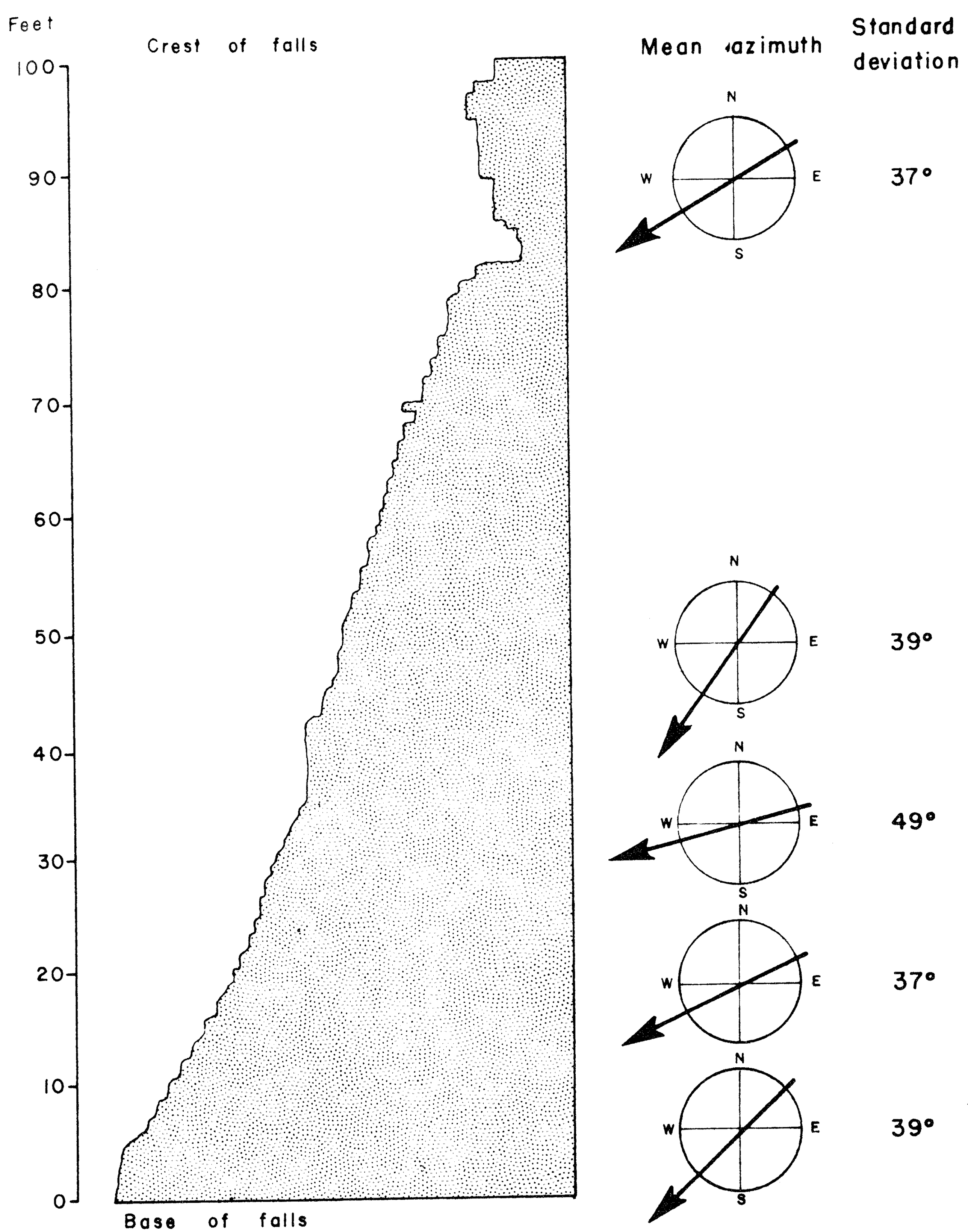
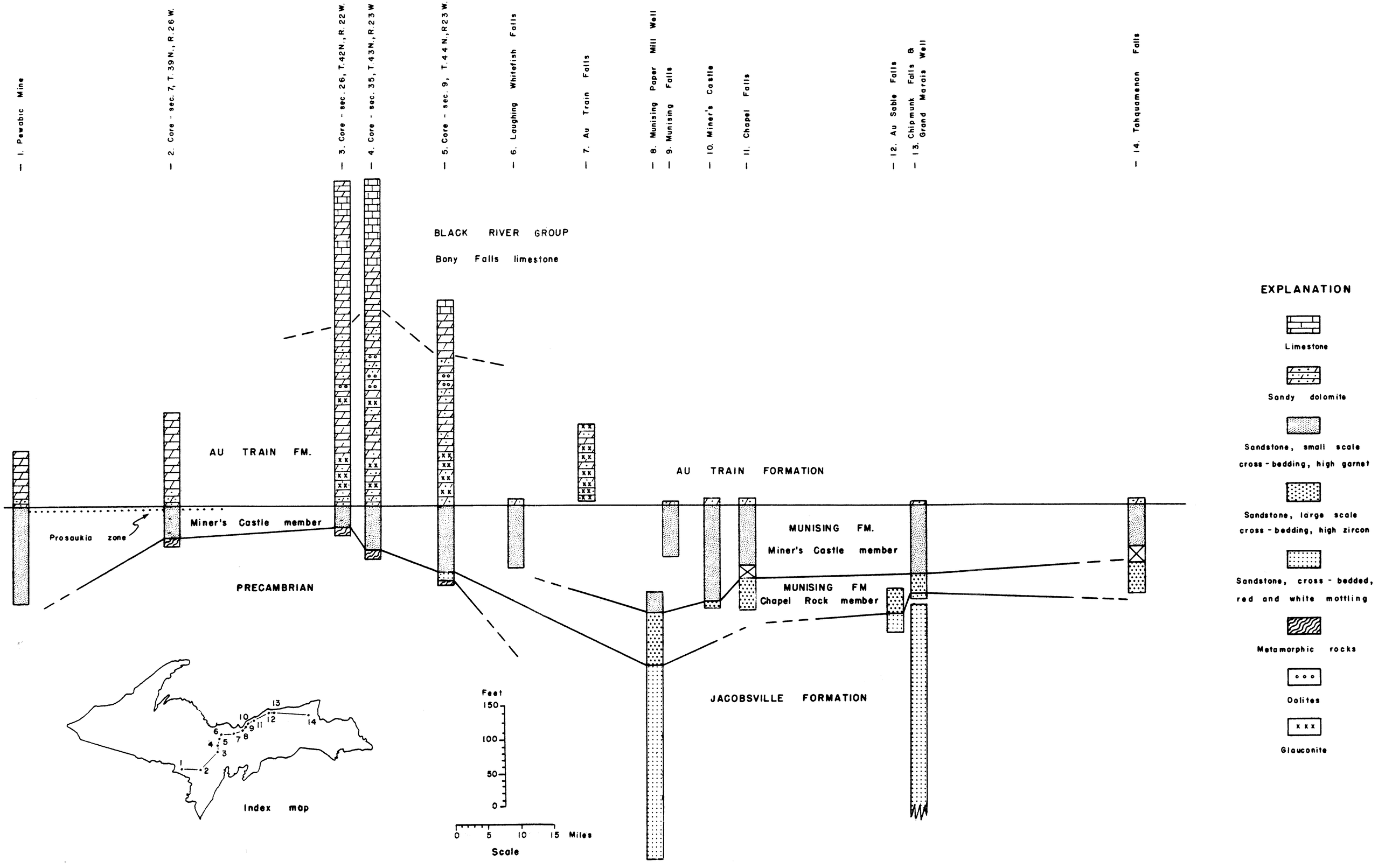
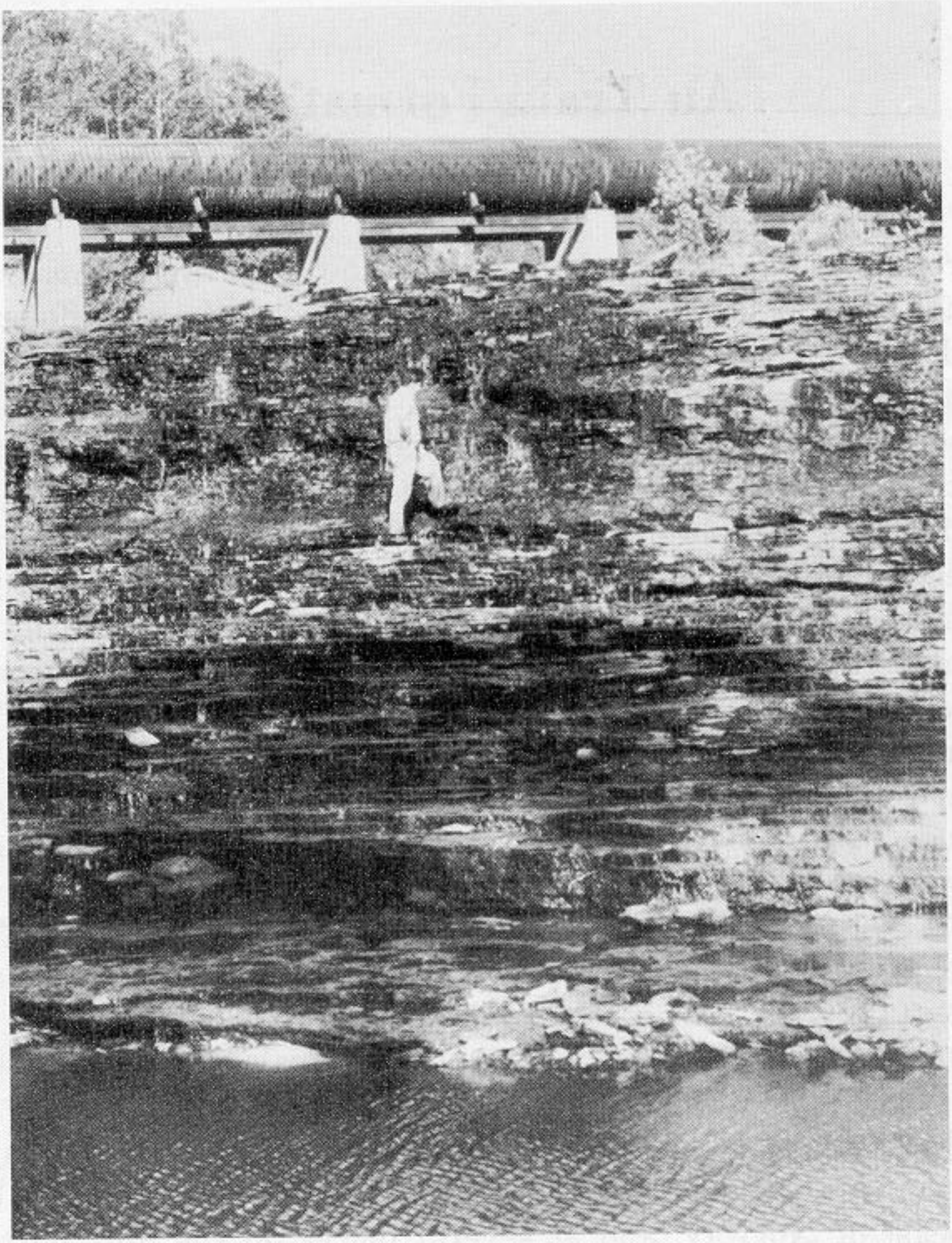
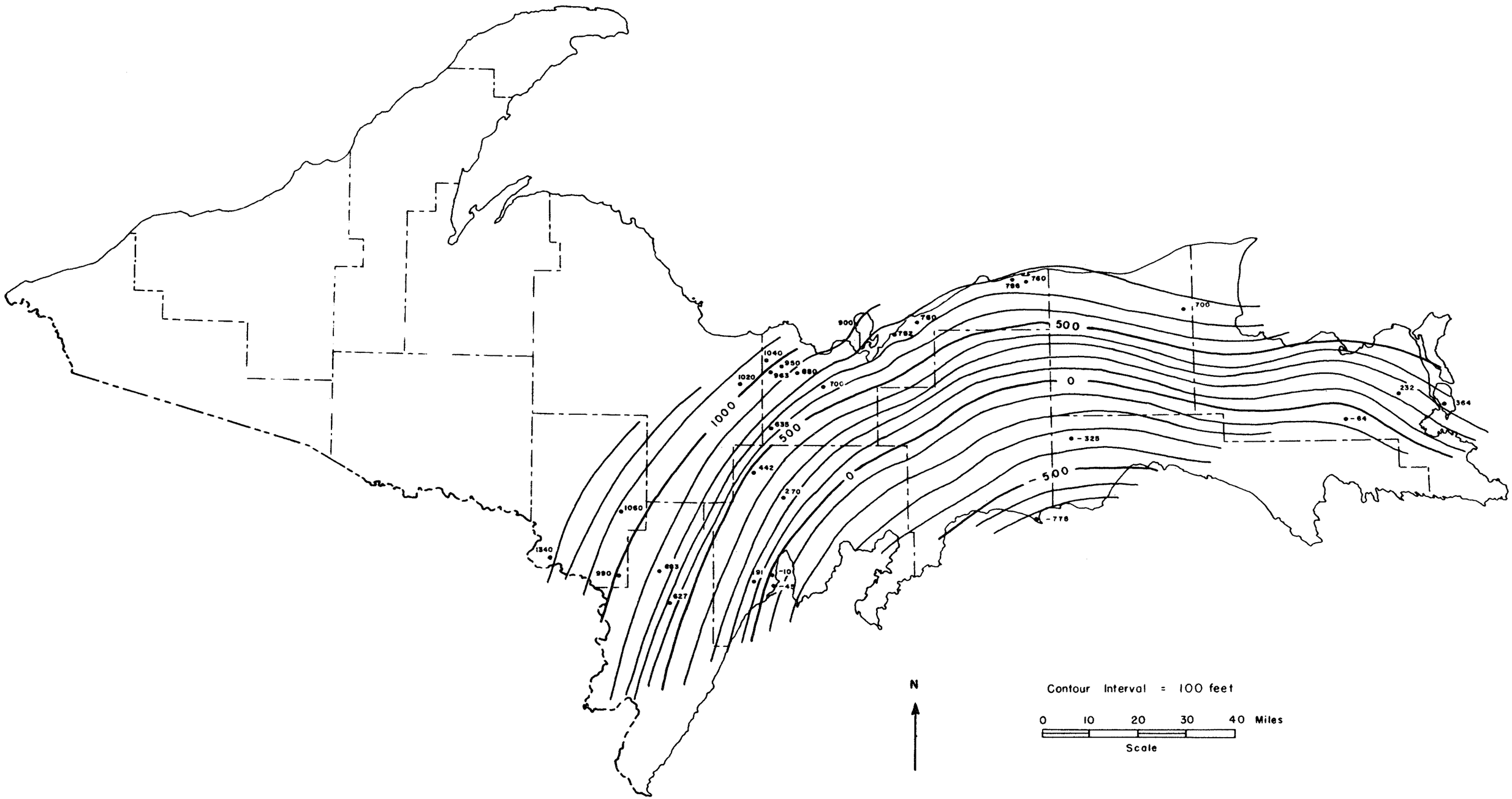

Feet
Crest of falls
Mean azimuth
Standard deviation
100
90
80
70
60
50
40
30
20
10
0
N
W
E
S
37°
39°
49°
37°
39°
Base of falls

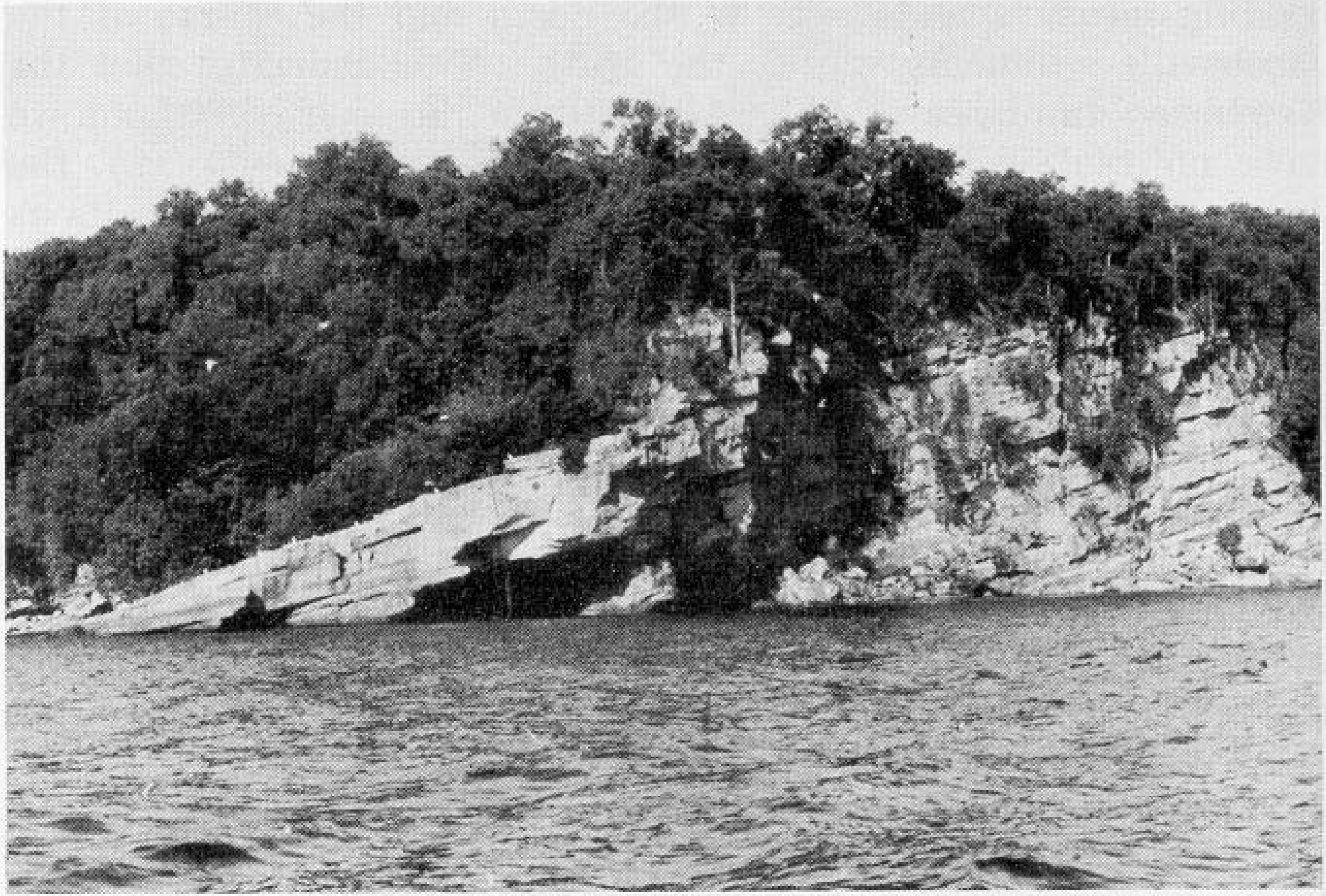

1. Pewabic Mine
2. Core - sec. 7, T. 39 N., R. 26 W.
3. Core - sec. 26, T. 42 N., R. 22 W.
4. Core - sec. 35, T. 43 N., R. 23 W.
5. Core - sec. 9, T. 44 N., R 23 W.
6. Laughing Whitefish Falls
7. Au Train Falls
8. Munising Paper Mill Well
9. Munising Falls
10. Miner's Castle
11. Chapel Falls
12. Au Sable Falls
13. Chipmunk Falls & Grand Marais Well
14. Tahquamenon Falls
BLACK RIVER GROUP
Bony Falls limestone
AU TRAIN FM.
Miner's Castle member
Prosaukia zone
PRECAMBRIAN
AU TRAIN FORMATION
MUNISING FM.
Miner's Castle member
MUNISING FM
Chapel Rock member
JACOBSVILLE FORMATION
Feet
150
100
50
0
0 5 10 15 Miles
Scale
Index map
EXPLANATION
Limestone
Sandy dolomite
Sandstone, small scale cross-bedding, high garnet
Sandstone, large scale cross-bedding, high zircon
Sandstone, cross-bedded, red and white mottling
Metamorphic rocks
Oolites
Glauconite

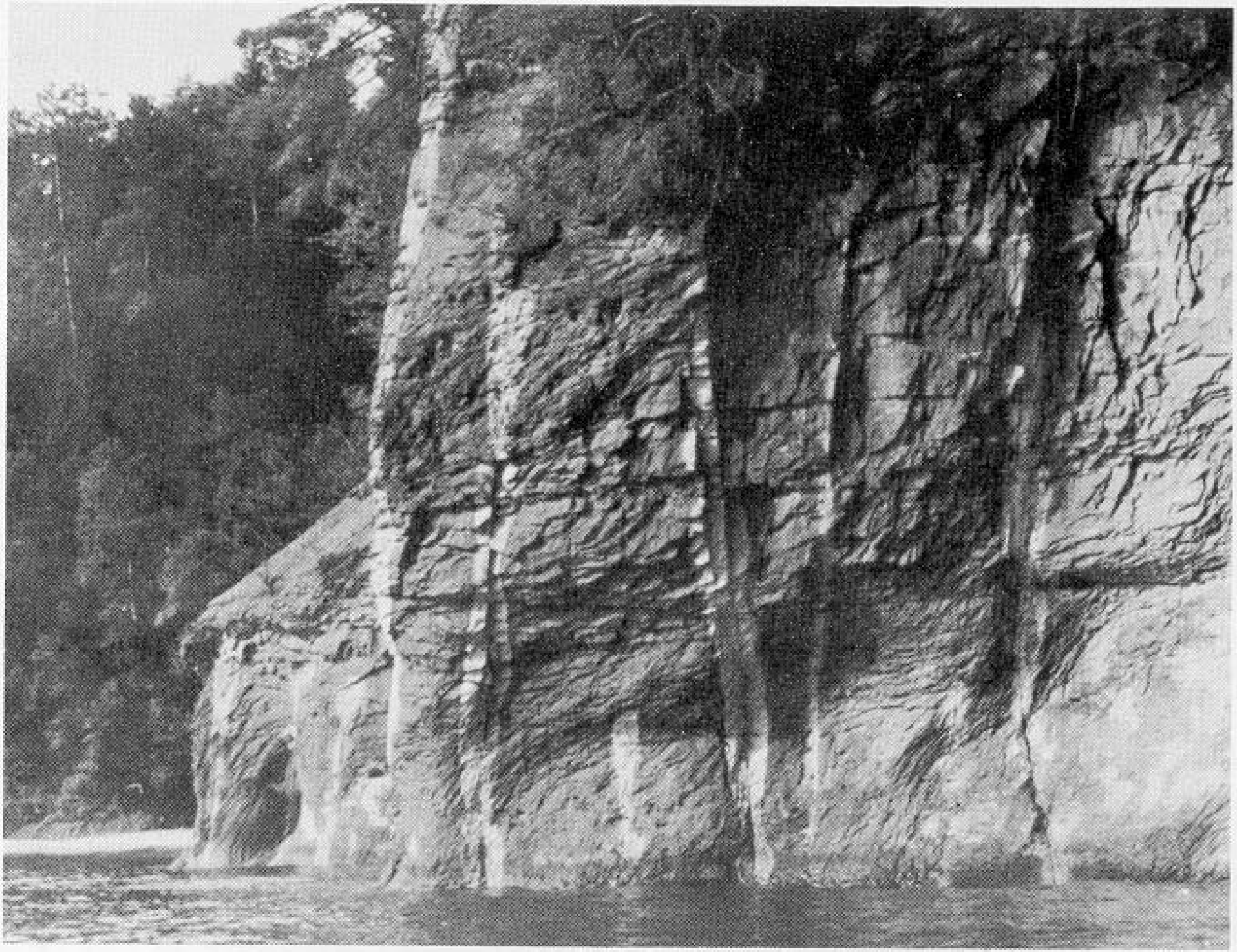


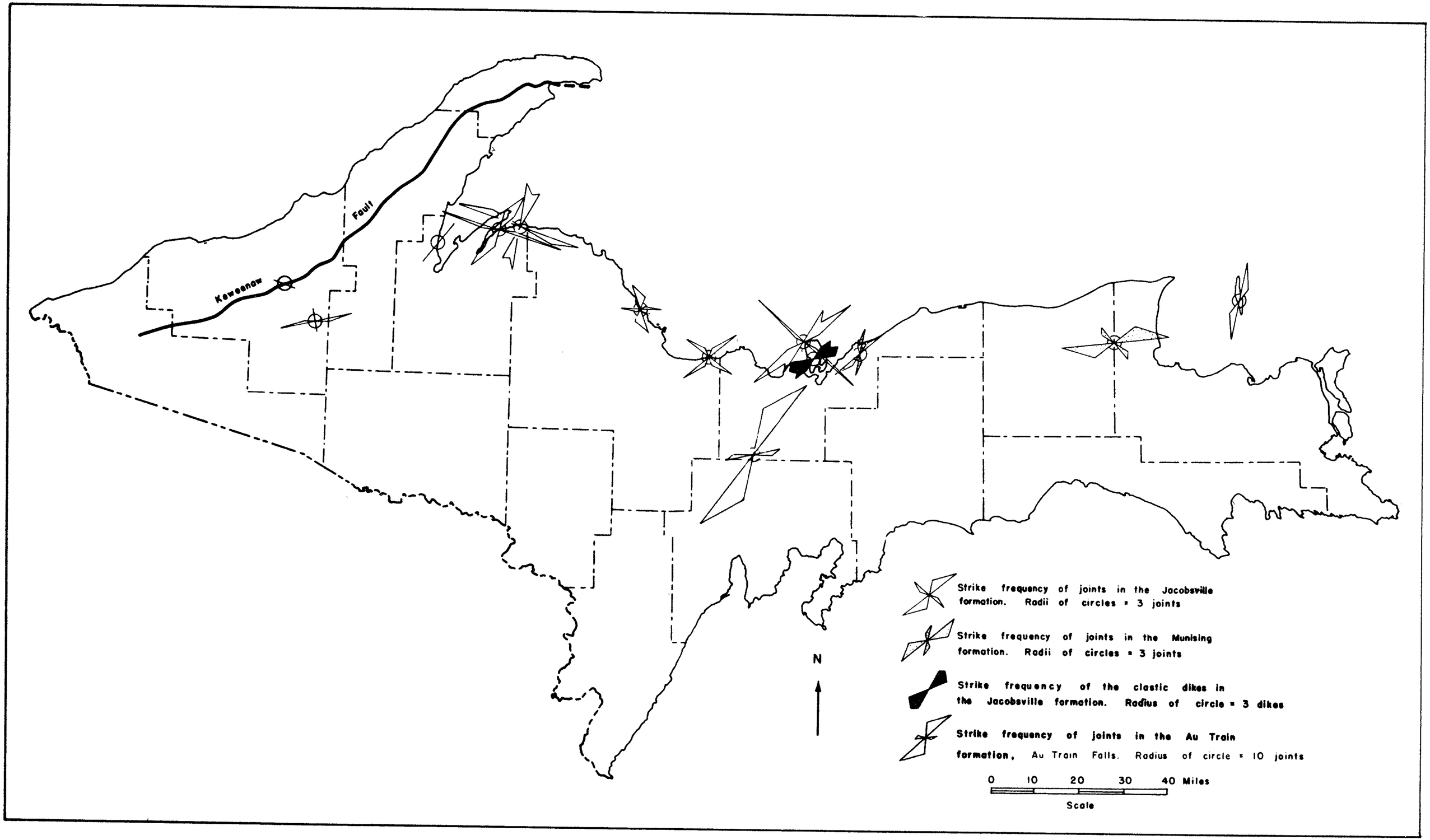
Footage	Section	Description of lithology
		Top of Upper Au Train Falls
		Sandy dolomite, grayish-blue to dark blue, beds 4-10 inches thick, some interbedded buff fine- to medium-grained sandstone units, several horizons contain abundant glauconite and authigenic pyrite
120		Glauconitic
		Sandstone bed 6" thick, buff to light gray, medium- to fine-grained, well rounded and well sorted
		Sandstone bed, same as above
110		
		Sandstone bed, same as above
		Authigenic pyrite filling vugs
110		Pure dolomite
90		Highly glauconitic
		Authigenic pyrite filling vugs
80		Sandstone bed 8" thick, fine- to medium-grained, buff to light gray, well rounded and well sorted
70		Abundant authigenic pyrite
		Highly glauconitic
60		Base of Upper Au Train Falls
50		Covered interval between Upper and Lower Au Train Falls
40		Sandy dolomite to dolomitic sandstone, buff to bluish-gray, beds 2"-6" thick, generally separated by thin lenses of silt or clay, bedding planes are undulatory, percent of sand varies throughout the section, glauconite extremely abundant especially near the base
		Glauconite and clay galls
		Crest of Lower Au Train Falls
30		
		Glauconite concentrated along several horizons, sandy units exhibit small-scale cross bedding, thin shale lenses separate units
20		
		Glauconite is extremely abundant as it constitutes between 10-30 percent of many thin units
10		
		Hard, weathers dark brown, beds from 8"-12" thick, several horizons contain pebbles of sandstone and dolomitic sandstone which apparently constitute an intraformational conglomerate
0		Base of Lower Au Train Falls

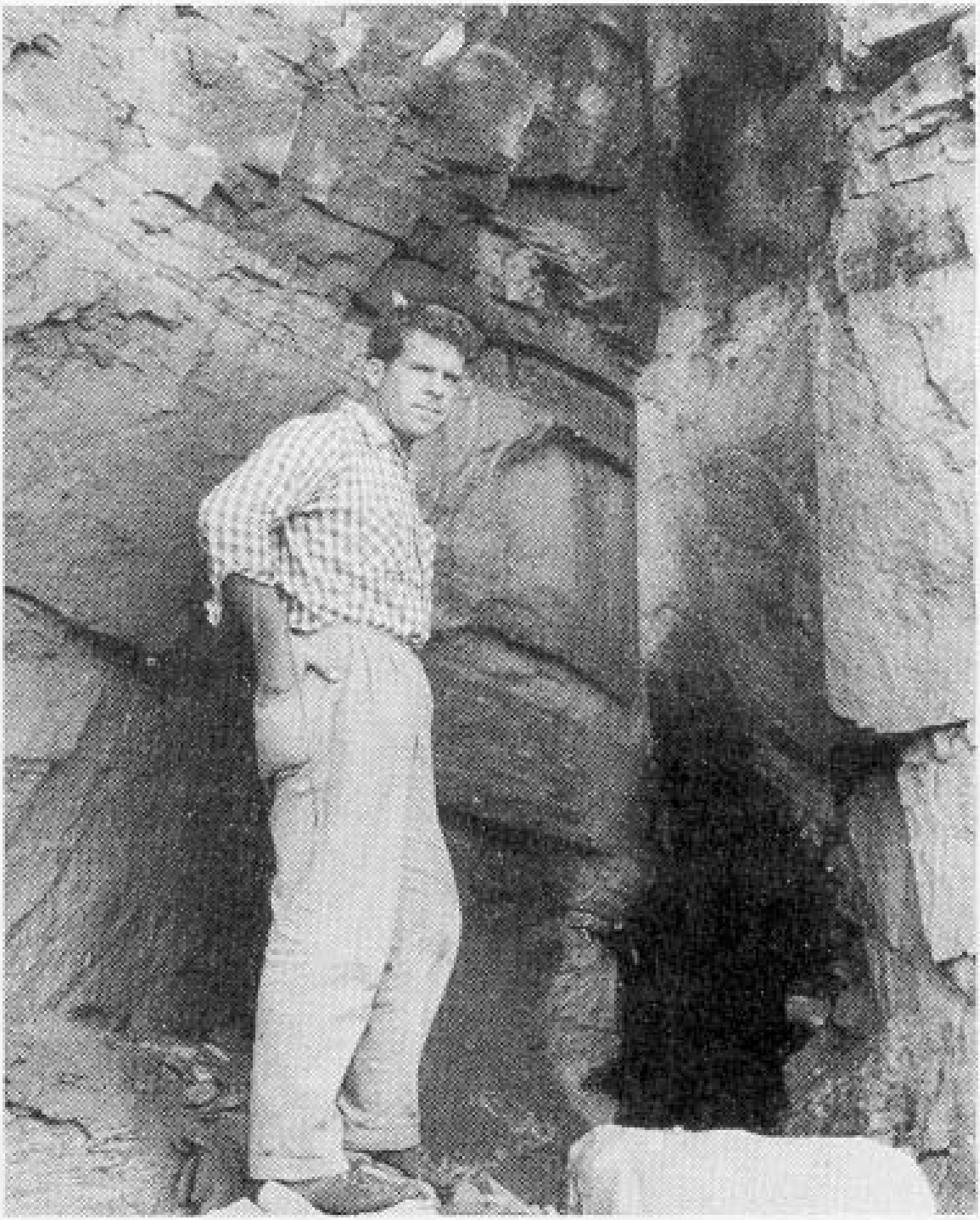


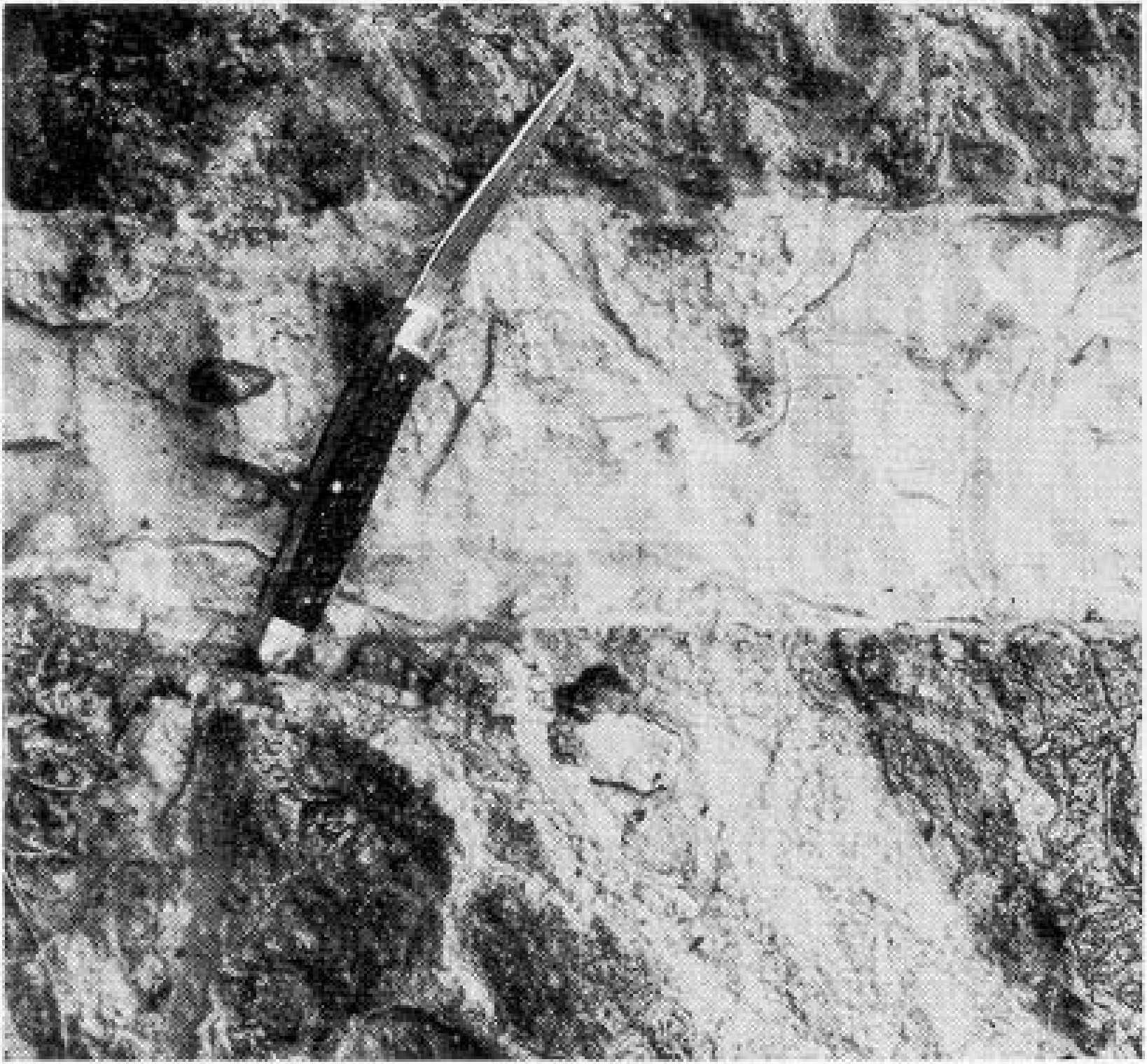
1000
500
0
-500
1040
950
963
880
1020
700
635
442
270
1060
1340
990
693
627
191
-10
-45
900
760
792
796
700
232
364
-64
-325
-778
N
Contour Interval = 100 feet
0 10 20 30 40 Miles
Scale

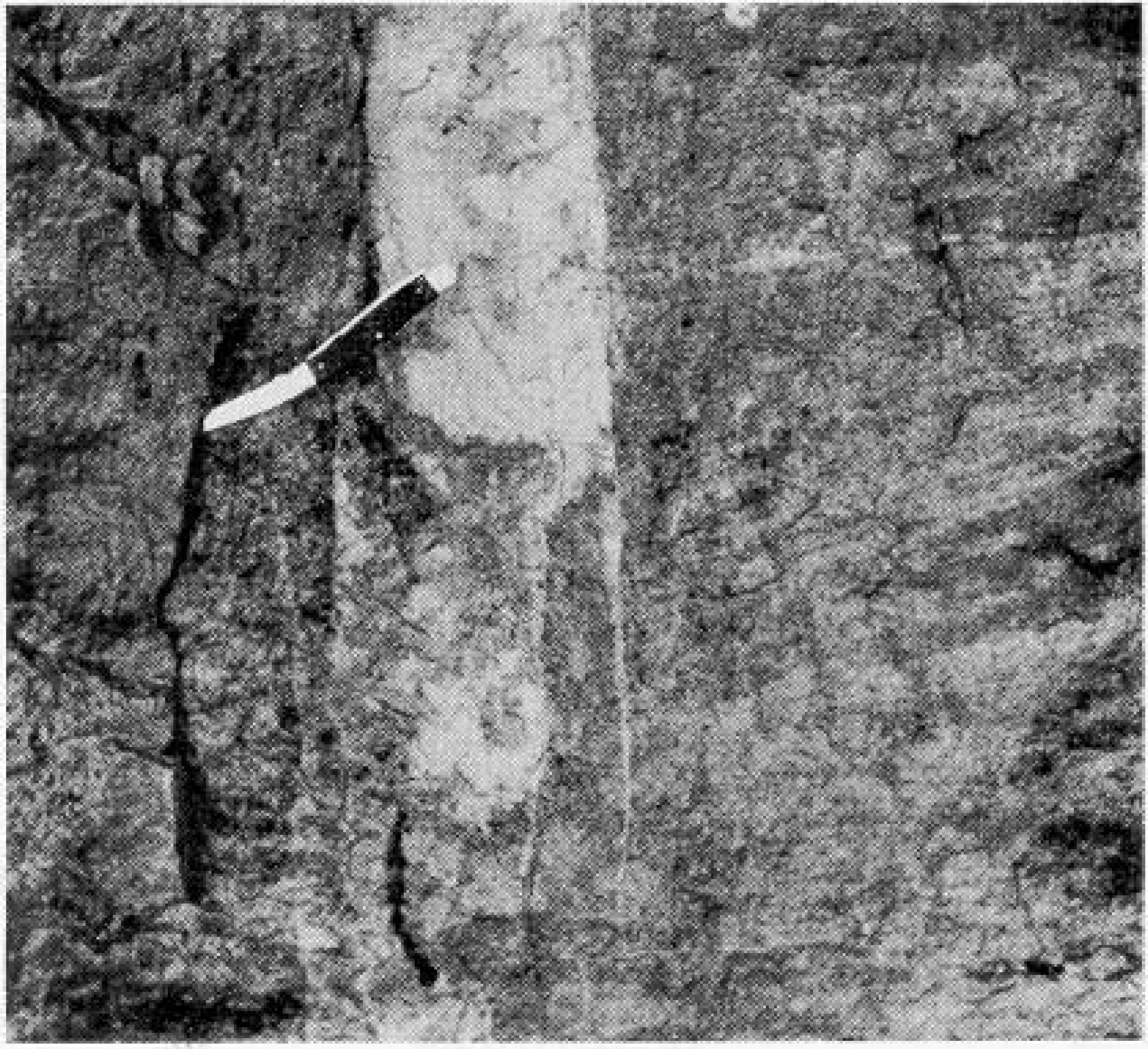


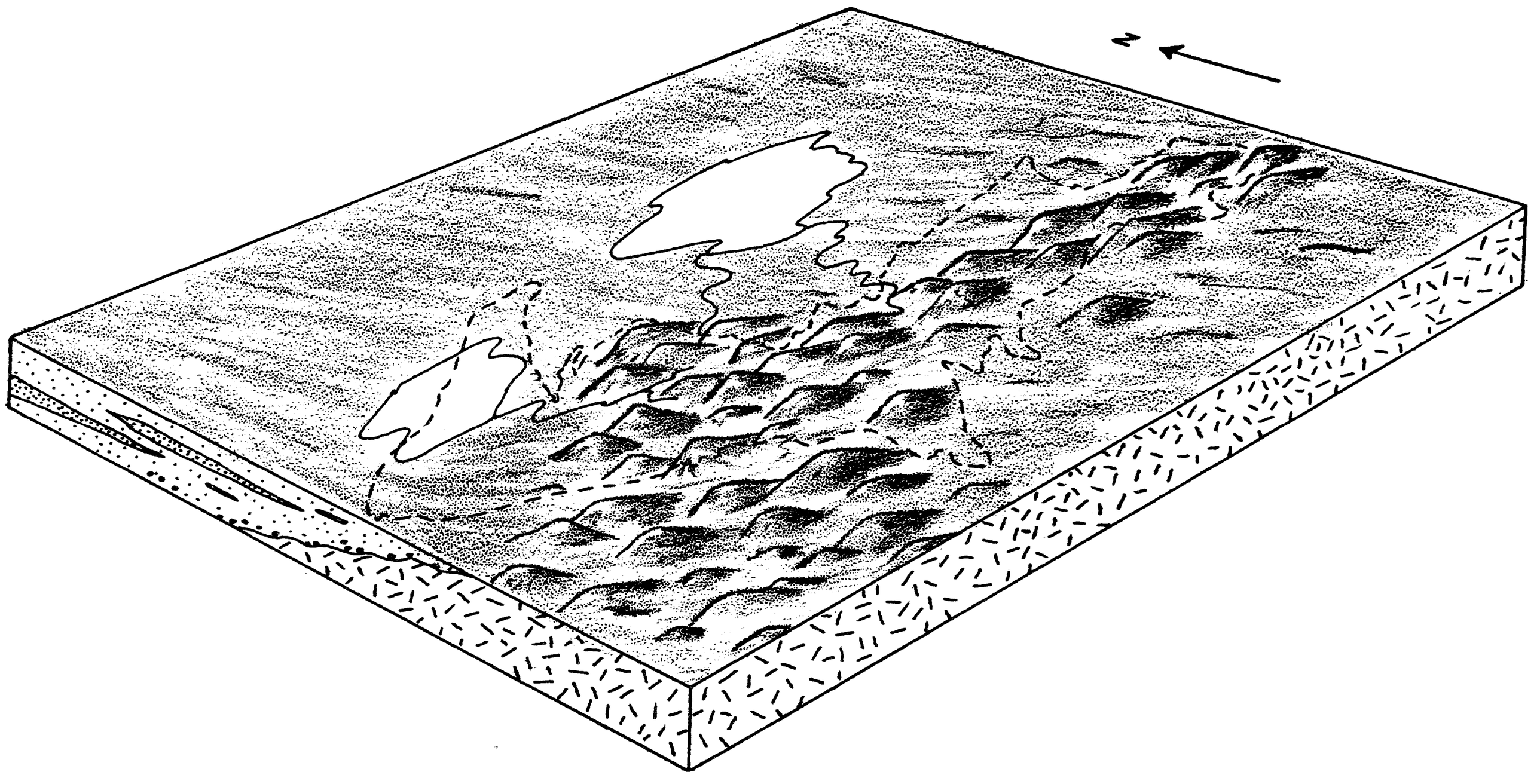


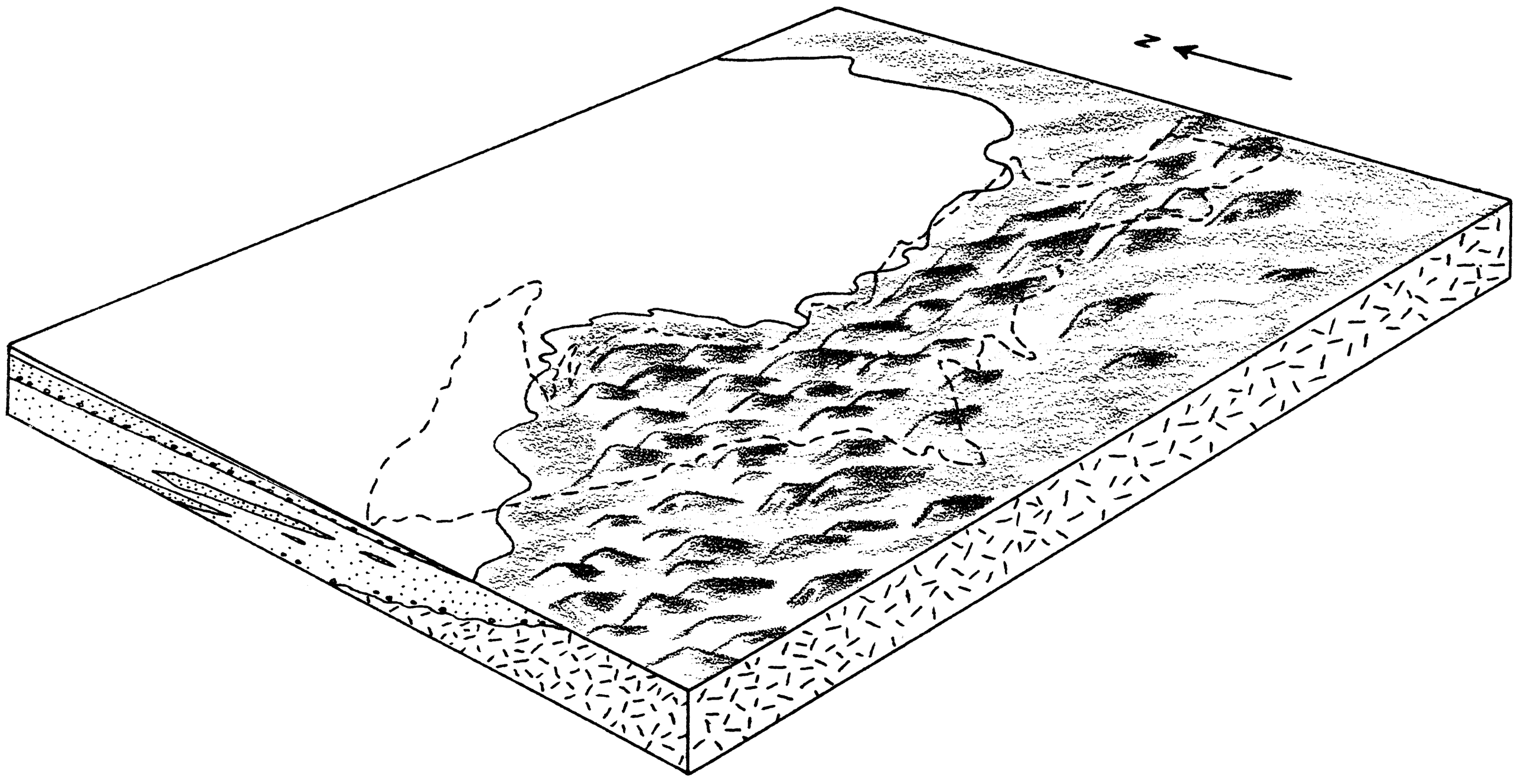

Kewaunee
Fault
N
Strike frequency of joints in the Jacobsville formation. Radii of circles = 3 joints
Strike frequency of joints in the Munising formation. Radii of circles = 3 joints
Strike frequency of the clastic dikes in the Jacobsville formation. Radius of circle = 3 dikes
Strike frequency of joints in the Au Train formation, Au Train Falls. Radius of circle = 10 joints
0 10 20 30 40 Miles
Scale

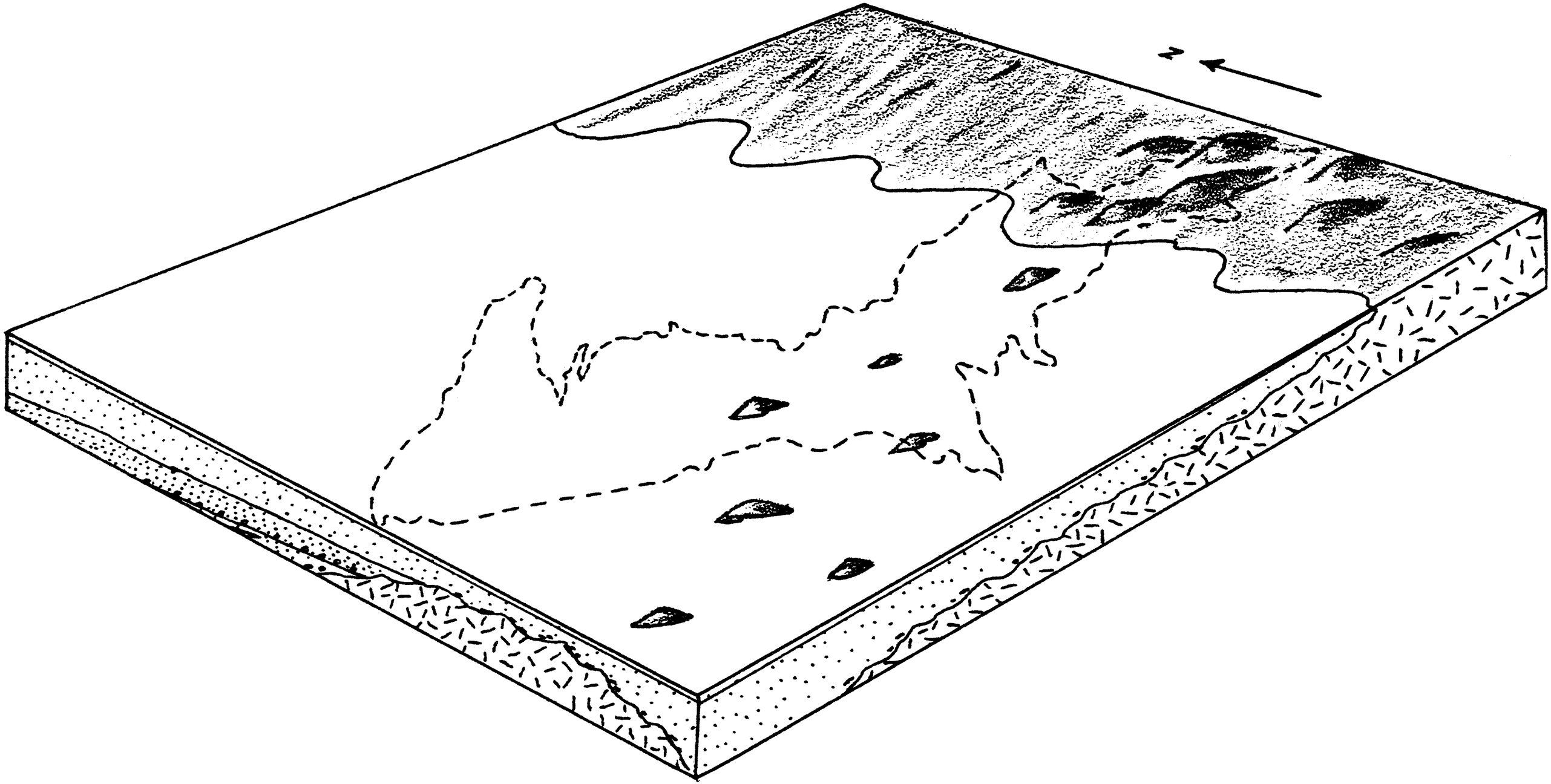


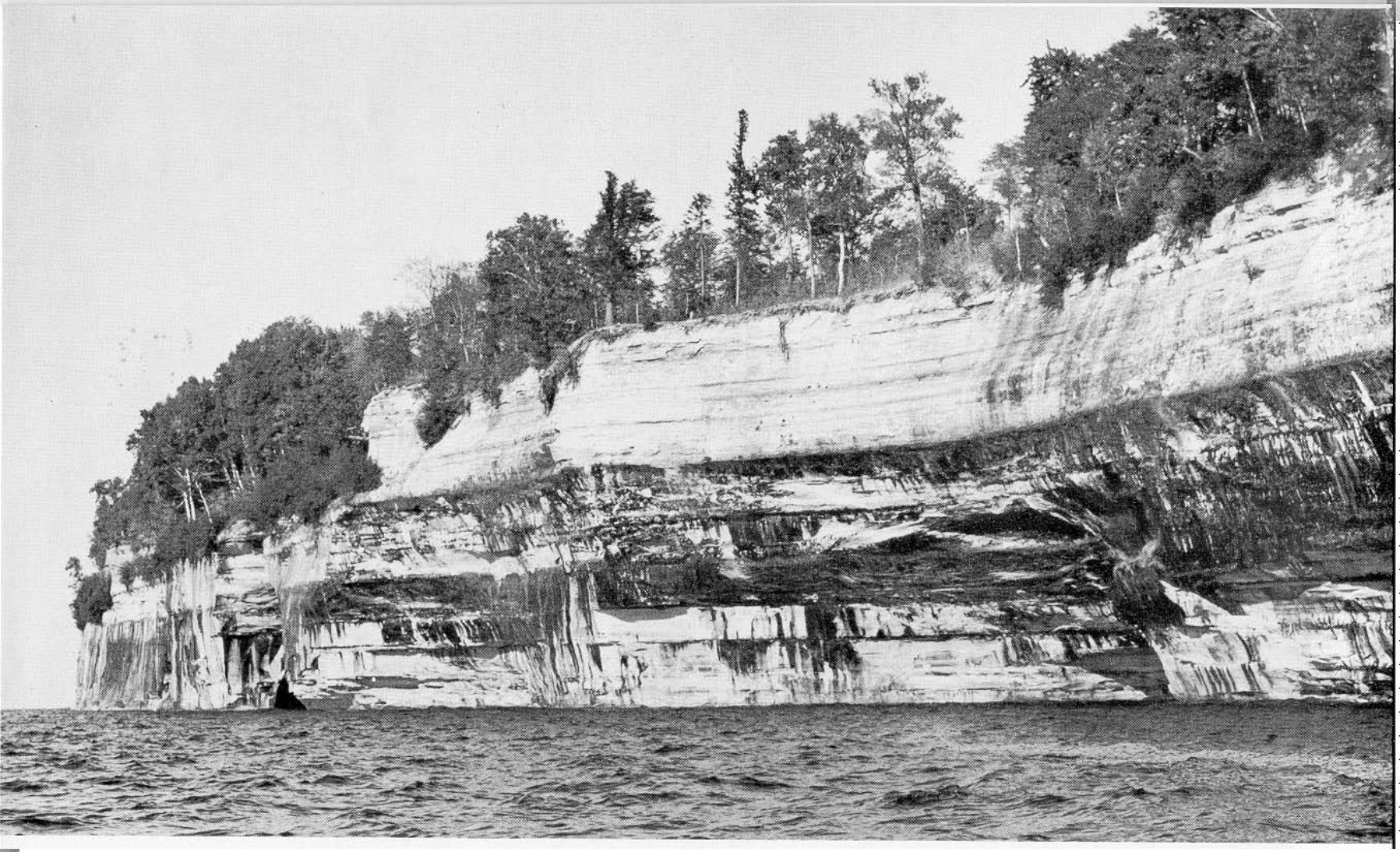





N


N


N



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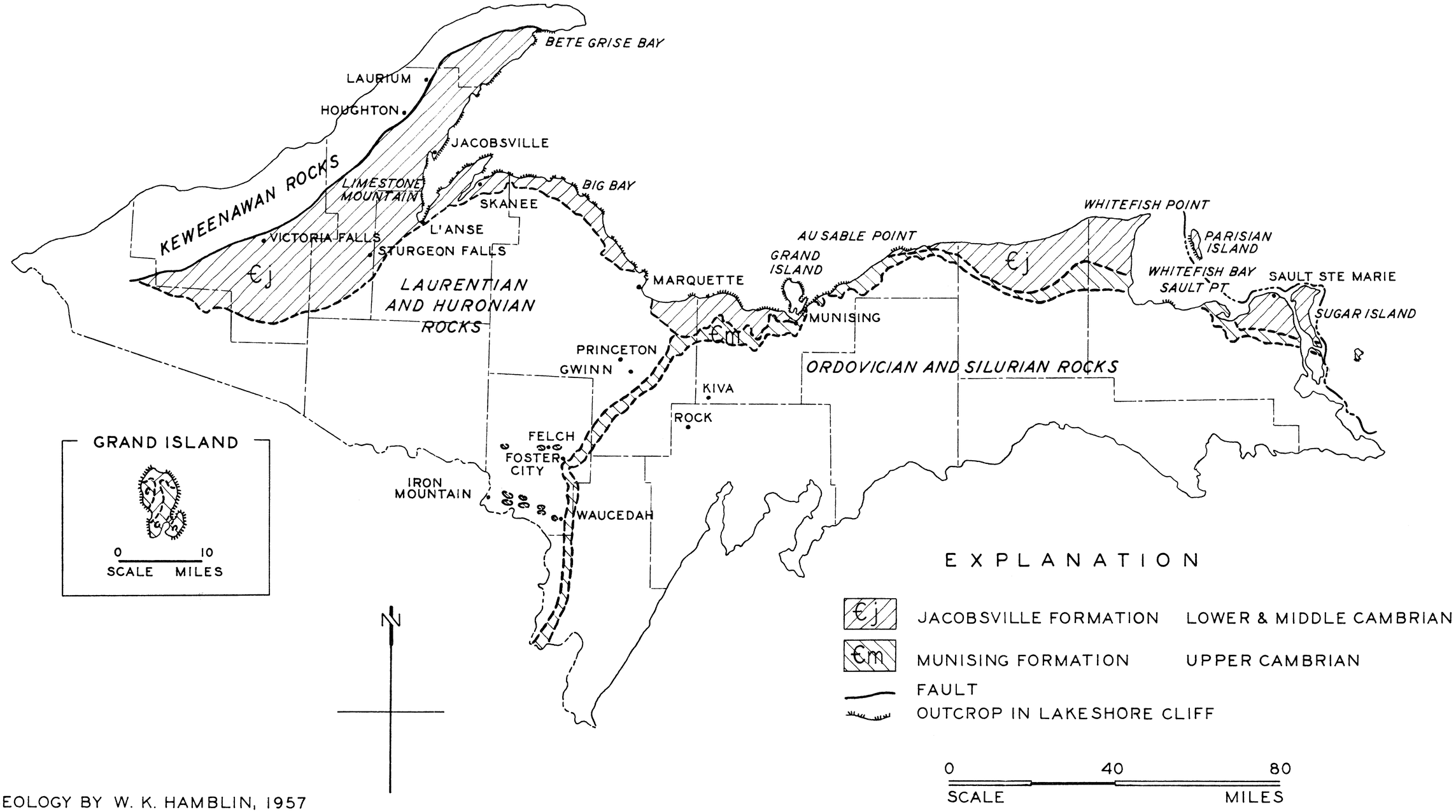


GEOLOGY BY W. K. HAMBLIN, 1957

GEOLOGIC MAP SHOWING THE DISTRIBUTION OF CAMBRIAN ROCKS IN NORTHERN MICHIGAN

LAKE SUPERIOR

LAUGHING FISH POINT

SHOT POINT

M-28

MUD CRK

SAND R

€j

LAUGHING WHITEFISH R.

DEER LAKE

€m

SHELTER BAY

AU TRAIN ISLAND

WOOD ISLAND

AU TRAIN POINT

€j

AU TRAIN BAY

AU TRAIN R.

€m

ROCK R.

AU TRAIN LAKE

LAUGHING WHITEFISH LAKE

SILVER CRK.

LAUGHING WHITEFISH FALLS

€m

NELSON CRK

Oat

MARQUETTE COUNTY

ALGER COUNTY

M-94

M-41

SLAP NECK CRK

AU TRAIN FALLS

Oat

GRAND ISLAND

€m

Oat

€j

€m

ECHO LAKE

TROUT BAY

SAND POINT

GRAND PORTAL

CHAPEL ROCK

CHAPEL LAKE

CHAPEL FALLS

MOSQUITO HARBOR

MINER'S CASTLE

MINER'S FALLS

MINER'S R.

MUNISING FALLS

MUNISING

WAGNER FALLS

ANNA R.

Oat

M-28

T 48N

T 47N

T 46N

R 23 W

R 22 W

R 21 W

R 20 W

R 19 W

R 18 W

R 17 W

BASE MAP FROM ADVANCE PRINTS OF U.S. GEOLOGICAL SURVEY TOPOGRAPHIC QUADRANGLES, LAND DIVISIONS TRANSFERRED FROM MICHIGAN DEPARTMENT OF CONSERVATION MAPS.

0 1 2 3

SCALE MILES

N

EXPLANATION

Oat	AU TRAIN FORMATION	MIDDLE ORDOVICIAN
	" BEDROCK EXPOSED	
€m	MUNISING FORMATION	UPPER CAMBRIAN
	" BEDROCK EXPOSED	
€j	JACOBSVILLE FORMATION	LOWER & MIDDLE CAMBRIAN
	" BEDROCK EXPOSED	

AREAS OF ABUNDANT OUTCROPS, SMALL OUTCROPS EXAGGERATED

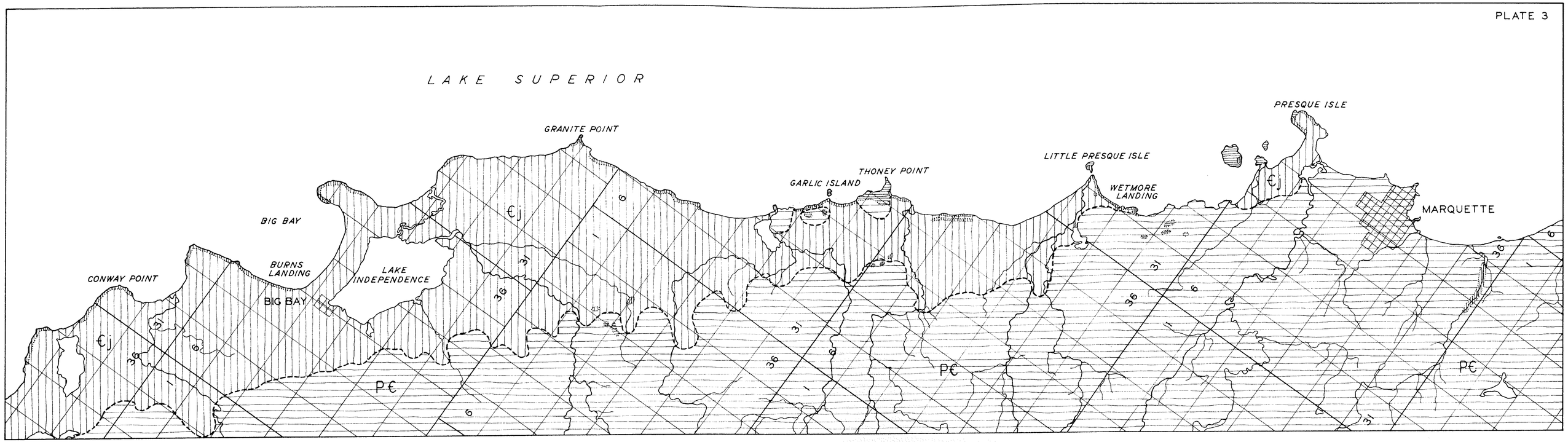
CONTACT

FAULT

A ABANDONED QUARRY

GEOLOGY BY W. K. HAMBLIN, 1957

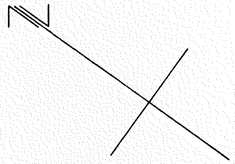
GEOLOGIC MAP OF PORTIONS OF MARQUETTE AND ALGER COUNTIES, MICHIGAN



BASE MAP FROM ADVANCE PRINTS OF U. S. GEOLOGICAL SURVEY TOPOGRAPHIC QUADRANGLES.

AREA INDEX MAP

0 1 2 3
SCALE MILES



EXPLANATION

€j JACOBSVILLE FORMATION LOWER & MIDDLE CAMBRIAN

" BEDROCK EXPOSED

P€ UNDIFFERENTIATED PRECAMBRIAN ROCKS

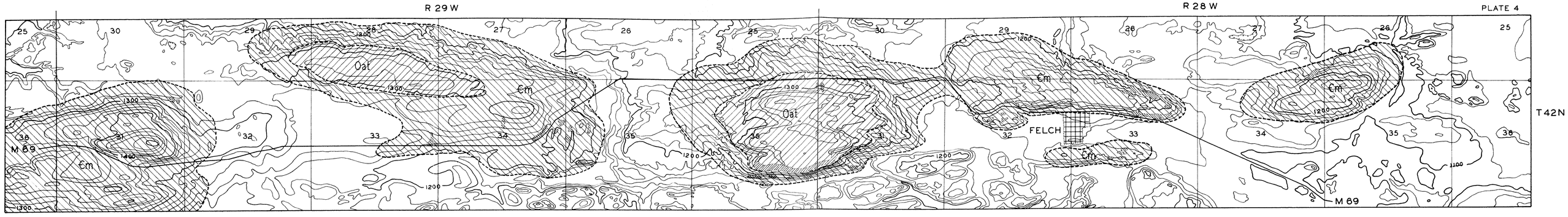
" BEDROCK EXPOSED

AREAS OF ABUNDANT OUTCROPS, SMALL OUTCROPS EXAGGERATED

---- CONTACT

GEOLOGY BY W. K. HAMBLIN, 1957

GEOLOGIC MAP OF THE COAST OF LAKE SUPERIOR BETWEEN BIG BAY AND MARQUETTE



BASE MAP FROM ADVANCE PRINTS OF U. S. GEOLOGICAL SURVEY TOPOGRAPHICAL QUADRANGLES.

AREA INDEX MAP

0 1 2
SCALE MILES

CONTOUR INTERVAL 20 FEET

N

GEOLOGY BY W. K. HAMBLIN, 1957

EXPLANATION

Oat	AU TRAIN FORMATION	ORDOVICIAN
	" BEDROCK EXPOSED	
Ꞓm	MUNISING FORMATION	CAMBRIAN
	" BEDROCK EXPOSED	

UNCOLORED - UNDIFFERENTIATED PRECAMBRIAN ROCKS

AREAS OF ABUNDANT OUTCROPS, SMALL OUTCROPS EXAGGERATED

CONTACT

GEOLOGIC MAP SHOWING THE DISTRIBUTION OF THE CAMBRIAN SANDSTONES IN THE FELCH AREA, DICKINSON COUNTY

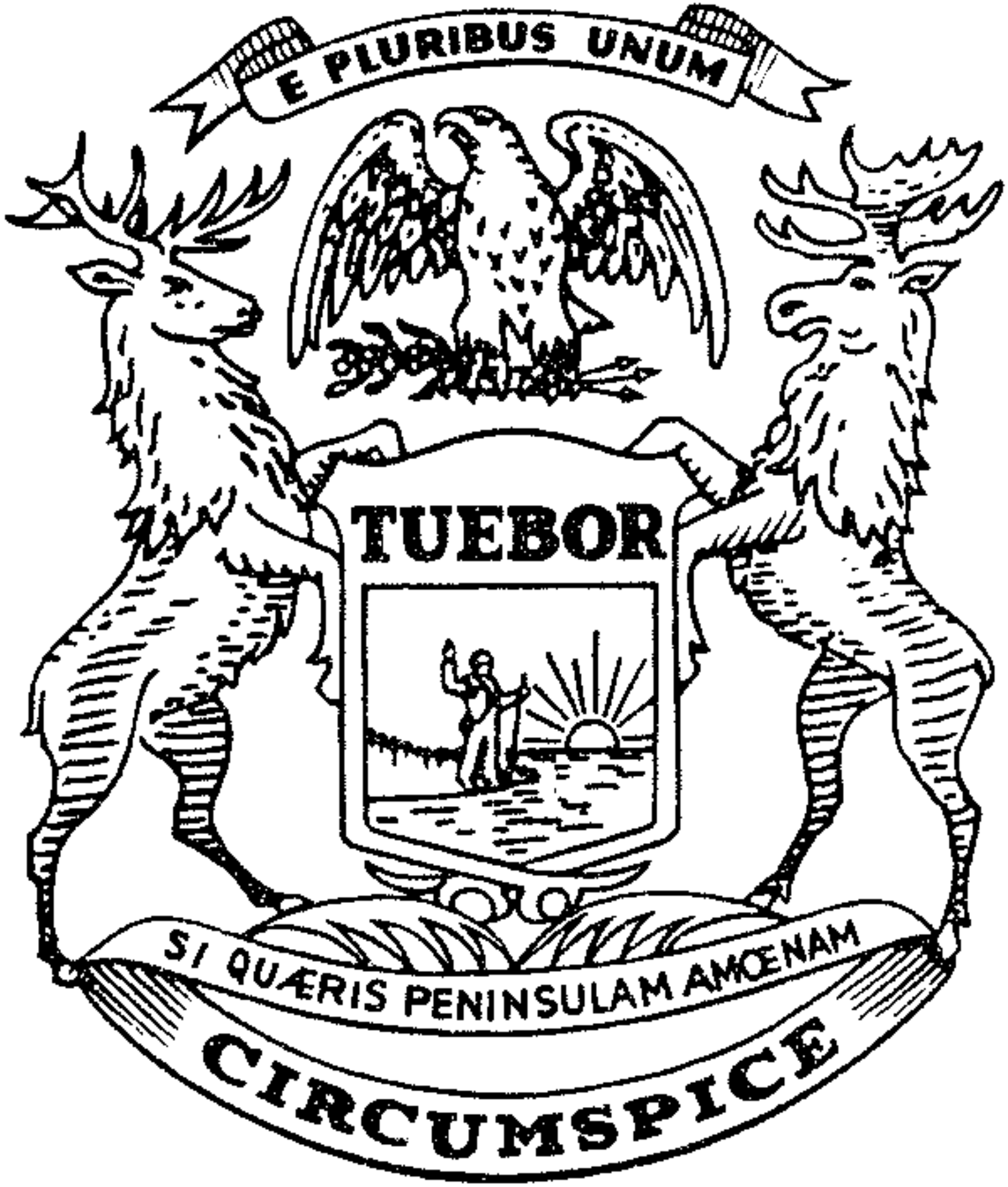

E PLURIBUS UNUM
TUEBOR
SI QUÆRIS PENINSULAM AMŒNAM
CIRCUMSPICE

TABLE 1

THEORIES PROPOSED FOR THE STRATIGRAPHIC POSITION OF THE JACOBSVILLE FORMATION

AGE	INVESTIGATOR	DATE	BASIS FOR CONCLUSIONS
Subsequent to Carboniferous	Owen, D. D.	1848	Strat. position
Triassic	Jackson, C. T.	1861	Lithology and strat. position
	Bell, R.	1869	Lithology and strat. position
New Red SS equivalent	Houghton, D.	1843	
	Rogers, H. D.	1848	Unconformity
	Jackson, C. T.	1849	Reported fossils
	Marcou, J.	1850	Strat. position
Permian	Macfarlane, T.	1866	Lithology
Old Red SS equivalent	Schoolcraft, H. R.	1821	Lithology
	Bigsby, J. J.	1824	Lithology
	Bayfield, H. W.	1845	Strat. position
	Locke, J.	1847	Strat. position
Silurian	Bigsby, J. J.	1852	
	Brooks & Pumpelly	1872	
Calciferous	Dana, J. D.	1862	
Potsdam	Hubbard, B.	1850	
	Foster & Whitney	1851	Strat. position
	Owen, D. D.	1851	
	Rivot, L. E.	1856	
	Rominger, C.	1873	Strat. position
	Wadsworth, M. E.	1880	Strat. position
	Irving, R. D.	1883	Strat. position
	Allen, *et. al.*	1916	Strat. position
Older than Potsdam	Logan, W.	1847	
	Whittlesey, C.	1867	
Cambrian	Van Hise & Leith	1911	Strat. position
	Lane & Seaman	1907	Strat. position
Middle Cambrian	Raasch, G. O.	1951	Strat. position
	Winchell, N. H.	1895	Unconformity
	Logan, W.	1851	
Keweenawan	Hotchkiss, W. O.	1933	Unconformity
	Thwaites, F. T.	1934	Similarity to Bayfield
	Leith, *et. al.*	1935	Similarity to Bayfield
	Oetking, P.	1951	Similarity to Bayfield

TABLE 2

PEBBLE COUNTS OF THE CONGLOMERATE FACIES IN THE JACOBSVILLE FORMATION

Type of pebble	Thoney Point*		Garlic Island**		Carp River*** (after Hultman, 1953)	
	No.	percent	No.	percent	No.	percent
Vein quartz	137	51.5	230	62.0	0	0
Potash feldspar	63	23.8	59	15.7	0	0
Quartzite	23	8.5	8	2.2	108	40.0
Peridotite	12	4.5	0	0	0	0
Clay pellet	12	4.5	23	6.2	4	1.8
Chert	8	3.0	2	0.5	0	0
Iron formation	8	3.0	24	6.5	18	8.3
Slate	1	0.4	18	4.9		
Dolomite	0	0	1	0.2	47	21.0
Sandstone pebbles	0	0	5	1.3	3	1.4

*Calcite cement constitutes approximately 20 percent of the rock.
**Calcite cement constitutes approximately 30 percent of the rock.
***Conglomerate facies consists of large boulders occurring in lenses throughout a stratigraphic thickness of approximately 200 feet.

TABLE 3

Pebble Counts of Basal Conglomerate of Munising Formation.

Type of Pebble	L. W. F. Spur. percent	AuTrain Spur. percent	Grand Island percent	Pictured Rocks percent	Chapel Falls percent	Sable Falls percent
Vein Quartz						
clear	10.3	11.3	9.3	6.8	28.5	54.2
milky	10.3	9.4	3.2	6.2	14.7	4.5
smoky	4.6	0.9	1.2	3.1	0.0	1.0
Total Vein Quartz	25.2	21.6	13.7	16.1	43.2	59.7
Quartzites						
red	20.6	4.2	14.7	26.0	4.6	0.3
brown	4.6	1.4	3.2	13.6	1.5	12.1
white	8.6	7.0	30.0	13.0	20.0	3.4
purple	0.0	2.8	4.2	1.8	0.0	0.0
black	28.0	24.4	28.5	27.8	7.6	8.7
banded	2.3	0.0	1.5	0.0	0.0	0.6
Total Quartzites	64.1	39.8	82.1	82.2	33.7	25.1
Chert	5.5	10.8	0.0	0.6	2.3	2.0
Cherty Iron Fm.	2.3	5.6	0.0	0.6	0.4	0.0
Brown Oölite Chert	0.0	0.0	0.0	0.0	20.0	12.6
Jacobsville	1.5	8.5	4.2	0.5	0.4	0.6
Granite	1.4	4.8	0.0	0.0	0.0	0.0
Slate	0.0	7.0	0.0	0.0	0.0	0.0
Basalt	0.0	1.9	0.0	0.0	0.0	0.0

PLATE 5

Fossils from the Munising sandstone and the Au Train formation, all X1 except where noted. All specimens in Museum of Paleontology, University of Michigan.

Prosaukia curvicostata Ulrich and Resser

1. Cast of pygidium with complete posterior margin. Hypotype no. 33343. Munising sandstone. Ledges along north side of U. S. Highway 2, 0.1 mile east of junction with Foster City road, 0.5 mile north of Waucedah, Dickinson County, Michigan.
2. Cast of cranidium with well preserved glabella. Hypotype no. 33338. Munising sandstone. Ledges at top of abandoned Breen Mine, sec. 22, T. 39 N., R. 28 W., Dickinson County, Michigan.
3. Cast of free cheek. Hypotype no. 33337. Munising sandstone. Same locality as original of fig. 1.
4. Part of thoracic segment. Hypotype no. 33342. Munising sandstone. Same locality as original of fig. 1.
5. Unusually large pygidium. Hypotype no. 34811. Munising sandstone. Base of north side of abandoned Pewabic Mine, Iron Mountain, Dickinson County, Michigan.
6. Free cheek with incomplete genal spine. Hypotype no. 34812. Munising sandstone. Same locality as original of fig. 1.
7. Small glabella with well developed brim and fixed cheeks. Hypotype no. 34813. Munising sandstone. Same locality as fig. 1.

Lungulepis ? sp.

8. Broken dorsal valve. Figured specimen no. 34814. Munising sandstone. Same locality as original of fig. 1.
9. Small complete dorsal valve. Figured specimen no. 34815. Munising sandstone. Same locality as original of fig. 1. X2.
10. Incomplete ventral valve. Figured specimen no. 34816. Munising sandstone. Same locality as original of fig. 1.

Lungulepis pinnaformis (Owen)

11. Well preserved ventral valve. Hypotype no. 34817. Munising sandstone. Same locality as original of fig. 5.

Briscoia sp.

12. Right pleural lobe of pygidium showing ribs and smooth peripheral area. Figured specimen no. 29959. Munising sandstone. Same locality as original of fig. 2.

Undescribed trilobite genus and species

13. Part of cranidium showing smooth glabella. Figured specimen no. 33348. Munising sandstone. Same locality as original of fig. 1.

Idioniesus sp.

14. Pygidium showing smooth peripheral lobes. Figured specimen no. 34818. Munising sandstone. Same locality as original of fig. 5.

Prosaukia ? sp.

15. Glabella with occipital and two glabellar furrows. Figured specimen no. 34823. Munising sandstone. Same locality as original of fig. 1.
16. Free cheek with short genal spine. Figured specimen no. 34824. Munising sandstone. Same locality as original of fig. 1.

Idahoia sp.

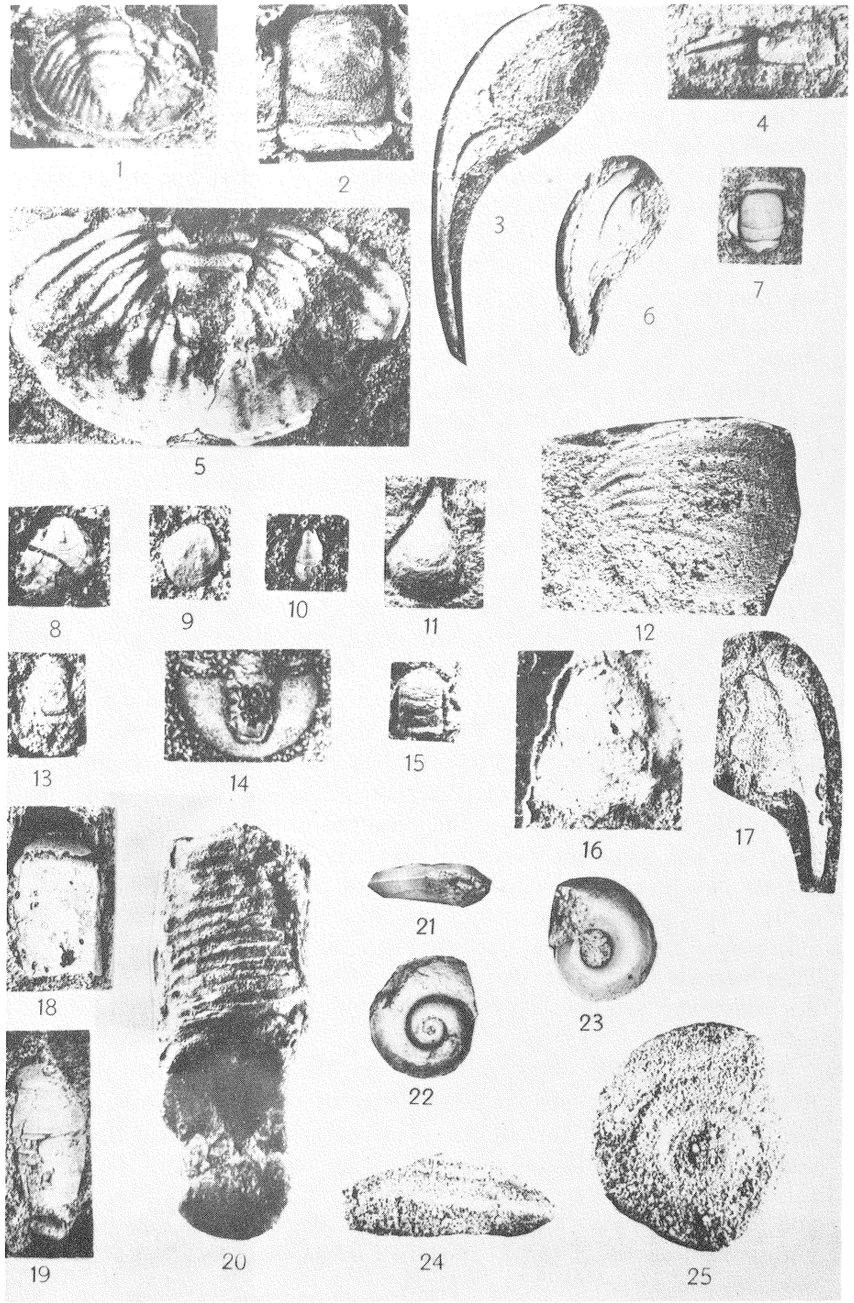
17. Part of cranidium showing glabella and occipital ring with axial node. Figured specimen no. 33347. Munising sandstone. Same locality as original of fig. 1.

Michelinoceras ? sp.

18. Part of living chamber. Figured specimen no. 34818. Au Train formation. Miner's Castle, Alger County, Michigan.
19. Part of cone showing closely set septa. Figured specimen no. 34819. Au Train formation. Same locality as original of fig. 18.
20. Fragment of cone of larger specimen. Figured specimen no. 34820. Au Train formation. Ledges at top of abandoned Austin Mine No. 2, NE¼, NE¼ SW¼, sec. 20, T. 48 N., R. 25 W. Marquette County, Michigan.

Liospira ? sp.

21-23. Lateral, dorsal, and ventral views of a specimen. Figured specimen no. 34821. Au Train formation. Same locality as original of fig. 18.

Ophileta ? sp.

24-25. Lateral and dorsal views of a specimen. Figured specimen no. 34822. Au Train formation. Sault Point on south shore of Whitefish Bay, Lake Superior, Chippewa County, Michigan.