Elmer A. White, 3901 S. Hattis Rd., (Route 1, Box 264), Whittemore, Michigan, is very accomodation and will welcome any reasonable request to visit his property. He is employed during normal working hours, but if he has the time he will take you on a personally conducted tour of these interesting karst features. They are in good hands. He is dedicated to their preservation and has many interesting tales to relate about their history, use, and present condition.

A beaver family has moved into one of the water filled sinks on the White farm and they are busily cutting and stripping the branches from all of the poplar trees nearby. Beaver only live in running water. Do you suppose they are trying to tell us something?

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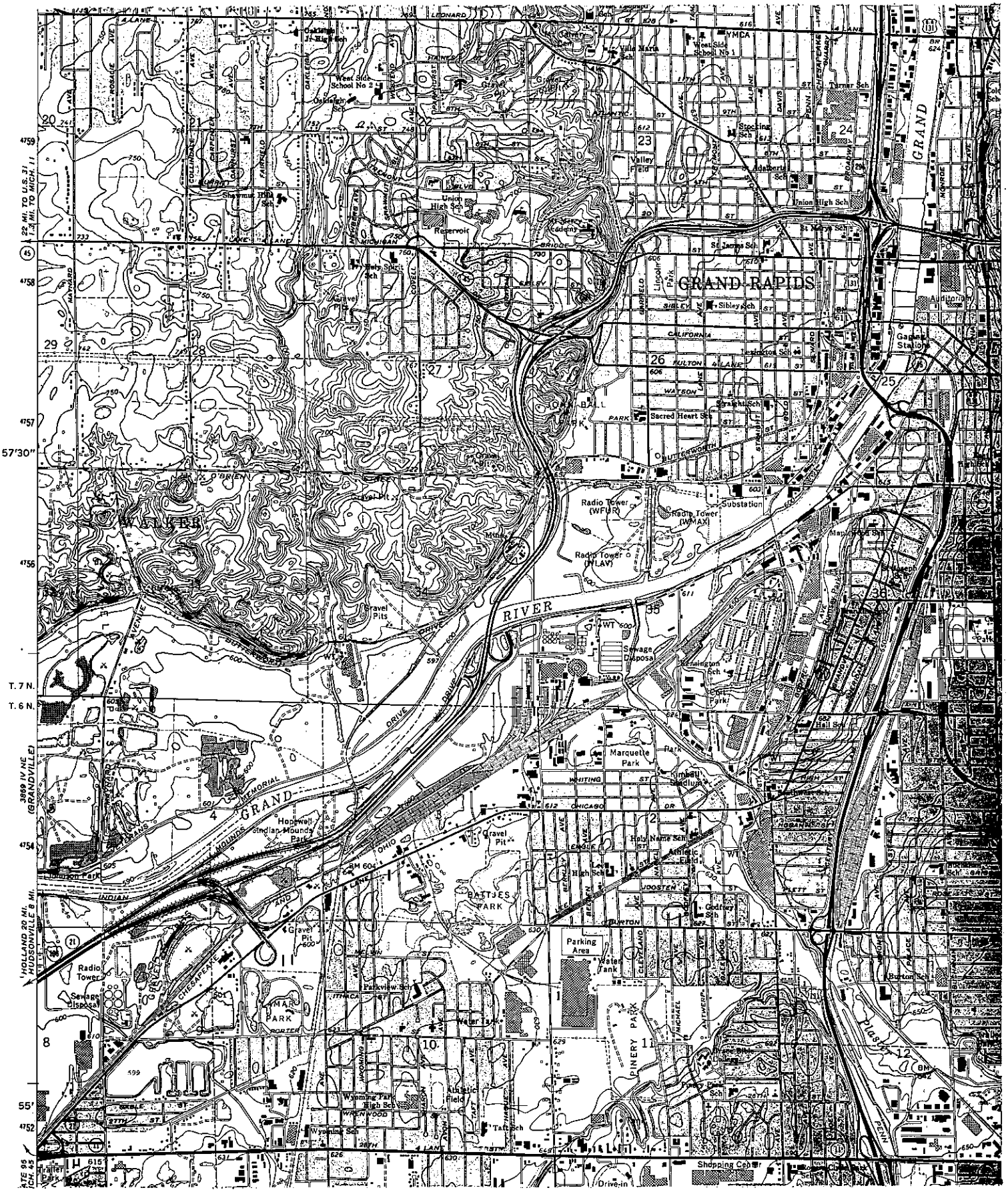


Figure 4: Above is a section of the Grand Rapids West Quadrangle printed by the U.S. Geological survey. The Grand Rapids Gypsum Co. office and mine location is circled. West of the circle are contoured depressions thought to be sink holes.

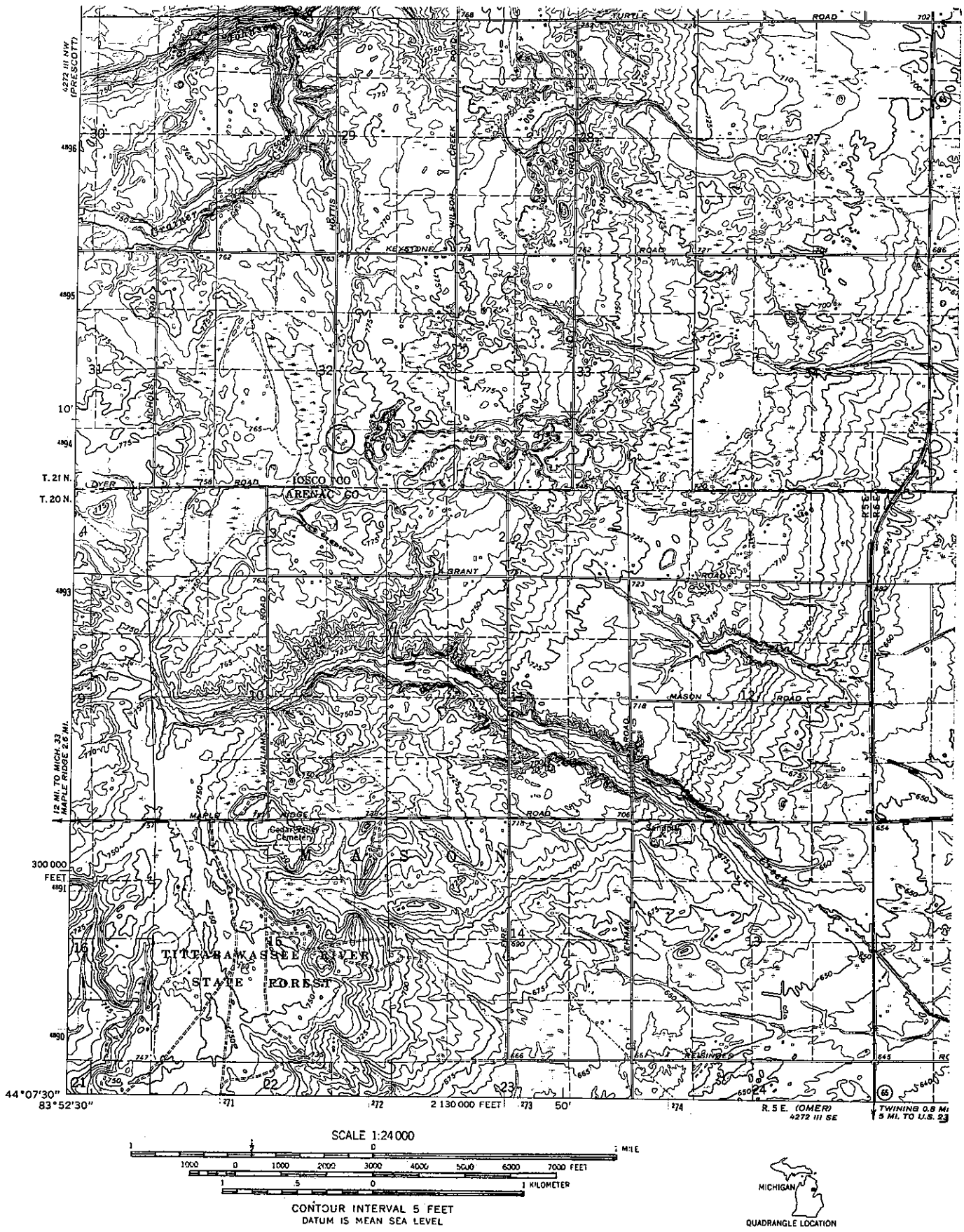


Figure 5: This is a section of the Whittemore Quadrangle printed by the U.S. Geological survey. The Russell A. White farm house is circled. East of the farm house are a series of contoured depressions trending North-East and South-West. These are currently active Gypsum Karst sink holes probably interconnected.

II MACKINAC ISLAND

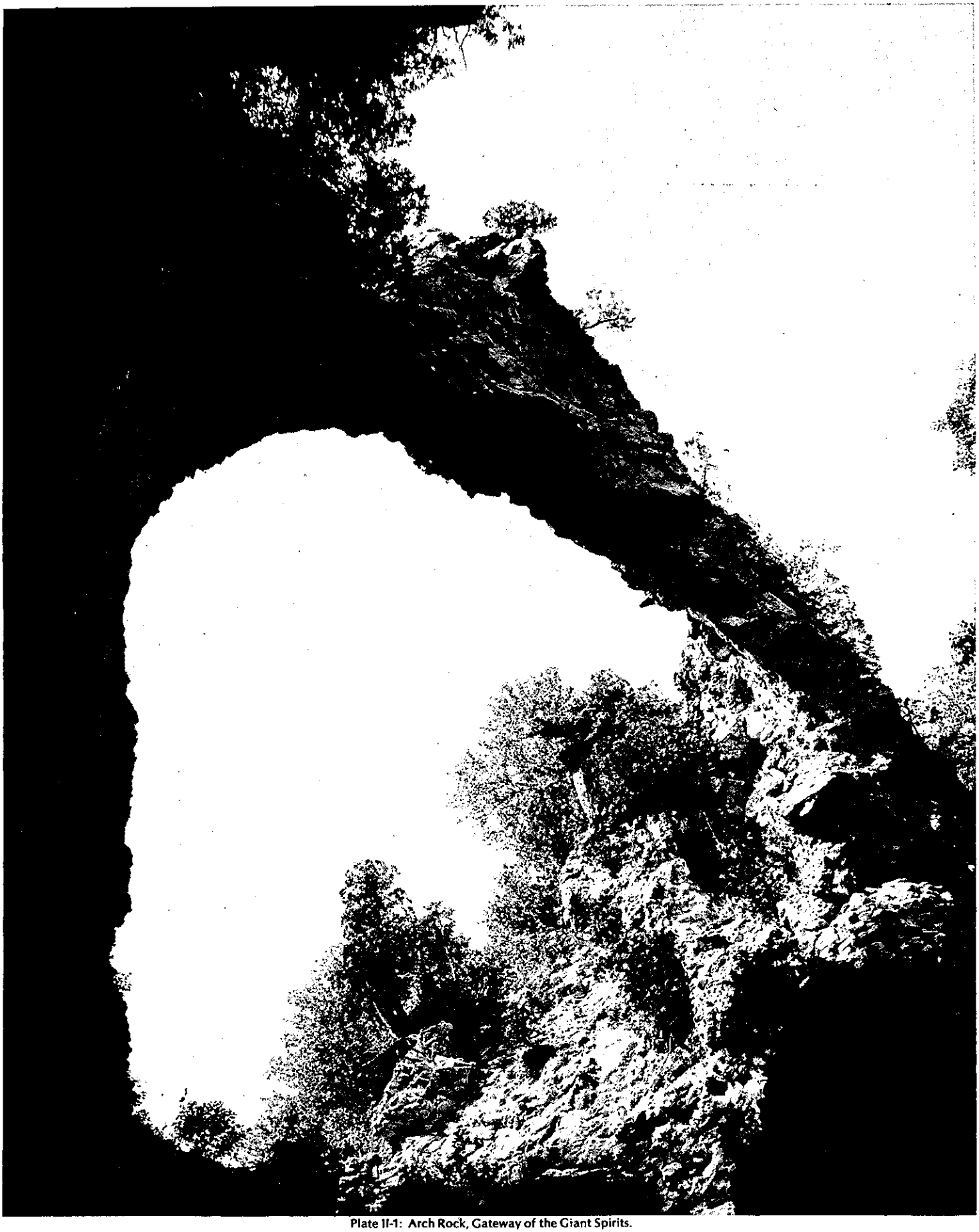


Plate II-1: Arch Rock, Gateway of the Giant Spirits.

A WALKING TOUR OF MACKINAC ISLAND

By: Tom Rea

During the 1977 National Speleological Society convention being held in Alpena, Michigan this summer, you will have an opportunity to visit an interesting and unique place, Mackinac Island. At least one guided tour will be conducted by Tom Rea, one of Michigan's earliest and most enthusiatic cavers. If you can't join the scheduled tour, but have time to visit Mackinac Island either before or after the convention, the following history and self-guided tour will introduce you to one of Michigan's most impressive natural and historical features. If at all possible, make the trip to Mackinac Island. Your only regret will be having to leave at the end of your visit. (Ed.)

The name of the island is spelled "Mackinac" and the town on the south shore of the straits is "Mackinaw" City. However, the word is always pronounced "Mack in aw". According to Henry R. Schoolcraft, who was an Indian agent on the island from 1833 to 1841, the name came from the Indian word "Mishi-min-auk-in-ong", meaning the place of the great dancing spirits.

The Indians of this area date the island's creation to the great flood. According to Indian legend, Mackinac Island was the first land to appear after the Flood and it was here that the spirits gathered to begin remaking the world. The island remained an Indian holy place, the home of the giant spirits, and, of course, the focus of many legends and tales.

In 1634, the explorer, Jean Nicolet, discovered Mackinac Island and claimed it for the King of France. The island immediately became a natural stopping point for the voyageurs using the Great Lakes as their trading highway between the trapping grounds of the Canadian north country and Montreal, the shipping point for European fur markets. All of the Northwest Territories fur trade eventually passed through the island via John Jacob Astor's American Fur Company, which was founded in 1808. Mackinac Island was the center for commerce until Astor moved westward in 1834.

The island's location amidst the Straits of Mackinac also made it a natural location for a fort. After the French moved out, the British garrisoned the island and, in 1780, built a fort. The orginal buildings are still intact and open to the public. Mackinac Island remained a military outpost and trading center until gradual settlement of the area eliminated the need for military protection and pushed the hunting grounds of the fur-bearing animals further north and west.

In 1895, the Federal government gave its holdings on Mackinac Island to the State of Michigan. Most of the island was developed as a state park and soon became a popular resort. The Governor of Michigan maintains a summer home on the hill behind the Fort. About five percent of the property, mostly on the northwest side, is still privately owned and fences should be respected.

Topographically, Mackinac Island is unique among the many islands that dot the Straits of Mackinac. Most of the islands, including huge Bois Blanc Island, are low and wet. Mackinac Island rises over 300 feet above the level of Lake Huron.

Nearly every interesting rock feature on Mackinac Island, pinnacle, cave, or arch, is a result of erosion around a mass of resistant limestone breccia. The most likely theory of the origin of this breccia is that the beds of salt deposited during the Silurian period were dissolved, forming vast caverns (eat your heart out!) into which the overlying limestone beds collapsed, breaking into small fragments which later cemented together forming the breccias.

When you look at Mackinac Island from the shore of the Straits at either Mackinaw City on the south or St. Ignace on the north, you can see two distinct levels or ledges. The highest level is known as Ancient Island. It is about half a mile long and a quarter of a mile wide. Sea cliffs associated with prehistoric Lake Algonquin (about 14,000 B.C.) skirt the Ancient Island completely. The highest natural point is at the southeast end of Ancient Island which drops away abruptly in a wave-cut precipice.

The lower terrace represents a second high water stage at about 2,000 B.C. after an intervening low. This is known as the Lake Nipissing stage. The Nipissing shore line cannot be traced all around the island due to later erosion. However, a Nipissing bar can be seen on the golf course west of Fort Mackinac.

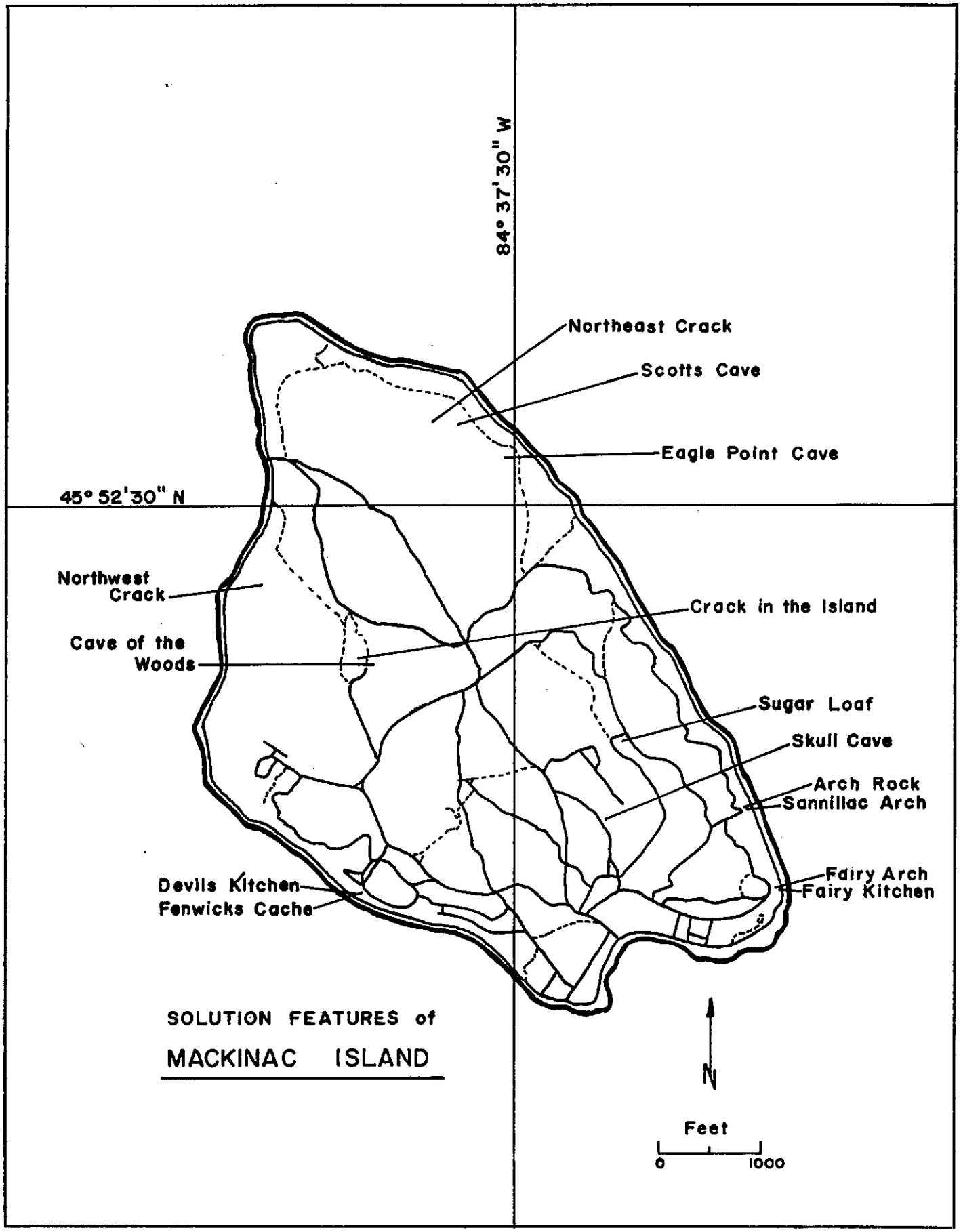
When you first set foot on Mackinac Island, you will think you have found the tourist trap of the century. The village is highly commercialized with dozens of shops selling hundreds of overpriced souvenirs to crowds of tourists. Don't be dismayed! Get a map inside the boat line office and start walking (no motor vehicles are allowed on the island), or rent a bicycle or carriage. When you get away from the village, the island is a delightful place with cool forests, rock beaches, springs, cliffs, and caves!

If you start walking northeast (counterclockwise) along the shore on East Shore Boulevard, you will soon come to Arch Rock. Arch Rock is a narrow natural bridge about 145 feet above Lake Huron. The cliff slopes steeply upward through the arch from the road. According to Indian legend, the arch was made by giant spirits who inhabited the island, and it served as their gateway.

Sanilac Arch is a much smaller arch through the same promontory that contains Arch Rock. Sanilac Arch is at right angles to the larger arch and forms a unique double arch arrangement. The Indians say that Sanilac Arch was the gateway for the spirit children.

Plate II-2: Sanilac Arch, Gateway of the Spirit Children.

Plate II-3: Sanilac Arch from the opposite side as previous photo.



SOLUTION FEATURES of

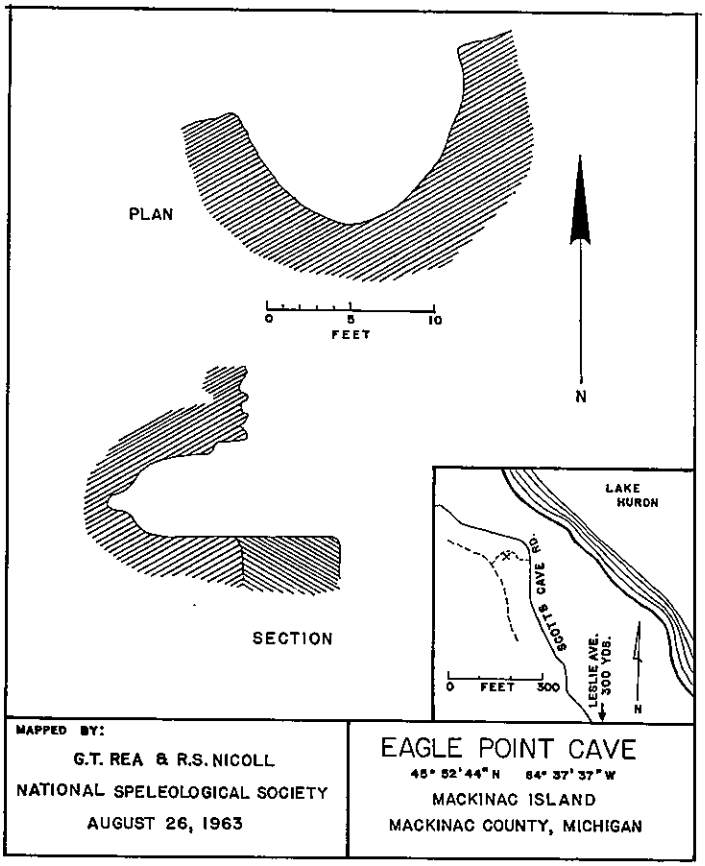
MACKINAC ISLAND

Plate II-4: Sugar Loaf, a sea stack which resembles a colonial sugar loaf.

After the giant spirits entered the island through Arch Rock, they made their way to Michabou's wigwam, now called the Sugar Loaf. The Sugar Loaf is a sea stack seventy-nine feet high with a cave in one side which served as the door to the wigwam. The cave entrance is about eight feet above the ground and is shaped like an inverted key-hole. The cave is a room nine feet high and six feet wide with a small passage extending all the way through the stack. There are two origins of the name. The Indian story is that one time the bees made a hive of the rock and completely filled it with honey. The stack also closely resembles a colonial sugar loaf.

Plate II-5: Eagle Point Cave was once a roosting place for eagles.

Further along, north of Arch Rock, is Eagle Point Cave. This is just a hollow shelter in the face of a cliff. The place was noted by the Indians because it served as a roosting place for eagles, worshipped as a divinity because of their fearlessness.



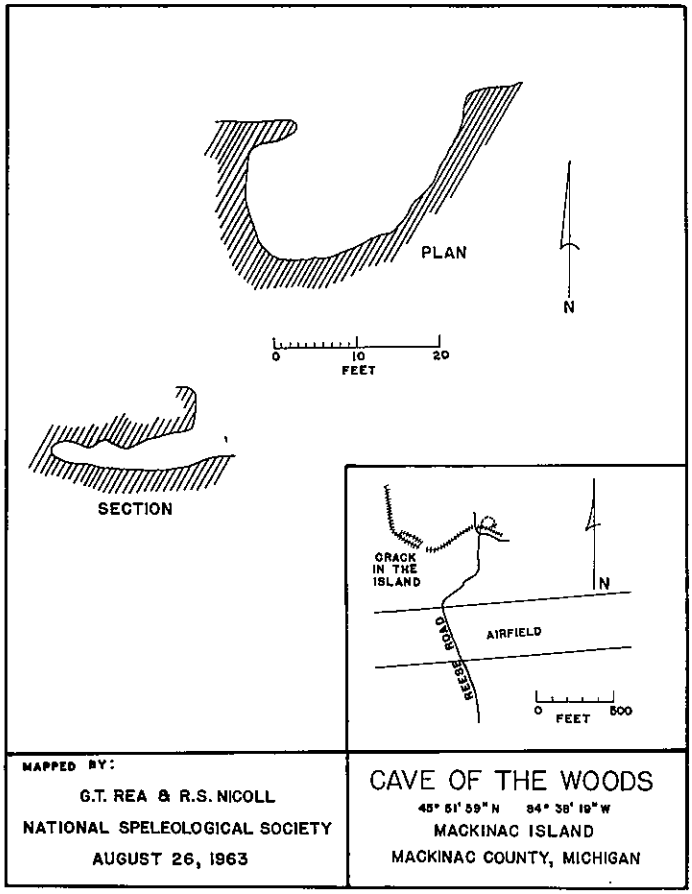
Just beyond Eagle Point is Scott's Cave. Scott's Cave is an example of Nipissing wave erosion within a breccia stack. It is about fifteen feet long and eight to ten feet wide with a nine foot ceiling. The cave is named for Captain Thomas Scott who commanded at Fort Mackinac in 1787. The cave has occasionally been known as Flinn's Cave.

On the south shore of the island, clockwise from the boat dock, about half a mile beyond the Grand Hotel, is the Devil's Kitchen This is a larger shelter cave associated with present day Lake Huron. During high surf, the cave becomes filled with water and impossible to enter.

About twenty-five feet above the Devil's Kitchen, in the same breccia stack, is a little cave known as Fenwick's Cache. The cave is named for Bishop Edwin Fenwick who was a missionary to the Indians. According to Indian legend, this was where the good fairies hid while the Devil cooked his food below. The cave entrance is a little crawl-in hole at floor level, to a round interior chamber a few feet in diameter where one can stand. There is a second small entrance at eye level, forming a window looking over the lake.

Plate II-6: Cave of the Woods is an isolated and picturesque cave well finding.

In the interior of the island, just north of the airfield, is Cave of the Wood. This small shelter cave was an Indian hiding place in the woods. It was also a burial vault at a much earlier time. This cave is isolated in a picturesque setting and is well worth the trouble of finding it.



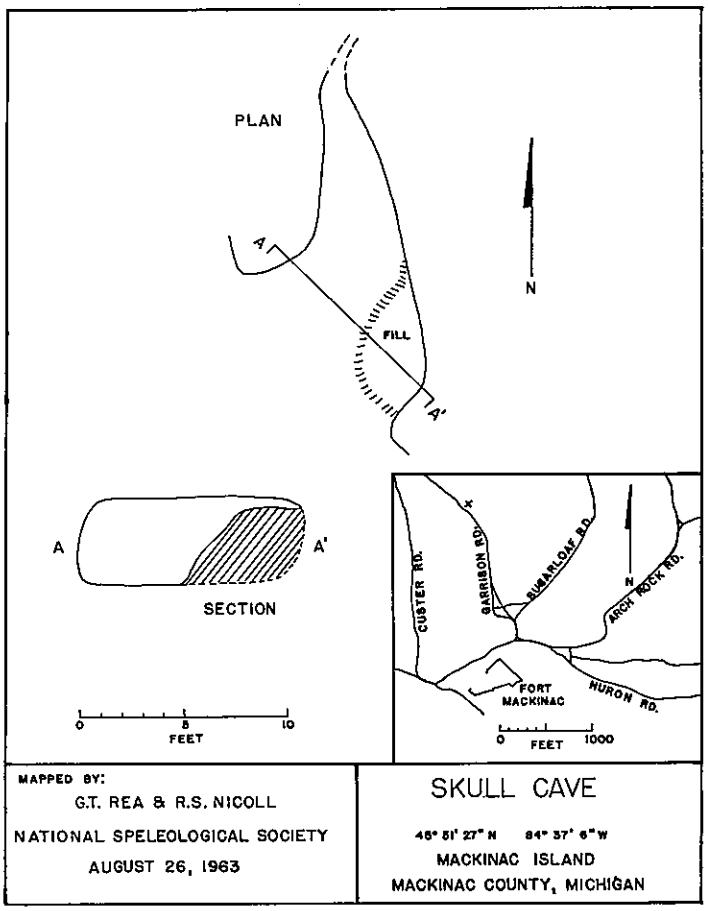
Near Cave of the Woods is the famous Crack in the Island. Many tales have grown up around this feature. Traditionally, it is the remnant of an extinct volcano. Indian legend says the island is to split in two some day. Actually, the crack is a solution feature of the limestone breccia. Similar cracks can be found all over northern Michigan and the Upper Peninsula wherever the flat surface of the limestone is exposed. There are some excellent examples at Mystery Valley near Leer, northwest of alpena.

The crack can be traced for nearly 1,500 feet and varies from six inches to five feet deep. There are several other similar cracks on the island, expecially northwest of the pumping station.

Plate II-7: Skull Cave, ancient burial vault of the Indians.

Half a mile north of Fort Mackinac, on Garrison Road, is Skull Cave, another sea cave on the Algonquin shoreline of the Ancient Island. Many tales and legends are told about this cave, which was also an ancient burial vault. The following is an example of the legends:

The chief, Kenu, sat within it waiting for Michabou, the Great Spirit, to answer the prayer which he had offered to him. He brought clay, materials from which, by the aid of Michabou, to make better peace pipes for his contentious people. While waiting, he was startled to see one of the skeletons in the cave move and begin to speak. 'Silver is under my feet,' said the hollow voice, 'of silver, with thy clay, make thou the pipes of peace and thy people shall find the spirit of peace whenever smoke from these shall rise.' Kenu did as he was told and then the skeleton which had spoken took them and blew on them, and filled them with peace-making power. Happy were the days now in the tribe of the peace-loving Kenu, and the power of his now-united nation was felt far and wide.



Insert Figure 4

If you are going to Mackinac Island, park in the city lot and take the Arnold Line boats from either Mackinaw City or St. Ignace. If you are going to drive across the toll bridge anyway, take the boat from St. Ignace, the fare is slightly less. This time of year boats leave as regularly as busses so there is no need to be concerned about the schedule until time to return. Don't miss the last boat, hotels are expensive and camping is not allowed on the island. Take your walking shoes and carry your lunch. The only place to get something to eat is the village and British Landing and it's expensive. Cave of the Woods would make an excellent clandestine camping site for one or two very quiet squatters but I'm not suggesting it and don't count on finding it in the dark.

Those who go on the guided tour during the convention will see Skull Cave, Sugar Loaf, Arch Rock and Sanilac Arch, Devil's Kitchen and Fenwick's Cache (time permitting), Cave of the Woods, rack in the Island, and some sinkholes.

III PRE— & POST—CONVENTION TOURS

Plate III-1: Niagaran Escarpment, Bruce Peninsula, Ontario, Canada.

CAVING IN ONTARIO

By: Kirk MacGregor

Approximately 150 caves are more or less recorded in Ontario. These range from a maze-cave over 2,000 m. long to caves less than 20 m. long. Most contain less than 100 m. of passage, and some, which are penetrated by daylight to the end, might not be considered as caves in other areas.

Only one of these caves is in northern Ontario. Bat Cave is about 100 m. long and is developed in granite. This cave is a major bat hibernation site and should be visited only in the summer. The cave is a several kilometer hike from Ouimet Canyon, a spectacular canyon accessible by road from the trans-Canada highway at Ouimet, which is about 40 km. east of Thunder Bay.

Plate III-2: Ouimet Canyon on the way to Bat Cave.

The remaining caves are found in rocks of four different periods in southern Ontario, as indicated on the map. These caves are of three types: solution caves, crevice caves, which appear to have been formed by rock movement and take the form of roofed fissures, and sea caves, which were formed mainly by the action of waves when the Great Lakes were at their higher prehistoric level.

We can start by describing some southern Ontario caves on the Bruce Peninsula. North of the Bruce Peninsula mainland is Flowerpot Island (#1), which has good examples of sea caves.

According to Fort (1966) there are five (numbered) main caves. They open into the cliffs on the east side of the island from terraces 12m to 24m above the present lakeshore. To quote from his article:

> Some are of spectacular size, both from the standpoint of volume and length. In cave number four, one enters a gaping mouth nearly 100 feet (30m) in height, climbs an underground mountain to a point near the ceiling, and crosses over to emerge from a rear exit on the other side of a headland. Cave number five, the longest, contains a labyrinth of passages at two levels with a total estimated length of a quarter of a mile (400m). Many walking passages lead far from the daylight of its several large entrances.
>
> This longest cave appeared to have been recessed far beyond the accountability of breaking waves. This is also true of cave number one, where a single bore of walking passage extends nearly 300 feet (90m) straight back into the cliff. There is no abrupt end, but the ceiling (decorated by clusters of 6 to 8 inch (15-20cm) stalactites) drops to a belly-crawl which I did not follow.

Flowerpot Island is a National Park, and a number of boat operators in Tobermorey, Ontario, provide rides to it for around $4 per person for a round trip. It is well worth visiting.

On the Bruce Peninsula mainland, we encounter an area with extensive karst and many caves. This is located on the map by the letter "B", but covers the whole of the northern end of the peninsula. It includes sinkholes, sinking streams and lakes, springs, and examples of three kinds of dolomite pavement. Sea Caves are well-developed along the north coast, especially in the vicinity of #5.

The northern Bruce also contains a few solution caves (e.g. #3) and the St. Edmonds Cave System. The latter is probably the longest sinking stream system in Ontario. The sink to rising distance is two kilometers, and the overall drop is 27m. The main caves in the system are Museum Cave at the sink, and Little Stream Cave at the resurgence. Both are short and very wet caves that end in sumps.

Plate III-3: Escarpment point in the Bruce Peninsula.

Moving south, we pass several caves, some karst, and numerous unrecorded sea caves. At #9 is Bruce Cave, a good example of a shelter cave. It is developed in a 15m dolomite cliff and has a pillar dividing the large entrance. The passage tapers to nothing in 15m. The roof is massive dolomite, with the cave excavated in the thinly bedded rock below.

South of the Bruce Peninsula two karst features are marked on the map. At "E" Hepworth Creek sinks and at "F" the Sauble River goes underground for about 1 km. East of these is the Wodehouse Creek Karst, an elegant example of a young sink-spring system developed in an escarpment (Cowell and Ford 1975).

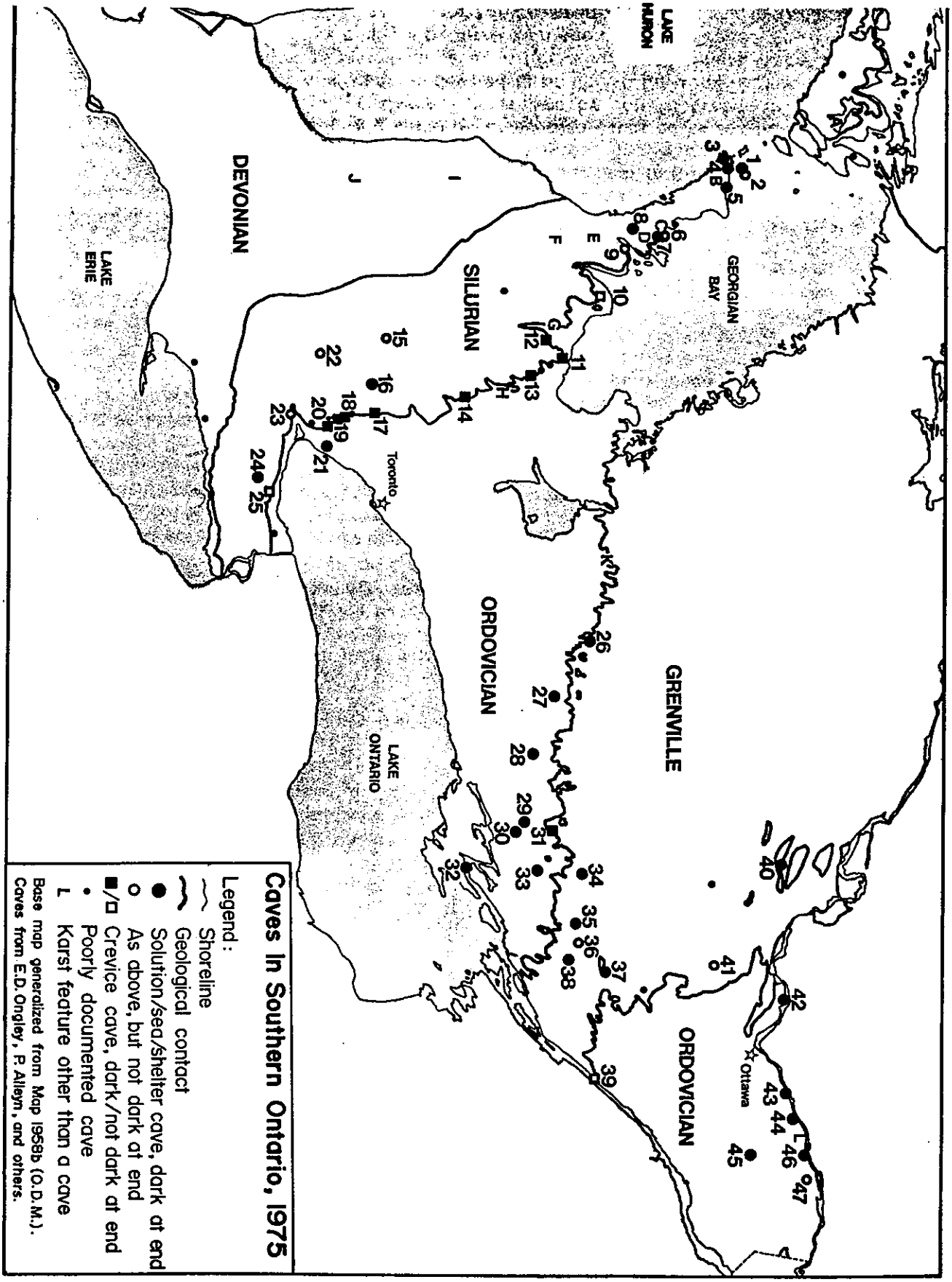
At #10, we encounter our first crevice caves. From here along the Niagara Escarpment to the Clinton Township Caves (#25), practically all caves are of this type.

At Rattlesnake Point (#19) there are at least three crevice caves. The major cave is a multi-level one which leads via a 4m climb to a small room about 15m below ground. Those wishing to see examples of crevice caves can try finding these. Rattlesnake Point is in a conservation area southwest of the town of Milton Heights, which is south of highway 401 on highway 25. The cave entrances are at the top of the cliff, ranging in location from very near the edge to about 25 meters back from it.

Visible from Rattlesnake Point is Mount Nemo (#20), which contains several crevice caves. The floor of the main one slopes down for about 8m to the head of a 5m drop. This drop is the only one I have seen that is suitable for body-rappelling without a rope. The fissure is about 0.4m wide and rather smooth-walled here, and the caver merely leans out into it, spreads his arms and thighs slightly and uses friction to slide the whole way down. Beautiful! From this point the cave drops about 4m and then rises a similar distance in about 80m before it narrows and ends in wedged, broken rock. The cave has a lake of variable depth in its lower section (which is unusual), some stalactites and the usual areas of cave coral and flowstone.

NOTE

The above descriptions are condensed from the chapter "Caves of Ontario" in the new book CAVE EXPLORATION IN CANADA. This book is the work on caves in Canada, and is well worth buying if you are interested in the subject. The book will be on sale at the Alpena convention and can also be ordered from The Canadian Caver.



The Silurian also contains a few solution caves, the best known being those at Rockwood (#16). These consist of about a dozen small caves more or less randomly developed at various places in the Eramosa Gorge. The largest is called Rockwood Cave. Its entrance is about 3.6m high and 9m wide and quickly funnels down to a crawlway which enters a small room. This used to be well-decorated with stalactites, but is now bare. From here a crawl leads about 25m to the end of the cave. These caves are in the Rockwood Conservation Area near Rockwood on highway 7, west of Guelph.

Moving east into the Ordovician rocks, we find Ontario's only cave in sandstone and conglomerate–MacKenzie Cave (#21). It consists of one straight passage about 25m long with a small room and a spring at the back. Further east, beyond the caveless areas of glacial drift around Toronto, Ordovician rocks again appear on the surface in the form of a band of limestone with much karst.

Here is Ongley's Hole (#26), one of the Ontario caves that probably has 200m-plus of passage. Only 118m are presently surveyed, but there are many unexplored side-passages that must interconnect to form a rectangular maze with considerable total passage length. The cave is developed in a tongue of limestone between two swamps. Some of the water from the swamp to the southeast flows through the cave to the lowerlying swamp to the north. While this flow is now vadose, the cave is a good example of phreatic development, and contains the only known example of phreatic sponge in Ontario (E.D. Ongley, personal communication).

The Warsaw Caves (#27) primarily consist of small fragments of rectangular maze, and larger segments of passage in breakdown. These caves are in the Warsaw Conservation area, near Warsaw, which is northeast of Peterborough. They may be worth visiting if you like small caves. Most of the other caves in this area are also small. Stoco Cave (#31) is an example of a crevice cave that is not on the Niagara Escarpment, and Tyendinaga Cave (#30) has short main passage up to about 8m high by 4m wide and good flowstone curtains (now partly vandalized, unfortunately).

At (#29) is the Moira Karst. This area extends along about 3km of the Moira River and includes sinkholes, partial sinkings and risings of the Moira River, limestone pavements, and small-scale karren.

As no serious attempt has been made to push and catalogue all of the caves, it can only be said that there are at least ten. At the south end of the Moira Karst are the Scuttleholes, several small caves and many sinkholes developed in weak, thinly-bedded limestone. At the north end of the karst are incompletely explored caves known to be up to 50m long. In between are several more caves covering a wide range of sizes. One was pushed to a total length of nearly 25m by four people working for four hours. The air flow looked good, but people don't flow!

Another is Moira Cave, by far the longest cave known in Ontario, and at present the longest known is Eastern Canada. Members of the Toronto Caving Group are working on the "Moira Project", a continuing mapping program, both in the cave and on the surface. The map shows much of the 965m of passage so far surveyed in Moira Cave. This map only hints at the complexity of the horizontal maze which puts the total length well over 2000m. The present surveyed straightline length of the cave is only 331m, a figure unlikely to increase greatly.

Because there is no other convenient way to specify locations in such a cave, the Moira Project has established Provisional Moira References (PMR). These work like military grid references, except they are aligned on true north, and six digits go to the nearest meter. Thus, PMR 463573 and PMR 323373 locate the northernmost and southernmost points on the map respectively. Lines of PMR are marked on the map at 50m intervals.

On the basis of summer water levels, Moira Cave divides into two parts, the dry north and the wet south. The gradual transition is at fairly constant temperature of about PMR 430500. Most of the north is dry in summer and has a fairly constant temperature of about 6° C year round. Passages here range from an area of crawlway maze centered on PMR 457550 to Technical Passage, the largest room in the cave (17m long by up to 3m wide and 8m high). This part of the cave is a bat hibernation site and should not be entered between October 1 and April 30.

Most of the south is wet all year round. During spring flood most passages are completely submerged, but in mid-summer the water averages about 0.3m deep. The temperature in this area varies considerable over the year. Measurements show that the temperature here follows the river temperature within 1° C, ranging from 0° C in winter to over 20° C in summer.

The southern section of the cave is a largely featureless maze. Most of the passages are stoopways or crawls and have a roughly triangular cross-section, being widest just above the rock floor. Nearly lenticular cross-sections, a "flat" ceiling, or undercuts at floor level are common, as are chaotic areas of breakdown. Goodfellow Hall, which extends south from PMR 381416 almost to the Resurgence Valley is the largest section of straight passage in the cave. It is up to 3m high by 1.5m wide.

Eastward from the Ordovician limestones of Moira Cave is the Grenville subprovince of the Canadian Shield. Dr. Brock Fenton reports that he has visited about twenty unrecorded caves in Grenville marble, all of them small crawls. He believes there must be hundreds of similar caves in the Grenville. A typical specimen is one of the Upper Rideau Caves (#37) which consists of a crawl leading 8m to a small, roughly spherical room. From here a crawl and squeeze up to about 40cm high leads to a second entrance in about 9m. End of cave!

Better things are found further northeast where the Ordovician limestone reappears. This limestone is exposed in a belt east of Ottawa, and also in several outliers west of the city. One of these outliers contains the Bonnechere Caves (#40), which have a total surveyed length of 253m (Ongley, 1965). This is split between three caves separated by breakdown. The longest individual cave has only 148m of surveyed passage, but it contains over 200m of passage.

The three main Bonnechere Caves are called the Entrance Cave, the Downstream Cave, and the Commercial Cave. Water flows from the river into the Entrance Cave, sinks into breakdown and is next seen in the river flowing into the Downstream Cave. It then flows into the small gorge east of the caves and re-enters the river. Water has been diverted from the Commercial Cave by several dams, but water levels and numerous scallops on the cave walls indicate that water used to flow through this cave.

The Entrance and Downstream Caves consist of large breakdown passages whereas the Commercial Cave consists of smaller passages generally unmodified by collapse. Except for a few small stalactites in the Commercial Cave, there are no speleothems in these caves. This is the better of Ontario's two commercial caves, and may be worth a visit if you are in the Ottawa area in summer (operation is seasonal). The cave is near Eganville, some tens of Kilometers west of Ottawa.

About 64km east of the Bonnechere Caves, we encounter the first of an east-west line of caves developed in a small north-facing limestone escarpment south of the lower Ottawa River. These are ordinary solution caves but they display a great variety of forms, ranging from a horizontal maze at Buckham Bay to the best pit known is Ontario at Plantagenet. This area also contains a number of karst features, such as the sinking stream at "L"

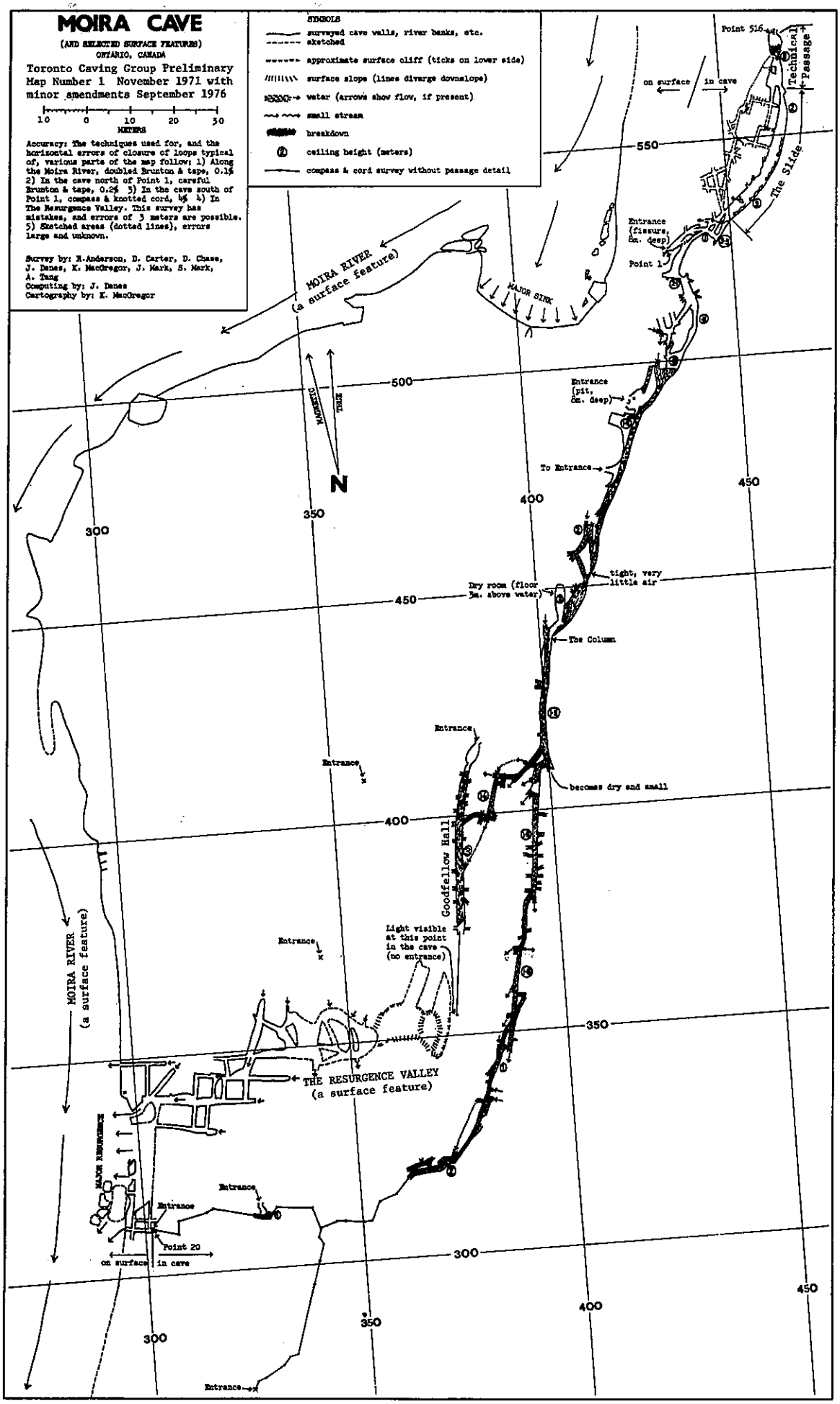
At Buckham Bay Cave (#42) a small creek disappears into a 4.5m deep sinkhole, flows through a maze of interconnecting passages, and exits at the bottom of the escarpment. The cave probably contains about 200m of small, gravel-floored "sewer tubes" with dead-end passages leading up to miniature surface shakeholes. Near the resurgence, the ceiling reaches walking height and has a few skylights. The area around the cave is a well developed limestone pavement concealed under luxuriant vegetation.

Near Orleans (#43), Leonard Creek sinks through a huge logjam to reappear 215m downstream as an impenetrable spring. The cave has several entrances, one of which leads to about 75m of 1.8m square main passage. Unfortunately, this promising beginning ends abruptly in crawlways, some of which have walls and ceilings of clay and a few boulders, and appear to be developed in glacial till.

Near Rockland (#44), two small streams sink in the top of the limestone escarpment mentioned above. Each enters a small vertical cave with two or three small pitches. Both of these caves have total depths of only about 18m and are easily free-climbed.

At Plantagenet (#46) is a small plateau containing a number of karst features. One is a blind pit about 12m deep, the largest known is Ontario. Another feature is Plantagenet Cave. It is entered by a crawl that leads to a stream passage that can be followed for 35m or so in each direction. Until about 1970, this cave was well decorated with many stalactites up to about 30cm long. Since then vandals have stripped it absolutely bare.

These are some of the caves of Ontario which might be of interest to cavers attending the NSS convention. They will be accessible if you return or arrive by way of Ontario, Canada


MOIRA CAVE
(AND SELECTED SURFACE FEATURES)
ONTARIO, CANADA
Toronto Caving Group Preliminary Map Number 1 November 1971 with minor amendments September 1976
10 0 10 20 30
METERS
Accuracy: The techniques used for, and the horizontal errors of closure of loops typical of, various parts of the map follow: 1) Along the Moira River, doubled Brunton & tape, 0.1% 2) In the cave north of Point 1, careful Brunton & tape, 0.2% 3) In the cave south of Point 1, compass & knotted cord, 4% 4) In The Resurgence Valley. This survey has mistakes, and errors of 3 meters are possible. 5) Sketched areas (dotted lines), errors large and unknown.
Survey by: R.Anderson, D. Carter, D. Chase, J. Danes, K. MacGregor, J. Mark, S. Mark, A. Tang
Computing by: J. Danes
Cartography by: K. MacGregor
SYMBOLS
surveyed cave walls, river banks, etc.
sketched
approximate surface cliff (ticks on lower side)
surface slope (lines diverge downslope)
water (arrows show flow, if present)
small stream
breakdown
ceiling height (meters)
compass & cord survey without passage detail
MOIRA RIVER (a surface feature)
MAJOR SINK
MAGNETIC
TRUE
N
Point 516
on surface
in cave
Technical Passage
The Slide
Entrance (fissure, 8m. deep)
Point 1
Entrance (pit, 6m. deep)
To Entrance
tight, very little air
Dry room (floor 3m. above water)
The Column
Entrance
Entrance
becomes dry and small
Goodfellow Hall
Light visible at this point in the cave (no entrance)
Entrance
THE RESURGENCE VALLEY (a surface feature)
MAJOR RESURGENCE
Entrance
Entrance
Point 20
on surface
in cave
Entrance
300
350
400
450
500
550

MINI TOURS

By: William Fritz

The following tours are designed primarily for pre- or post-convention use. However, the Garden-Fayette Tour is only about three and a half hours from the convention site.

STURGEON RIVER COUNTRY

To a box canyon, a gorge, waterfalls, and an old silver mine.

The Sturgeon River country will be unique to many cavers. If you have grown used to sedimentary rock, get ready for igneous and metamorphic.

Start at the junction of U.S. 141 and U.S. 41 in Baraga County. Follow U.S. 41 northwest for 2.95 miles to CANYON FALLS REST AREA.

Canyon Falls is a very scenic twenty foot waterfall located in Michigan's largest box canyon. A one mile self-guided trail leads past the falls and follows the lip of the canyon past excellent small swimming holes. The canyon is in Bacco Quartzite of Huronian Age.

Plate III-4: Canyon Falls in Michigan's largest box canyon.

After visiting the canyon, follow U.S. 41 northwest for 12.30 miles to a county road just before Baraga State Park; if you reach the campground, you just passed the road! Follow the road 2.4 miles to an intersection with a jeep trail. Bear right on road for 0.5 miles to Forest Service Road 191. Turn right and follow 191 for 10.8 miles to Forest Service Road 193. Turn right. After 1.05 miles, there is a ½ mile trail to STURGEON RIVER FALLS AND GORGE.

Here, the poorly marked trail drops over the lip of the gorge. After a steep climb down the hill, one comes to the top of a high cliff which is ideal for rapelling. If the cliff edge is followed upstream, it is possible to climb down to the floor of the gorge and visit the scenic falls. The falls is formed where resistant bedrock has squeezed the river to half its normal width and thus, is quite impressive even in the dry season. Swimming is possible and the falls is little visited on weekdays.

After returning to the car, continue on 193 for 3.40 miles and turn left. Follow this road 0.30 miles to the parking area at the base of SILVER MOUNTAIN.

There is a trail to the top of Silver Mountain and the view from the top at 1312 feet is spectacular and well worth the climb. However, at the base of the mountain, just to the left of the trail, is the entrance to Silver Mountain Silver Mine. Although only about 100 feet long, the mine is interesting. A great deal of the distance involves wading, but this can be nice on a hot day. Caution is necessary at the end since the mine ends in a pool about twelve feet deep. The silver mining was attempted by the National Company prior to 1850. Apparently the Chippewa superstition of Silver Mountain being bad luck held since mining was abandoned in 1847.

Return to the intersection of 191 and 193 and turn right. Follow 191 7.0 miles to Sturgeon River State Forest Campground. This, like most of Michigan's State Forest Campgrounds, is free. It is a nice place to spend a night away from civilization. From here, either backtrack or follow 191 to a "T" intersection and bear left to M-28. Follow M-28 to U.S. 141 to U.S. 41. This completes the tour and is about a two hour drive from Pictured Rocks, the next tour.

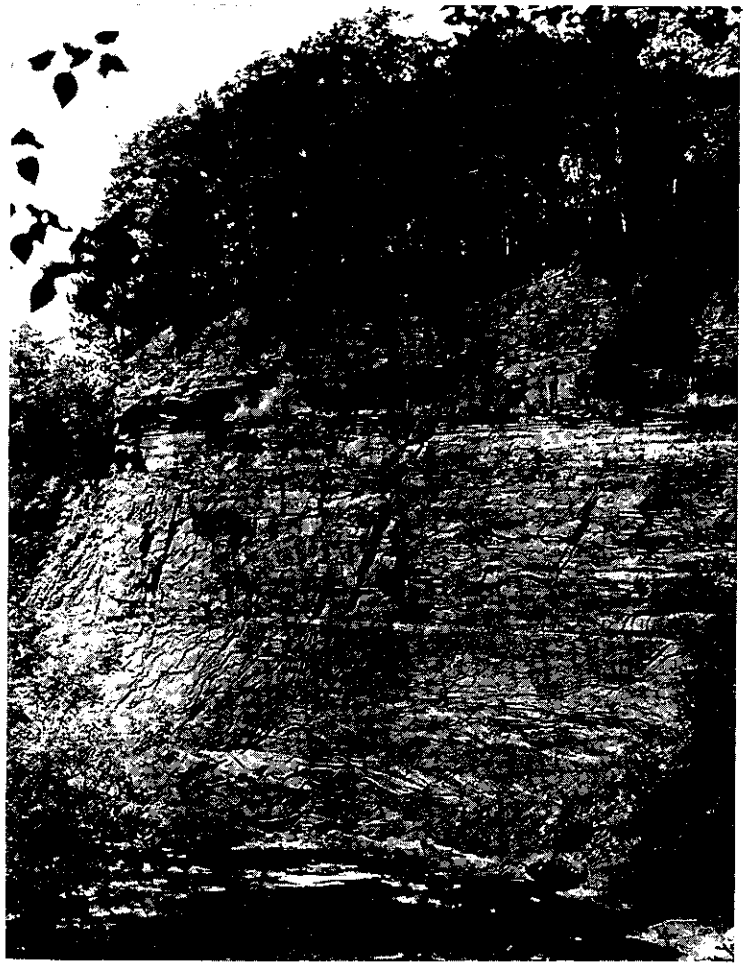


Plate III-5: Sturgeon River Gorge, some of Michigan's surprising terrain.

Plate III-6: Silver Mountain Silver Mine sure looks like a cave!

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PICTURED ROCKS

To sea caves, high cliffs, sand dunes, waterfalls, and beaches.

Start at Pictured Rocks National Park Headquarters in Munising. Pictured Rocks consists of three major sections. From Munising, the first of these is a fifteen mile section of high multi-colored sandstone cliffs. The cliffs, which reach up to 200 feet in height, contain sea caves, arches, columns, and promontories.

Continuing east, we find 12-Mile Beach. This lengthy, broad, sand-and-pebble beach is ideal for sunbathing, hiking, and photography. Unfortunately, due to low water temperatures in Lake Superior, swimming is only for the brave!

Finally, we come to the Grand Sable Banks and Dunes. The Grand Sable Banks are a glacial deposit rising 275 feet above the present lake level. Perched atop them, the Grand Sable Dunes rise an additional eighty-five feet and cover an area of five square miles.

The best way to see the Pictured Rocks is by foot or by boat. A hiking trail runs the length of the park, with camping by permit in the interior sections. Information is available at park headquarters. Boat tours of the cliff section are available at Munising. The tours last about three hours and cost $5.75 for adults and $3.00 for children under twelve. Boat tours of the dune section are available in Grand Marais at the east end of the park. These tours last one hour and forty-five minutes and cost $3.00 for adults and $1.50 for children under twelve. Many of the features of the park can be seen only by boat, and, although you could use a canoe, the water is cold and rough and requires an expert.

Plate III-7: Miner's Castle, famed Pictured Rocks landmark.

The best general up-to-date information of the park is available at park headquarters. However, a brief word on the geology of the park will help in its understanding. The following outline is courtesy of Pictured Rocks National Lakeshore:

The geological history of the National Lakeshore area is limited to two relatively brief intervals of geologic time: the Cambrian and early Ordovician periods when sediments deposited in shallow seas 500 million years ago became the sandstones that form the Pictured Rocks escarpment; and the Pleistocene epoch when glaciers reworked and mantled the underlying bedrock with a nearly continuous veneer of drift.

Bedrock is best exposed along the escarpment where bluffs rise 50 to 200 feet above Lake Superior and extend 17 miles from Munising to the Beaver Basin. For a short distance inland from the escarpment, usually no more than several hundred yards, bedrock may be seen in occasional outcropping. Elsewhere in the National Lakeshore, bedrock is found only where it forms a low bluff around the north and east side of Au Sable Point, and in the gorge at Grand Sable Falls.

The Jacobsville sandstone, of questionable lower and middle Cambrian age, is the oldest formation in the lakeshore. It is a feldspar-rich, quartz sandstone, deep red in color with white mottlings. Although the Jacobsville formation has a thickness of 1,100 feet, only the top several feet rise above lake level.

The Munising sandstone, which was formed during the middle Cambrian period, lies above the Jacobsville formation and is divided into the Chapel Rock member and the Miners Castle member. The lower 2 to 15 foot section of the Chapel Rock member is a conglomerate. This layer contributes many of the colorful pebbles of quartz and other minerals found along the Lake Superior beaches. The next 49 to 60 feet is pink or light buff to brown, medium grained sandstone with several thin, blue-shale beds. The Miners Castle member is a soft, friable, silty-shaley quartz about 140 feet thick. The beds in the top 20 to 40 feet of the latter section are frequently "burrowed". Limonite imparts a light yellow-gray color to the member and occasionally red to some thin beds. In the western half of the escarpment, the late Cambrian Trempealeau formation crops out only along the top edge of the cliff. The Trempealeau is a light brown or white, hard, dolomitic sandstone. Where present it forms a cap rock on the weaker Miners Castle member.

Above the Trempealeau, and very similar in appearance and lithology, is the Prairie du Chien formation (upper Au Train) of early Ordovician age. Within the National Lakeshore the Prairie du Chien is exposed only at Miners Falls.

All the formations rise eastward so that the Trempealeau is missing east of Miners Castle, but the Jacobsville, which is below lake level at Miners Castle, is well exposed beneath the Chapel Rock conglomerate east of Miners Beach and again in the gorge at Grand Sable Falls.

The Pictured Rocks escarpment has been carved by frost action and wave erosion of the present lake, as well as higher lake stages, into a plexus of shore cliff features such as: stacks, caves, sea arches, thunder caves and promontories. These features have been named Lovers Leap, Rainbow Cave, Grand Portal, Miners Castle, Chapel Rock, The Battleships, Flower Vase, and Indian Drum Cave. Most of the features can be reached by hiking but only Miners Castle is accessible by automobile. The best way to appreciate the cliffs is by boat tour.

Lakes, ponds, bogs, streams, and waterfalls are common throughout the area. Each is performing its task of slowly helping to shape the land and adding its particular attractiveness to the landscape.

Plate III-8: Pictured Rocks arches caused by wave action.

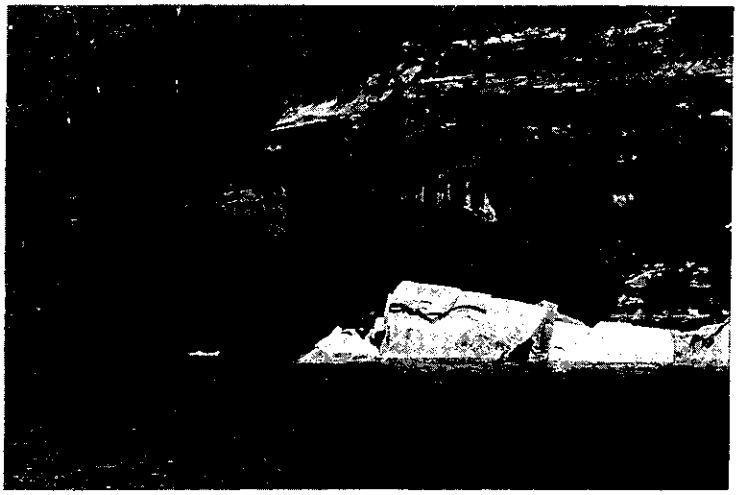


Plate III-9: Multi-colored sandstone cliffs at Pictured Rocks.

There are many waterfalls along the Pictured Rocks escarpment. All are fed by small streams from small watersheds and are thus most active in the springtime during wet periods. One of the most interesting is Munising Falls. Here the Trempealeau cap rock formation forms a shelf which overhangs the Miners Castle sandstone by 25 to 30 feet. A large natural amphitheater behind the 50 foot waterfall allows visitors to walk in back of the falling water without getting wet. At the head of Miners Basin is Miners Falls. Chapel Falls, fed by a tributary stream into Chapel Lake, is especially picturesque when viewed from below. It has practically no free fall, but is a long series of cascades dropping a total of 90 feet. The stream at the lip is normally only about 10 feet wide but as it drops over the cascades it spreads out in a thin white veil 30 feet wide.

Bridalveil Falls and Spray Falls are formed where streams fall, about 90 feet, directly into Lake Superior, adding greatly to the beauty of the Pictured Rocks.

At Grand Sable Falls, the stream draining Grand Sable Lake cuts into the Chapel Rock and Jacobsville Formations where they lie beneath sand dunes. The deeply wooded setting is exceptionally beautiful and its but a short walk from the lakeshore.

During a one million year period, ice sheets of all four glacial stages probably advanced intermittently through what is now the National Lakeshore area. However, ice advancing through the area during the Valders substage, the most recent of the Wisconsin stage of glaciation, wiped the surface clean and left only its own record. Between 7,000 and 8,000 years ago the ice margin stabilized along a line that curves gently south-eastward from Marquette to Traunik and then northeastward to Munising. From Munising to M-77, the line lies about 4 miles south of the present Lake Superior shoreline. West of the moraine belt, and extending nearly to Melstrand, the line marks the northern edge of an outwash apron, designated as the upper Kingston Plain.

In time, several small and separate outwash plains formed that are now seen as terraces on the face of the upper Kingston Plain both east and west of Kingston Lake and on the southern rim of the Beaver Basin.

The most prominent outwash feature is Grand Sable Banks, a huge formation about 5 miles long and rising to 275 feet above the level of Lake Superior at about a 35 degree angle. The banks are composed of sand and gravel material which filled a very large crevasse in the retreating glacier.

Perched on top of the banks are the Grand Sable Dunes covering an area of 5 square miles and rising 80 feet taller than the banks. The dunes were initiated at a time when the waters of former lake stages such as Nipissing began to subside. Sand was blown up into ridge rows from successive beaches. The dunes, in general, are actively moving inland from their original position. The prevailing winds off Lake Superior continue to erode the banks, adding material to the dunes.

Continued withdrawal of the glacier margin from the slope south of Grand Marais opened a succession of channels. Lower terraces were formed at this time, each one graded in turn to the level of a newer and lower outlet. The narrow shoreline terrace, lying below the lower Kingston Plain terrace, drops from 780 feet at the western end of the Beaver Basin to 720 feet at Sullivan's Landing. The picturesque transverse valleys at Chapel and Little Chapel Lakes were sluiceways used by water spilling across the Portal Point headland.

The outwash surfaces contain ice block depressions known as kettles. Kettles are more abundant in the three highest outwash surfaces often occurring in clusters. A notable grouping of kettles is found along a line that begins on the upper Kingston Plain and bears North/northwestward 8 miles through Kingston Lake on the lower Kingston Plain.

Grand Sable Lake occupies a very large kettle that may also mark the location of a pre-Valder's valley. The kettle is presently a mile wide and 2½ miles long but is being filled at its northern end by sand dunes 50 to 80 feet high that are shifting toward the southeast as they are nourished with sand blowing from the top and north face of the Grand Sable Banks.

As the ice margin retreated northward from the position of the present shoreline, a lake began to form at a low level, lower than the present lake surface. Isostatic uplift of the northern Great Lakes region gradually raised the water level to 640 feet in the National Lakeshore area, almost 40 feet higher than the present water level. This ancestral stage of Lake Superior, which occupied the Superior basin about 3,800 years ago, has been named the Nipissing stage. Shoreline bluffs, cut by wave action of the Nipissing stage, may be seen at Sullivan's Landing. Farther west, embayments of this stage occupied Beaver Basin, Chapel Lake Gorge, and the lower valley of the Miners River. Sand, drifting along the shoreline, built bars across the mouths of the embayments separating Beaver Lake as well as Trappers, Little Beaver, Chapel, Little Chapel, and Miners Lakes from the open lake.

West of the Mosquito River the surface material is a sandy till deposited beneath the moving glacier in a ground moraine. The surface was extensively fluted by the moving ice and an occasional drumlin may be seen.

Pictured Rocks is about an hour's drive from Manistique on the Garden-Fayette Tour.

GARDEN—FAYETTE TOUR

To Michigan's largest spring, an historic park, a small crevice pit-cave, a fishing village, and (maybe) a new cave.

Starting at the siphon bridge in Manistique, travel west approximately 6 miles on U.S. 2 to M-149 in Thompson. Follow M-149 north for 10.5 miles to KITCHITIKIPI.

Kitchitikipi is Michigan's largest spring. It occurs in the bottom of a large, water-filled sink and gives off enough water to supply a large stream. The spring contains large trout and the state provides an open bottomed boat from which the spring may be seen erupting in the bottom of the sink. A state park permit must be obtained to enter. The fee is $1.00 per day or $5.00 annually.

From Kitchitikipi, return south 4.5 miles to Cooks Road. Follow Cooks Road 6.4 miles through Cooks to U.S. 2. Follow U.S. 2 west 3.0 miles to Garden Corners. Take Delta County Road 483 south for 15.6 miles through Garden to the State Park Road. Follow the road 1.2 miles south to FAYETTE STATE PARK. A permit is necessary here also.

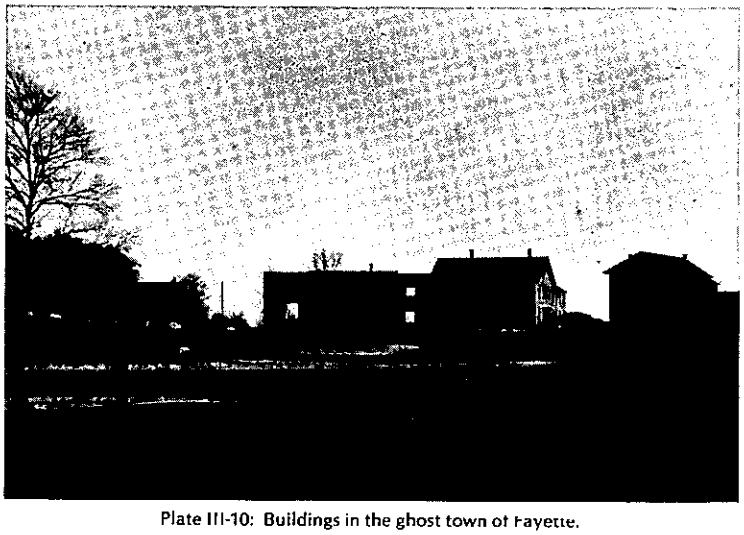


Plate III-10: Buildings in the ghost town of Fayette.

Fayette was a profitable iron smelting town owned by the Jackson Iron Company which operated the furnaces there from 1867 to 1891. Laid out in 1866, the town quickly grew to a population of five hundred after the furnaces began production. When the company stopped iron smelting the town was virtually abandoned. Twenty-six buildings have been restored. (See Ghost Towns article)

From a geology standpoint, Fayette is interesting as well. It is surrounded by high cliffs of Niagaran dolomite. Be sure to take the cliff-top trail for an excellent view of the town and the bay. Across the bay, Burnt Bluff, with its 160 foot cliffs, is visible.

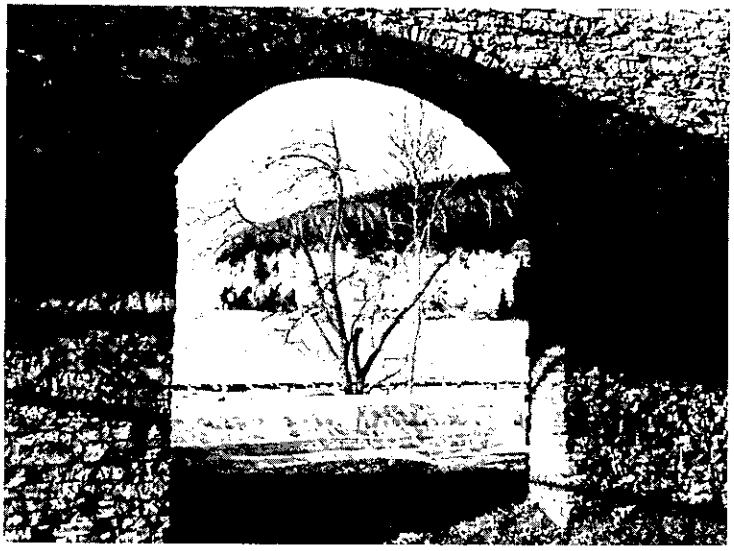


Plate III-11: Burnt Bluff cliffs of dolomite through an old mill window.

From Fayette, return to Delta County Road 483 and proceed south 2.5 miles to Road 012. Follow 012 east 2.0 miles to a sharp left turn. A jeep-trail continues straight. Follow the trail, which may not be passable by car, 0.4 miles to a blazed foot trail on the right. The trail leads to CREVICE PIT.

Crevice Pit is a small pit between large blocks of dolomite. It is approximately 30 feet deep and was apparently caused by faulting. A small pool of water is normally found at the bottom. Vertical equipment is needed to enter.

Return again to Road 483 and continue south 1.0 miles to Road 014. If this road were followed to the west, it would lead to Burnt Bluff. Burnt Bluff has some small caves which supposedly contain Indian pictographs, but is is now a private resort and is strictly posted. Check at the convention desk for any change of status and for specific directions.

Continue south 4.7 miles on 483 to FAIRPORT. Fairport is a small, New England style fishing village on the shore of Lake Michigan. For anyone who has not seen fishing boats and net racks, this is an ideal chance. In addition, the town store provides a beverage stop as well as possible information on the next stop.

Return north on 483 2.1 miles from the main Fairport intersection to Sac Bay Road. Follow the road east. At 0.5 miles, you will cross a side road and at 0.8, the gravel ends. From this point, use your judgement; the road will be impassable to anything except four-wheel drive in wet weather. Two tenths of a mile past the gravel, there is a gate followed by a rise. After another 0.25 miles, a rocky trail across dolomite pavement leads into a long clearing on the right. According to several local sources, there is a cave near the west edge of the clearing. Good hunting. Incidentally, caution is advised here since there are BEAR in the area.

After your search, return to 483, which becomes Schoolcraft County 435 after 5 miles. This route takes you through typical northern bush with some dunes. After 18.3 miles, you return to U.S. 2 at Thompson. At this point the tour ends.

THE SUBTLE SINKHOLES OF MONROE

By: John Moses

General Description of Monroe County Karst Area

To the eye, Michigan's Monroe County presents a low leve relief. From the western border with Lenawee County at a maxim elevation of just over 690 feet, the surface slopes gently east to L Erie at 570 feet above sea level. This represents a maximum drop feet per mile.

The bedrock dips gently in the opposite direction, strik along a NE-SW axis. There are very few natural outcrops ever association with prominent karst features. Monroe County, howe retains the least glacial cover of any region in southeastern Michig Following glacial retreat, the county was part of the ancestral L Erie. One of the major glacial lake beach lines can be traced o north-south line through the center of the county, passing just eas the Whiteford Township line, north through the village of Lulu, crossing the Raisin River to the east of Dundee. This is the Pleistoc Forest Beach and has interfered with the development of natu surface drainage in Whiteford Township.

The bedrock is entirely of sedimentary origin, prima dolomites, sandstone, and limestones of Devonian and Silurian a This is the only area in the lower peninsula of Michigan where Siluri age formations are not covered by younger rocks.

There is limited vertical extent to the development of soluti channels above the water table. A study(2) of water well l established a piezometric (artesian) water level above the bedr surface in many parts of the county. It also limits the likelihood gaining access to such air-filled caverns as might exist. Seaso fluctuations of the water table, however, of as much as 50 feet h been reported. Water well pumping has also had a marked effect lowering the water table below historical levels. In Lulu Qua owner Ron Brink reported that water would always flood the qua during winter months until a natural gas well was drilled nearb Water formerly perched atop an impermeable layer must now be a to circulate past the outside of a poorly cemented well casing to lo levels.

(2) Mozola, 1970

Sinkholes are developed in both Devonian and Silurian a rocks. The greatest number of sinks is developed in a single dolomi outlier of rocks of the Detroit River Group; mixed limeston dolomite, and shales of Devonian age. This outlier is underlain a totally surrounded by the older Sylvania sandstone. This outlier is p of a bedrock high point in the subsurface topography of the county.

The surface drainage in the county is poorly develope Agricultural improvements have included the installation of maj systems of field drains and channels. Big Sink in Whiteford Townsh receives the intermittent flow from several such sources. Based on t quantity of debris lodged in the stream courses, it is apparent th the sink receives large volumes during periods of high runoff Functioning as a sinkhole lake part of the year, the subsurfa channels are not always able to carry away all of the inflow.

Ottawa Lake Sink is a similar performer. In the late summ months, the lakebed can be walked dryshod. During its wett periods, the volume of water it can hold has been reduced from earli years. One possible explanation is the artificial diversion of fie runoff away from the Ottawa Lake depression.

The existing natural surface drainage and apparently that the subsurface drains against the dip of the bedrock, following t topographic path of least resistance. The regional flow is towards t Lake Erie basin. The local flow is more erratic.

Dolomite is the dominant rock type in which sinkholes ha been developed in the region. The interbedding of salt within t dolomites of the Detroit River Group to the north of Monroe Coun has led one author(1) to suggest an interesting hypothesis for sinkho formation. Ground water attacking the salt has left solution cavit at depth. The overlying surface rocks have subsided into the cavitie leaving fractures and zones of weakness for shallow ground water follow. The hypothesis has also been suggested for application to t sinkholes in the Alpena - Cheboygan, Michigan region. There is absence of supporting data (e.g. brine wells) to allow any follo through on such a mechanism.

Salt collapse does have intuitive appeal for explaining the general nature of sinkhole development in other parts of Michigan. Speaking strictly from the less-than-scientific cave-hunter's point of view, most of the major sinkholes in the Alpena area don't "feel" right. While the sinkholes and frequent earth crack features are reasonably significant, there is little about them to suggest carbonate solution as a mechanism of formation. Catastrophism would seem a more visually satisfying term for what has occurred there. Unfortunately, there has been considerably less systematic study applied to the Alpena region than even to the "subtle sinkholes" of Monroe County. Salt collapse has been identified by petroleum geologists as a force working at depth within the Michigan Basin in providing structural traps for petroleum. Some of the beds in which deep structural traps of petroleum occur outcrop along the rim of the Michigan Basin. These include the Dundee Limestone and the Detroit River Group. The latter provides for sinkhole development in Monroe County.

In Monroe County, however, there is adequate evidence that the carbonate rocks are themselves actively being removed by chemical solution. One example is found in the Big Sink area, as shown in Plate III-12. The rock outcropping surrounds a shallow hole on the northeast end of Big Sink. The surfaces of the dolomite blocks are etched to a depth of approximately three inches by grooves of solutional origin. This is the only known rock exposure associated with sinkhole development in Big Sink. The most highly developed solutional features in Monroe County are found in the abandoned quarry at Lulu. In Plate III-13, the west wall of the quarry shows extensive development of solution conduits along the bedding surfaces. The size of these tubes may provide some insight into the nature of subsurface drainage elsewhere in the county.

(1) Michno, 1972

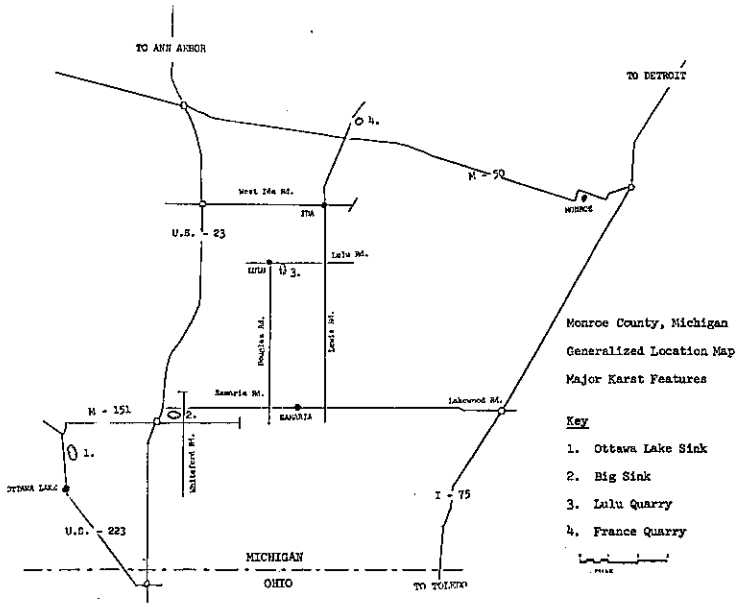
Plate III-12: Karren on dolomite blocks around Big Sink outlet.

Plate III-13: Solution conduits along west wall of Lulu Quarry.

DESCRIPTION OF PRINCIPLE KARST FEATURES

1 Big Sink

The "Big Sink" title is something of a misnomer. The area is actually a broad doline dotted by small collapse sinks and swallow holes. Located in the south-central portion of Section 2 of Whiteford Township, the Big Sink depression is approximately one-half mile long from east to west by one-quarter mile wide. The depth has been estimated at 18 feet.



There are apparent linear structures controlling the development of many of the swallow holes in the Big Sink. As measured by Michno (1972), the 9 swallow holes along the southern rim follow a bearing N 70° E. Northwest of the swallow holes, earth cracks in the wooded area follow a parallel alignment to that of the swallow holes.

A central feature of the Big Sink is a compound sink and swallow hole configuration. Several field drains appear to terminate at this point and the bottom of the sink is littered by fish skeletons; some larger than 10 inches. Sherzer(1900) reported that fish enter the lake that occupies the Big Sink depression during spring run-off via surface streams and drains. The size of the skeletons raises the question of the orginal source of the fish. When visited during the later summer and fall months of 1976, standing water was observed only in two small ponds at the extreme western end of the Big Sink area. Pictures taken of the area during the early spring show that the entire depression can fill with water. Emptying of the lake can occur within a few days. Sherzer suggested one possible mechanism. Clays and surface fill which obstruct the subsurface conduits freeze during the winter months. Subsequent thawing follows the period of initial surface melt and runoff.

The rock outcropping in Plate III-12 is also near the site of what has been described as a main drain for the lake. Relying again on Sherzer's observations, the water is reported to exit so rapidly as to create a whirlpool effect. During the dry months in which current field work was done, only small open channels could be seen, as surface sedimentation effectively blocked possible openings.

2 Ottawa Lake Sink

At various periods in its recorded history, the large depression for which the nearby village of Ottawa Lake was named has been so dry as to obscure the fact that a lake was ever present. During other times, the water has persisted long enough to allow short-lived efforts at commercial exploitation. Natural fluctuations in the lake-water level have been augmented by efforts to reclaim a large part of the former lake bottom for agriculture. The surface outlet of Ottawa Lake has been dug out and field drains divert natural runoff. During an extended period of lower than normal precipitation, (1976-77) there was no standing water in the sink. Only large mud cracks with their resident salamanders seeking moisture at the lowest level indicated that the area still saw service as a lake during wetter periods.

Ottawa Lake Sink is approximately 5 miles WSW of Big Sink, still within Whiteford Township. U.S. Route 223 passes along the western margin of the sink. The bowl-like depression has a length of more than 2 miles and is a half mile at its widest point.

The north end of the sink is near the bedrock topographic high point for Monroe County. Several active swallow holes are reported around the rim of the lakebed. North of the head of the sink, an active swallow hole in a deep road drain channels surface drainage underground and possibly into the local drinking-water supply. The resident across the road described discoloring and silting of his well-water supply following rainstorms.

There was an unconfirmed(3) report of a cave located in the south end of the sink, but it is presently not possible to discern even a rock outcropping.

3 Lulu Quarry

Located just east of the village of Lulu, south of the count road of the same name, this inactive dolomite quarry provides one of the best sites for examining Monroe County karst. All things are relative, however.

The quarry was developed here to take advantage of a natural sinkhole and thin coverage by glacial till. The material removed from the excavation was used as foundation and building stone prior to the introduction of cement to the region around 1850. The quarry was abandoned long before the turn of the century.

The present owner of the quarry, Ron Brink of Lulu, indicated that he had acquired the quarry and nearby acreage for the purpose of developing a homesite and small lake. This was to be accomplished by plugging a NS crack traversing the quarry with clay or concrete. In early 1977, late summer of that year was given as tentative timetable for inundation of the quarry on a permanent basis.

(3) Scherzer, 1900

As with Whiteford Township's sinkholes, the dolomite here is apparently just above the Sylvania sandstone. The bedding of the dolomite is quite thin and provides a line of least resistance for solution, especially evident along the west wall of the quarry. Plate III-13 provides a partial view of abandoned solution channels along bedding planes. The lowest solutional parting visible in the photograph creates the interesting illusion that the entire upper mass of rock is suspended ¾ inch above its heavily rippled floor.

This degree of immature solutional development may be sufficient to explain the subterranean drainage over a large part of the county. The addition of Lulu's Crack to the list of karst features in Monroe County has offered some renewed interest in the potential of the area to produce human-sized passages.

Shown in Plate III-14, a north-south trending joint cuts the floor of Lulu Quarry. Removal of several large blocks of dolomite from the slot in December, 1976, revealed a low passage about 4 feet wide, floored with dirt fill. The passage followed the course of the joint to the north. After a short distance, the fill almost totally obstructed the opening. The passage can be seen to continue past the fill. Unusually hard freeze conditions have permitted only limited effectiveness in subsequent efforts at excavation by Michigan Interlakes Grotto members. During the spring thaw it is expected that the quarry will accept its normal quota of run-off. This may halt any further digging efforts.

Plate III-14: Field assistant (1.) and author contemplate Lulu's Crack.

4 Other Karst Features

Over 30 sinkholes were located by Michno (1972) in Whitef Township during his field work. Most of these are concentrated i broad area extending southwest from Big Sink to Ottawa Lake Si Highway construction involved in the widening of Michigan Route appears to have obscured several of the smaller swallow holes.

North of Ida, a small cave is located in a shallow sinkh approximately 100 yards west of the France Stone Company qua property. By most definitions it would not be considered a true ca but it does offer one of the two human-sized subsurface cavities Monroe County.

Conclusions

The Monroe County karst appears to be typical of immature stage of development in an undissected lowland. Solut is limited to Detroit River Group dolomites near the contact with Sylvania sandstone. Solution features are closely integrated with water table. Few permanent surface streams are found in the west half of the county. However, no ground water resurgences have be documented to provide a direct connection with sinking stream Traditionally, it has been stated that the subsurface water emerges springs along the Lake Erie shoreline.

Most of the bedrock features of the region are obscured b thick cover of glacio-lacustrine sediments. Observable karst featu are limited to the few locales of bedrock topographic highs. T seasonal influx of sediments into solution channels results in sinkh ponding.

There is a great deal of potential for study in the Mon County region. Its potential as a caving area is unfortunately m limited than like-named counties in more spelean locales.

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IV HISTORICAL & RECREATIONAL FEATURES OF MICHIGAN

Plate IV-1: Old lighthouse near Pictured Rocks.

GHOST TOWNS OF MICHIGAN

By: Dave Luckins

Old abandoned buildings, saloon doors swinging in the wind, tumbleweed drifting down the dusty streets of some forgotten western frontier town; this, the typical Hollywood movie image, is the most widely held image of a ghost town. However, there are more ghost towns in the State of Michigan alone, than in all the states west of the Mississippi River and, while they usually lack the tumbleweed, these are genuine ghost towns. They are relics of the brilliant gaudy boom and bust cycles that governed Michigan's economics and history until the 1900's when industries that weren't dependent strictly on natural resources such as trees and minerals began to develop and bring stable, long-term jobs to Michigan's work force.

Michigan's people, industries, and geography have conspired to determine the growth of the State of Michigan as we know it today and the growth and decay of hundreds of towns throughout the state at the same time. The state has been governed by three nationalities; the French, the British, and the Americans. It has had three major industries; mining, lumbering, and automobile manufacturing, and the geography can be divided into three areas; the wild and harsh upper peninsula, the great lumbering areas of the northern lower peninsula, and the settled southern farm lands.

The arrival of the French and British did little to establish lasting towns in Michigan. The French, interested in fur trading, established forts which later became cities at Sault Ste. Marie, Michilimackinac (now St. Ignace), and Detroit. The British acquired the area by treaty after the French and Indian War and used the French forts to wage war against American rebels in Ohio and Kentucky. The Americans gained Michigan in 1783 under the Treaty of Paris, but weren't able to gain control of the area until General "Mad" Anthony Wayne's troops occupied Detroit in 1796.

While the southern lower peninsula was quickly settled by the Americans and developed in stable farming communities, the northern areas of Michigan were abandoned by the British and ignored by the Yankee traders for almost fifty years. Early American maps of Michigan showed the bulk of the state to be worthless swampland. The few towns developed by the French and the British decayed and, except for the forts and cities like St. Ignace, the Sault, and Detroit, all traces have disappeared.

In 1845, copper and iron deposits were discovered in the Upper Peninsula (U.P.) and a rush of speculation followed. It wasn't until 1856, however, and the completion of the St. Mary's Falls Canal at Sault Ste. Marie that the ore could be removed to the factories of the East. The land rush which took place at this time would rival anything shown in the old western movies. Thousands of immigrants arrived each year to work the mines and the Upper Peninsula quickly became a melting pot

Each nationality settled in its own area and built a carbon copy of the town they left in the old country. It was not uncommon to find a town of Belgians located less than a mile from a town of Finns or Swedes. Each town was different in character and each nationality worked at a different mine.

The English miners from Cornwall were the first to settle in the U.P. They arrived after the copper and tin mines played out in England in the early 1840's. When mining began to die in the 1890's, the English were so well established that almost every mine had an English supervisor or captain. Because they spread around to run so many mines, the English established very few towns with a true English flavor. They did, however, leave the Cornish pasty to be enjoyed. Shops selling these delicious meat pies abound in the U.P.

The Finns arrived next and settled in the Keweenaw Peninsula followed by the Swedes who settled around Ironwood. The Belgians settled in Dickinson County, the Hungarians in Menominee County, and the Italians settled along the route serviced by circuit priest Father Mazzuchelli of Milan, Italy. Ghost town hunters can often tell the nationality of the towns founders simply by inspection of the ruins and the plants in the area that have reverted to their wild state, or by checking the names on gravestones in the local cemetaries.

Some of the Lakeshore Convention staff can trace their family trees back to the early Michigan settlers. Carol Fritz, our guidebook editor, comes from Finnish stock in the Keweenaw Peninsula. Today, her parents maintain a summer home in the newly resettled ghost town of Beacon Hill near Houghton-Hancock where her mother was born and raised.

My grandfather met my grandmother in the town of Ironwood where he was a mine supervisor. When the mine played out they returned to Yorkshire, England where they had twelve children, the last of which was my mother, Mabel Kelley (Luckins). To support the twelve children, Grandpa followed the mining work around the world until he died in the 1920's from gold dust in his lungs in a South African gold mine. Very few miners lived beyond the age of forty and most Michigan miners died by the time they were thirty-two, after only working for twenty years. Yes, many started when they were twelve years old.

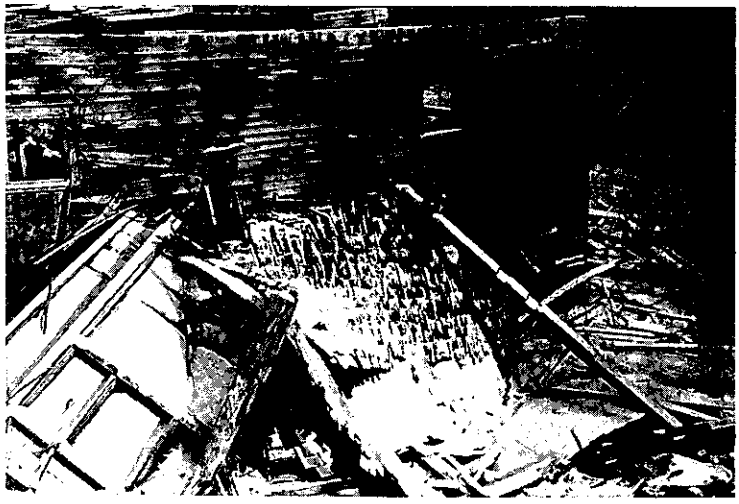


Plate IV-2: Old mill typical of many ghost town buildings.

Hundreds of ghost towns dot the Upper Peninsula, but the first one a visitor should see is the town of Fayette in the limestone rich Garden Peninsula along side of Lake Michigan. Its the only restored ghost town in the state and is now maintained as a State Park. The caves in the ghost town of Burnt Bluff, about six miles away are also of interest. (See Mini Tours)

The Jackson Iron Co., founded July 6, 1848 acquired 16,000 acres of heavily timbered land from a Mr. Squires in 1864 to begin construction of a furnace town to be named after the company's general agent, Fayette Brown. Christmas Day, 1867, marked the first day iron was run at Fayette. By 1875, the furnaces had produced more than 70,000 tons of iron. In 1880, approximately 200 men worked at the furnaces making Fayette one of the largest and most important towns in the Upper Peninsula.

The iron companies made it a practice to ban liquor from all company towns and, along with that, they also banned almost all other forms of pleasure enjoyed by miners and furnace men. Fayette, being a company town, was under these tight rules when, in 1880, it became apparent that the workers were determined to spend the monthly payroll (approximately $6,000 in gold) on something more than Bibles.

Enterprising businessmen were quick to provide what the male population wanted by bribing the local law and company officals to look the other way while they established saloons and brothels outside the town. The doom of Fayette was forecast by a circuit minister who foretold of the destruction of the town if the men didn't repept

Within two years, husbands and boyfriends were being cheated in the saloons and rolled in the streets. The final straw came when a young girl escaped from the Stockade, a saloon owned by Jim Summers, on the outside of town. The Stockade was a fenced saloon and brothel designed to keep the good ladies from town out and to keep the working girls in. (Not all the girls were there of their own free will; some were working off the debts of their fathers or husbands in other towns).

The escaping girl fled to the deputy sheriff assuming he'd protect her. Instead, she was quickly turned over to the Stockade owner. When the town folks discovered that their officials were in cahoots with the brothel owners, they decided to rescue the girls. Within hours all the girls were rescued, the brothels and saloons destroyed and Jim Summers was left upon the shore to die, his body beaten and bloody. So it goes in frontier towns.

Perhaps the preacher was right in his gloomy forecast. In 1883, fires destroyed the furnaces and many felt that the town was doomed. New furnaces were built, but weren't really used because mining was dying in Michigan. By 1900, the town was almost empty except for some fishermen. The trees and foliage returned to the denuded 100 foot limestone cliffs and Fayette was again the garden spot of the area.

Today, the remains of the town consist of the furnaces, machine shop and general store, all built of local limestone. The hotel, homes, and apartments and some of the shops, all built from local materials, are still standing, some in poor repair.

One of the largest lumbering towns in Michigan is the ghost town of Pequaming, located about eight miles north of the town of L'anse at the base of Keweenaw Bay. The huge smokestacks and water tower are visible for miles. The town, founded in 1878 by Charles and Edward Hebard and H.C. Thurber, was built to serve as a lumber mill town.

The Hebard and Thurber mill, by 1880, was producing twenty-five million feet of lumber and twenty-five million shingles annually. By 1910 the timber was almost exhausted, the mill having produced over 500 million feet of lumber, and the town started to decline.

Around 1920, Henry Ford announced that he intended to buy one million acres of land to support a new factory to produce wood parts for his automobiles (primarily the Woody Station Wagon). After much searching, he purchased almost all of Pequaming and much of the land around L'Anse.

Using the same techniques as he used on (or for) his auto workers, Ford rebuilt the town to be a model lumber mill city. He established neat white frame houses (in Ford's mind all cars should have been black and all houses white), recreation centers with movies and radios, fancy dining rooms with china, electricity, running water and fire hydrants. He paid his workers $6.00 a day, forced them to give up drinking, made them save a portion of their pay and go to church.

Inspection of your home and investigation of your mores was standard practice; if you didn't meet Mr. Ford's standards you were fired. The old lumberjacks didn't object to the inspections, they were standard company town practice, but they objected to the drinking ban and to forced church attendence. They despised Ford, but took his money.

Ford still owns most of the land in the area, but the towns and mills have been shut down and the people have moved away. Not very much has changed in the area since wood parts have been dropped from cars and the town of Pequaming remains as an interesting example of paternal capitalism.

Just a few old buildings are all that remain of the town of Shelldrake. The town, once named Edwards after its first resident, is visible from M-123 between Paradise and Whitefish Point. You can reach it by following an old trail off the main road through a shallow marshy area to the buildings.

Shelldrake, named after a duck common in the area, was considered a model town for its time. There was a sawmill, houses for the workers, a hospital, school house, and an icehouse which could store enough meat to last a town of 1,000 all winter. Most of the buildings were plastered (a progressive event in the 1890's) and piped for hot water supplied by the sawdust burner.

A succession of lumber companies operated in Shelldrake and removed the specific kind of lumber that they needed; pine, hemlock, ironwood, and others. Nothing, of course, was replanted. When the lumber was gone, the companies withdrew and Shelldrake died. The post office was closed in 1922.

One other town is worth mentioning at this point, not so much because of its importance (it didn't have any) but because nearly everyone at the convention will drive through it. The town of Fiborn is located in the heart of Michigan's newest caving area.

Fiborn was named after W.F. Fitch and Chase S. Osborn, former Michigan governor. The town was another company town owned by these men. The foundations along the road to the caves are the workers homes. Around the side of the quarry are the remains of the general store. The cutting house and the crusher are in the qua Old railroad beds, limestone homes and old log cabins can be foun the woods nearby. The log cabins are trappers cabins and predate town while the stone houses are the homes of company official.

Even after the town died the homes, which were very v constructed, remained standing and, around World War II, Indi moved into them. The land was then owned by a large company held as a reserve. The company objected to the Indians, the st goes, so one night the local law set fire to all the houses and bur them to their foundations. It's not known if they warned the Indi first.

Traveling to see the towns of Fayette, Pequaming, Shelldra and Fiborn will take at least a full day. These particular towns w selected because they represent different types of towns, are different areas of the U.P., and are easy to reach. Other towns wh aren't true ghost towns but are shadows of their glory are Burnt B Point, near Fayette, Nahma, a lumber town about fourteen miles e of Rapid River and five miles south of US-2, Epoufette, on the shor Lake Michigan, and Gould City.

The ghost towns of the lower peninsula aren't as v preserved as their upper peninsula counterparts. The more rapid longer growing season has allowed nature to remove the blight wh man inflicted upon the area. In addition, the towns of the north lower peninsula were faced with another hazard–forest fires.

The classic story of big business raping the land is found in northern lower peninsula of Michigan. Railroads, seeing the need timber in the expanding eastern states, purchased huge tracts of l in Michigan. They then sold the timber rights and forced the lum companies to ship on their railroads or steamships. The railro developed the concept of lateral expansion which is now being u by the oil companies.

After the land was cleared, the railroads sold the lanc farmers. Full page ads were run in the papers in Europe describing land as prime, virgin, rich, ready to farm, and close to transportati Thousands of immigrants from eastern European countries came a found land filled with pine stumps as wide as eight feet in diame highly inflammable brush, and a very thin layer of mulch and topso The land near transportation had already been purchased by peo from southern Michigan to set up stores and businesses. Thousand the immigrants quit or were burned out.

With the trees gone, the cooling winds which formerly bl gently through the northern forest had nothing to slow down th speed. During the winter, winds of over eighty miles per hour wo bring sub-zero temperatures from the north, while in the summer winds would sweep out of the south bringing temperatures in the l 100's and blowing the topsoil away. In the process, a spark would st a fire and soon thousands of acres of brush would burn and so wo any home or town in the way.

At one point, in 1906, approximately 85,000 acres of land v on fire in Michigan. As people left the land, the State reclaimed it back taxes. By 1910, major conservation projects had been launch and most of forest near Alpena had been seeded.

Unlike the upper peninsula mining and lumbering towns, th in the lower peninsula didn't develop into wide open towns. To sure, towns like Alpena, Boyne City, and Charlevoix developed first bawdy mill towns and enjoyed a scandlous growth that is amus when one considers their respectable appearance today. Most of towns which remain developed as rail centers to collect and sl goods south to the big cities of Saginaw, Detroit, and Lansing. Tow like West Branch, Grayling, Gaylord, Posen, and Rogers City were stops on the railroads, which guaranteed their existence.

Another town which should have had a guaranteed exister was the town of Metz. In 1908, the town had an extensive saw n trade, several general stores, a saloon, hotel, two or three liveries, a even a cigar factory. The summer of 1908 had seen the a threatened by high winds, thunderstorms, and forest fires, accordi to Mrs. Dale Roeder of Detroit. As a little girl of nine, she rememb waiting at the rail station in Posen on a hot October day as the town Metz and several smaller surrounding towns were destroyed by fir Logging trains had been sent from Posen to Metz to try to bring out survivors. Mrs. Roeder's cousins lived in Metz.

When the first logging train returned to Posen there w several flat bed cars full of survivors, but Mrs. Roeder's cous weren't among them. Panic gripped the family when they heard t the other two trains might not make it back to Posen because the h

of the fire was warping the rails. A second train pulled in and among its passengers, Mrs. Roeder reports, were her soot covered cousins.

The third train, which was following close behind the second train, derailed about five miles from Metz when the rails melted. Two crew members and thirteen passengers were killed. Today, the Village of Metz has erected a marker remembering the day that the future of the town and the lives of so many were wiped out.

Crawford's Quarry wasn't destroyed by fire, but by a hole in the ground. In the early 1860's, Francis Crawford landed at Burnam's Landing on the shore of Lake Huron. Crawford and his wife, Cynthia, platted a village and cleared the land. In the early 1870's, Crawford built a county court house and was determined to establish a county government under his control in Crawford's Quarry. The county government formed by Crawford was declared illegal and a new government was formed, with the county seat at Rogers City, in 1875. At the same time county elections were held and Crawford's son Tom was elected county treasurer. The new treasurer continued to maintain his office in Crawford's Quarry while the rest of the county government worked out of Rogers City. When a new treasurer was elected, Tom refused to turn over the books and fled on a tug boat to evade arrest.

When the lumber played out, Crawford's Quarry became a ghost town. It came to life around 1910 once more when what is described as high calcium limestone was discovered in the area. The name of the town was changed to Calcite and the town became the home of the world's largest limestone quarry. The old site of Crawford is now a hole in the ground.

Bell, located in the Bell Pines Park, along the Lake Huron Shore was also known as False Presque Isle Harbor. It was a lumbering village which furnished all the ties, fence, and car material for the Chicago and Canada Southern Railroad west of the Detroit River. The town is noted because of its long, secluded beach of Lake Huron.

The study of ghost towns is really a study of the hopes, dreams, and courage of people like you and me. When you visit one of the towns described or if you find some on your own, stop and reflect on the drama of human life that occurred before we were born. Try to find the old cemeteries and read the names on the stones aloud, for these brave people who risked all deserve to be remembered. Should you find noticeable hollows in the cemetery overgrown with sweet smelling flowers, you have found the first Americans in that area and are in the midst of true heros.

ACKNOWLEDGEMENT

In the state of Michigan, there is only one expert on the subject of ghost towns, Mr. Roy L. Dodge. Without his three volumes of MICHIGAN GHOST TOWNS, this article wouldn't have been possible. You may obtain copies of MICHIGAN GHOST TOWNS by writing to: Glendon Publishing, 129 E. North St., Tawas, Michigan.

POINTS OF INTEREST

While the tours and articles preceeding this section cover the major geologic and historical-recreational features of Michigan, there are many other points of interest which you might enjoy visiting while traveling through this state.

BELL PINES or Besser Natural Area is only fourteen miles north of Alpena on East Grand Lake Road which turns off U.S. 23. The area has 4,500 feet of lakeshore with 500 feet of that being sandy beach.

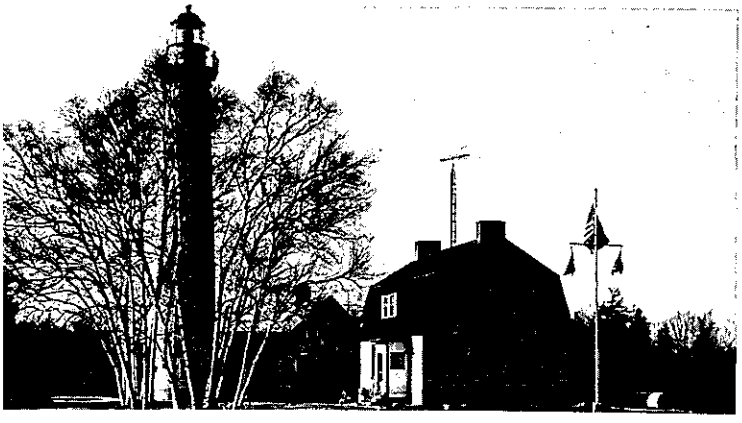


Plate Iv-3: Presque Isle lighthouse, built in Abraham Lincoln's time.

PRESQUE ISLE HARBOR AND LIGHTHOUSE are located on East Grand Lake also. They are about twenty-three miles north of Alpena. The harbor has a marina and the Old Lighthouse is now a museum housing relics of the wood-burning steamer era. The tower with its three foot thick walls offers a great view of the harbor and Lake Huron.

HARTWICK PINES STATE PARK located seven miles NE of Grayling on M-93 off I-75 in the center of the northern third of the lower peninsula is one of the largest virgin stands of white pines remaining in Michigan. It has an excellant indoor-outdoor museum of lumbering artifacts and offers a chance to walk among the trees which once covered most of Michigan.

SLEEPING BEAR DUNES, Michigan's other National Lakeshore, has within it two state parks which are open to the public. This area of dunes, some of them 400 feet high, is located on the western side of Michigan's lower peninsula along the Lake Michigan shoreline. The Sleeping Bear Dunes are west of Traverse City and north of Frankfort on State Routes 22 and 109.

THE SOO LOCKS. If you stay on I-75 after crossing the Mackinac Bridge into the upper peninsula, you will eventually end up in Sault Ste. Marie, the location of the Soo Locks. The locks were built to aid ships in navigating the St. Mary's River connection between Lake Superior and Lake Huron. You can take a boat tour through the locks or just watch the sea going ships do it from various overlooks.

TAHQUAMENON FALLS is Michigan's highest above ground waterfall. Located in the upper peninsula fourteen miles west of Paradise near M-123, frequent signs make it impossible to miss and it is a nice stop on your way to or from the Grand Sable Banks and Dunes. The upper peninsula has over 150 known waterfalls and if you enjoy that sort of thing, a Waterfalls Guide to Michigan's Upper Peninsula is available at any of the Tourist Information Centers.

The SENEY NATIONAL WILDLIFE REFUGE about sixty miles west of Tahquamenon Falls on M-28 and right on your way to the Pictured Rocks Tour was established on timber-stripped burned-over land that reverted to the state for taxes when farmers who bought it from the lumber companies discovered that the sand and swamplands were worthless for agriculture. The 95,000 acre refuge now is home to a variety of water fowl, eagles, sandhill cranes, songbirds, and fur-bearing animals such as otter, mink, bobcat, fox, and deer. There are car tours, nature trails, fishing and picnicking areas. Further details may be obtained at Tourist Information Centers.

MINES—If mines are your "thing", the U.P. has several which are open to tourists. Iron Mountain Iron Mine on U. S. 2 in the western U.P. offers a train and foot tour of 2,600 feet of mine drifts and tunnels. It is located in Iron Mountain, Michigan.

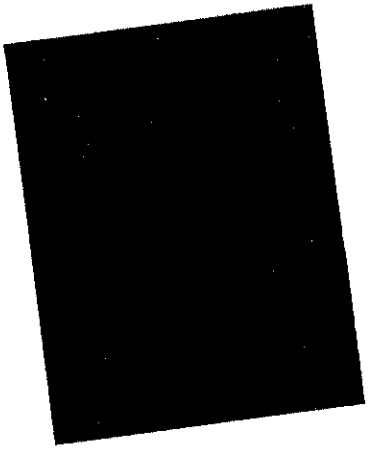
Arcadian Copper Mine near Hancock, Michigan in the Keweenaw peninsula is an excellant example of the mines which made Michigan's Copper Country famous. The walking tour takes you 300 feet underground for a quarter mile tour.

THE COPPER COUNTRY is all of the area in the U.P. where copper was mined. It is picturesque country and a great place to camp and introduce yourself to rugged but beautiful Lake Superior. The twin cities of Houghton and Hancock are considered the gateways to the Copper Country.

Houghton is also the main jumping off point for one of our most unique National Parks. ISLE ROYALE NATIONAL PARK in Lake Superior can only be reached by seaplane or boat. The island of about 210 square miles has an outstanding ecological environment which is home for everything from timber wolves to moose. There are 160 miles of hiking trails, inland lakes for canoeing, fishing trips, and unbelievable scenery. Details on lodging and transportation are available at the Park Headquarters in Houghton.

Last, but not least, are the PORCUPINE MOUNTAINS, Michigan's biggest state park. Located near Ontonagon on M-107 in the northwestern corner of the U.P., the park consists of 58,327 acres of rugged forests and mountains on the shore of Lake Superior. The camping, fishing, and back country hiking are unbeatable.

Armchair Cavers REJOICE!



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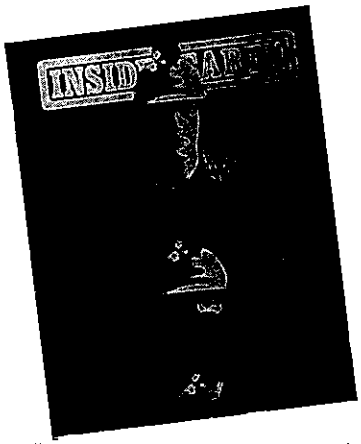

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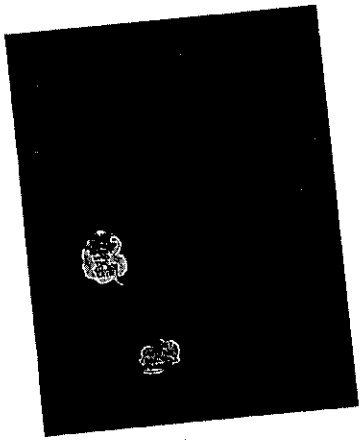

NUMBER ONE. Only 250 copies of this prototype issue were printed and they were sold out soon after they came off the press. We have four pristine copies left and will donate the entire purchase price to the NSS, in the name of the purchaser. (Note current price!) This is a hot collector's item. Articles on Texas and Mexican caving, Mammoth Cave, lava tubes, all-women caving, rabies. 80 pages. $75.00 ppd.

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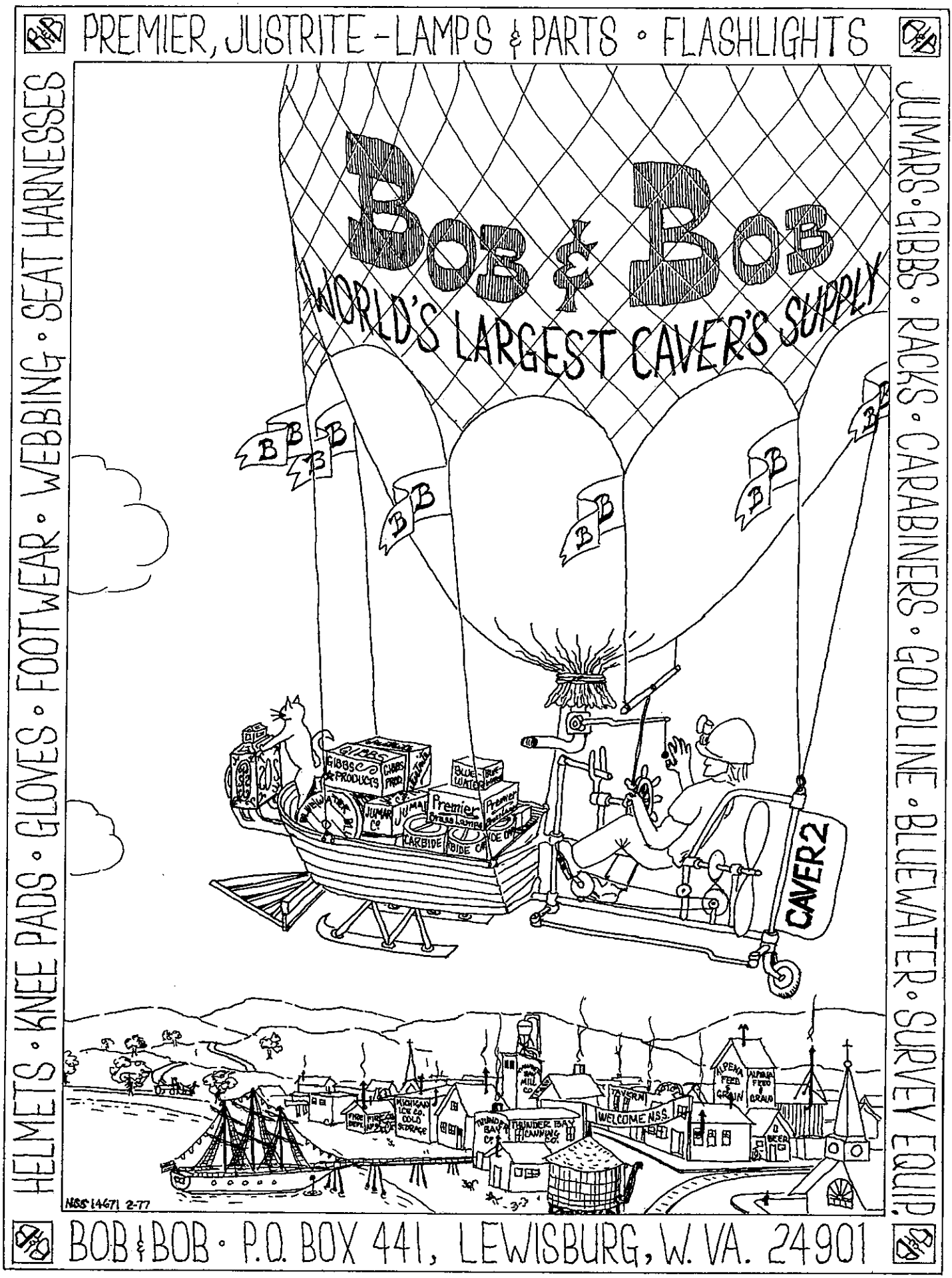
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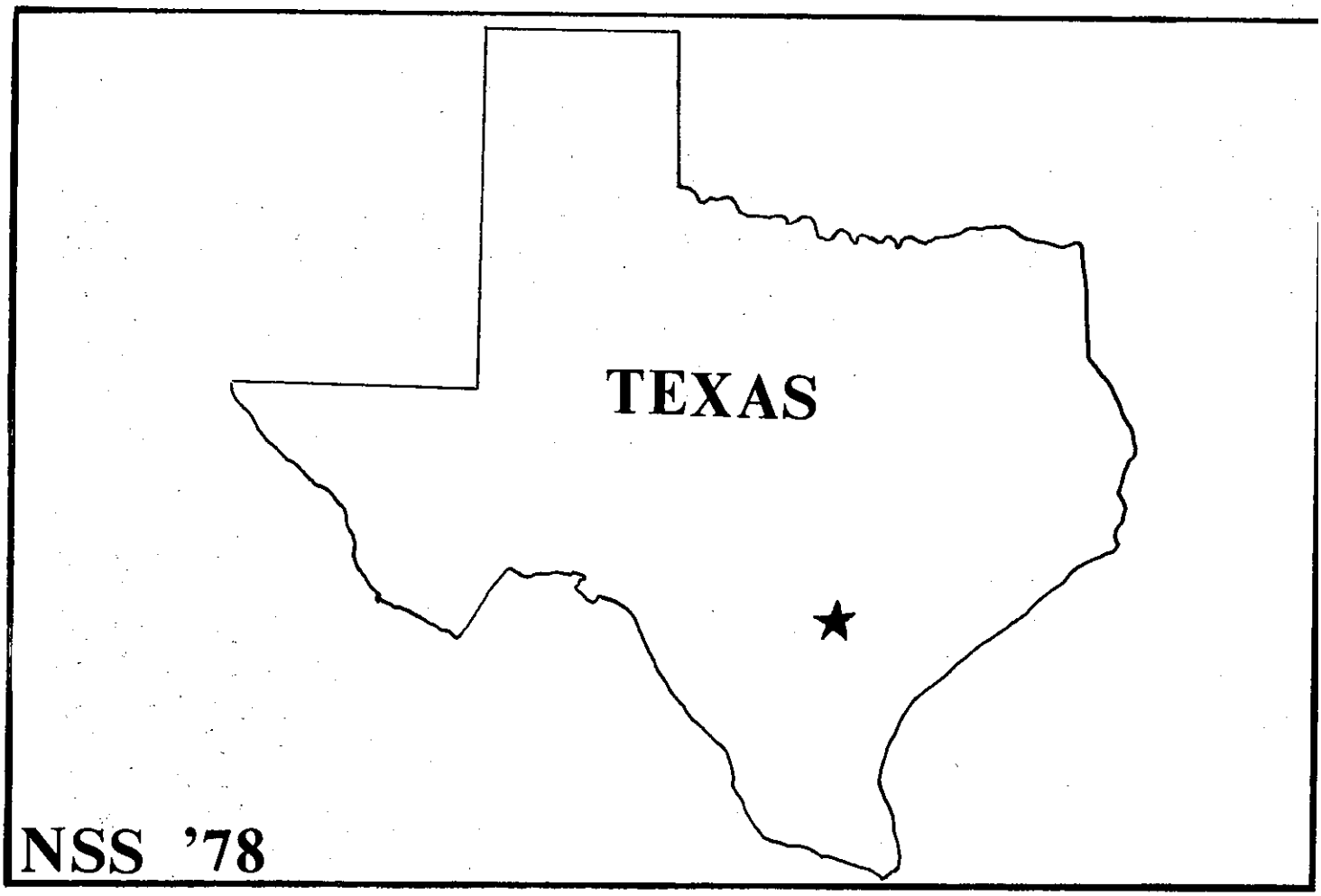

The 1977 NSS Convention Committee would like to thank

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notes: