

# SOME PROBLEMS OF THE PRECAMBRIAN GEOLOGY OF NORTHEASTERN WISCONSIN: A REVIEW<sup>1</sup>

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Recent studies of Precambrian rocks in parts of northeastern Wisconsin and southwestern Michigan (fig. 1) have shed some light on the complex geology of that area, but also have raised some problems and have emphasized the need for extensive, detailed work in northeastern Wisconsin. Some aspects of these problems will be reviewed briefly.

In the Upper Peninsula of Michigan, the occurrence of iron ores early called attention to the wide distribution of Precambrian sedimentary rocks. These rocks were correlated with the type Huronian by Van Hise and Leith (1911) and others, although their equivalence with the original Huronian has been questioned recently. James (1958) has used the term Animikie Series for these sedimentary strata and designated them as Middle Precambrian (table 1). In Michigan, granites and basic volcanic rocks (greenstones) of several ages have been recognized and the relations of some of them to the Animikie sediments determined.

TABLE 1

*Generalized Precambrian stratigraphic succession in Dickinson and Iron Counties, Michigan  
(modified from James, 1958)*

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Upper Precambrian	
Keweenaw Series.	Diabase dikes and sills (probable age about 1,100 million years)
Middle Precambrian	
Granitic intrusive rocks	(probable age at least 1,400 million years)
Metadiabase and metagabbro	
Animikie Series	
Paint River Group	
Baraga Group	
Menominee Group	
Chocoday Group	
Lower Precambrian	
Gneissic granite and other crystalline rocks	
Quinnesec Formation	(position uncertain)

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Along the Michigan-Wisconsin border near Iron Mountain (fig. 1), a belt of sedimentary and basic volcanic rocks, the Quinnesec Formation, borders the recognizable Animikie rocks of the Menominee Range. The age of the Quinnesec Formation has been variously interpreted as Keewatin to Keweenaw (Lower to Upper Precambrian) and is, as yet, not unequivocal.

In Wisconsin, the Quinnesec Formation is intruded by granite (fig. 2). The relation of the granites of Wisconsin to the Animikie rocks of Michigan is obscure and the determination of the age of the Quinnesec Formation is clearly important for a proper understanding of the regional geology. Isolated patches of Animikie-like sediments are known in Wisconsin, as at McCaslin Mountain (fig. 2), Rib Hill, and Baraboo, but their relationship to the surrounding granites is not clear in all cases. Unfortunately, throughout much of Wisconsin, recognizable stratigraphic units are absent. This, plus the sparsity of radiometric dates, makes difficult any interpretation of the age of the granitic and metamorphic rocks.

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The problem is accentuated by the extremely limited outcrop coverage throughout most of northeastern Wisconsin.

Because of the importance of establishing the age of the Quinnesec Formation, it is not surprising that the granitic and metamorphic rocks exposed to the south of the Menominee District were formerly studied only to determine their relationship to the Quinnesec Formation. Consequently, early work on the Wisconsin granitic rocks described merely the northernmost exposures of a large Precambrian granitic complex. All workers in this area have recognized that the granitic rocks intrude the Quinnesec Formation. The age assigned the granites, however, has depended on the inferred stratigraphic position of the Quinnesec Formation.

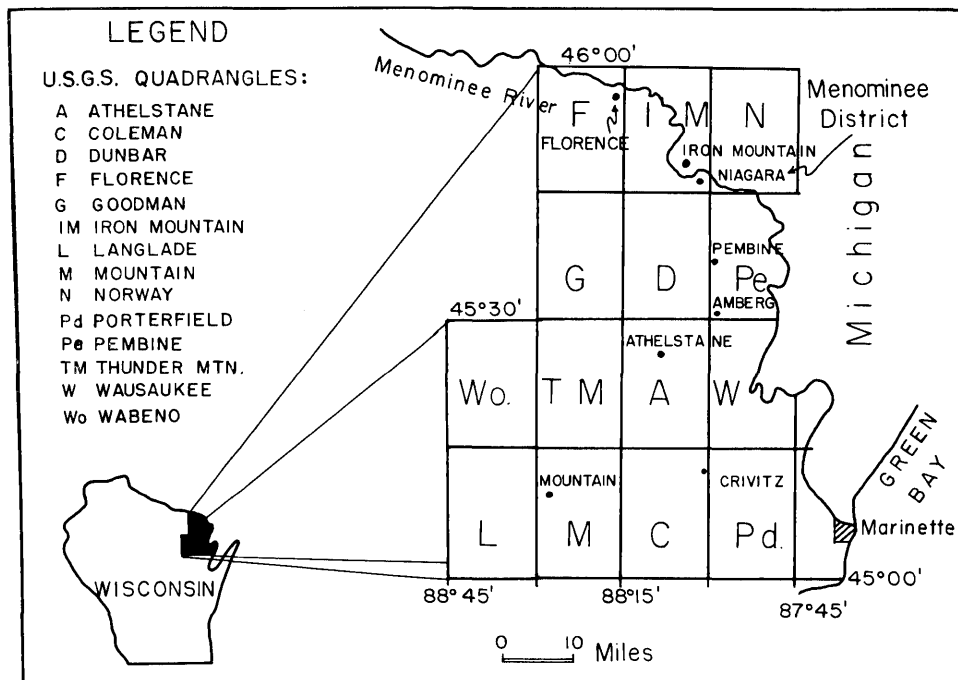


FIGURE 1. Index map of northeastern Wisconsin.

#### THE AGE OF THE QUINNESEC FORMATION

The Quinnesec Formation crops out a short distance south of the Baraga Group of Middle Precambrian rocks in Michigan. In that general area, the Baraga Group consists of the Michigamme Slate and the overlying Badwater Greenstone. However, the northern limit of the Quinnesec Formation is very poorly exposed and the unit is not seen in contact with the Animikie strata of the Menominee District. Folding and faulting are common in the area and the stratigraphic position of the Quinnesec Formation could thus be interpreted in different ways. Workers who have considered the formation to be older than the Animikie strata (i.e., Lower Precambrian in age) include Foster and Whitney (1851), Rominger (1881), Irving (1889), Williams (1890), Winchell (1893), Van Hise and Bayley (1900), Bayley (1904), and James (1958). Among those who have interpreted the Quinnesec Formation as younger than Lower Animikie strata (i.e., Middle or Upper Precambrian) are Credner (1869), Brooks (1880), Van Hise and Leith (1911), Leith, Lund, and Leith (1935), and Bean (1949).

Clearly, the field relationships in the Menominee District are such that further field work in this area is unlikely to resolve the problem of the age of the Quinnesec

Formation. It is possible, however, that work to the west of the Menominee District may provide a solution to the problem. In the Florence area (fig. 1), Dutton (1960) described sedimentary and greenstone beds which strike northwest, dip to the south, and are folded and faulted. He correlated these rocks with the Upper Animikie Paint River and Baraga Groups of Michigan (table 1). If the greenstone is part of the Quinnesec Formation and is in normal stratigraphic sequence, then the formation must be at least Middle Precambrian in age. How-

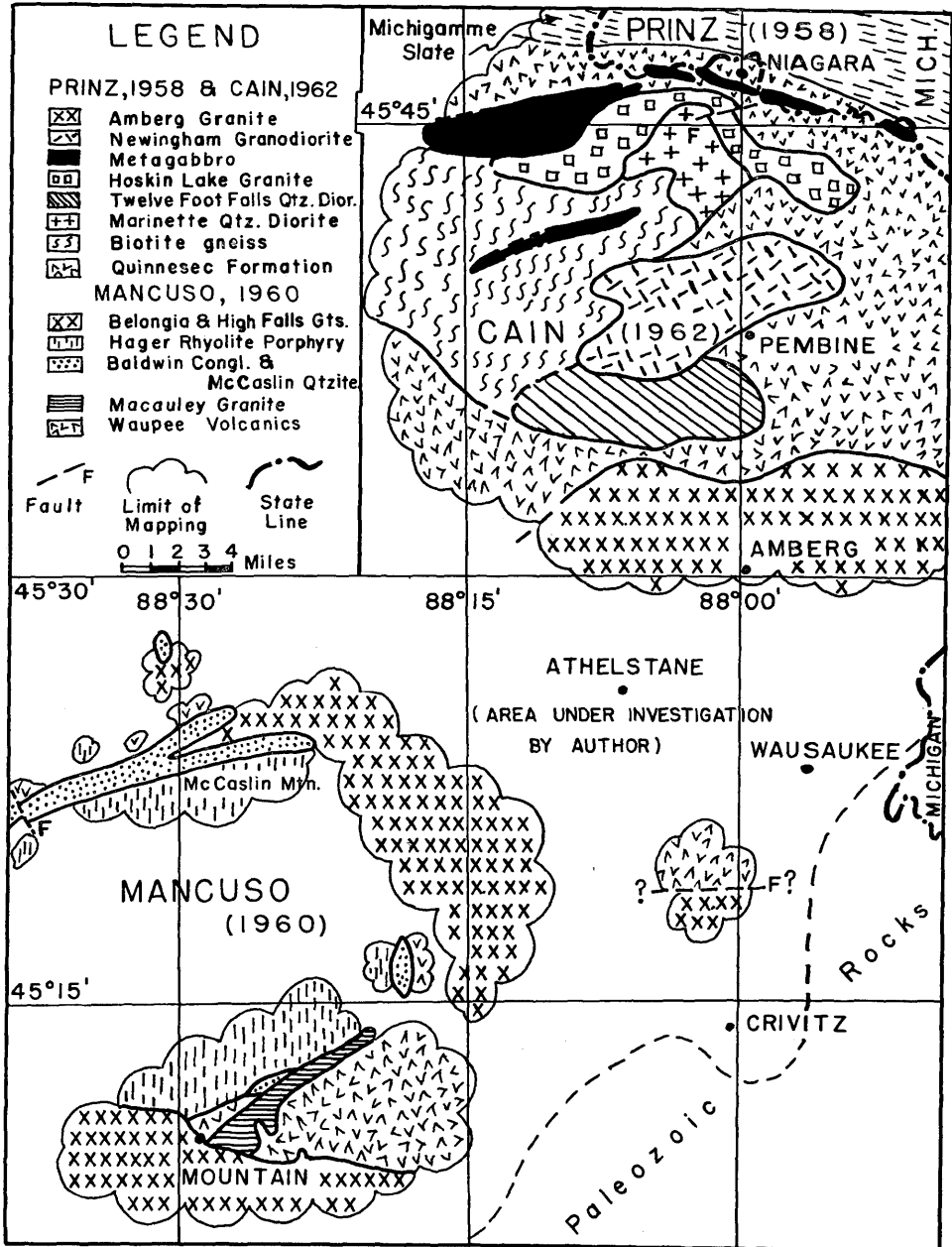


FIGURE 2. Geology of part of northeastern Wisconsin.

ever, it is possible that the greenstone is part of the Badwater Greenstone which is already known to be Middle Precambrian (James, 1958). Alternatively, the greenstone mapped by Dutton may be unrelated to either the Quinnesec Formation or the Badwater Greenstone. The situation is complicated further by the possibility of a fault contact between the Animikie Series and the greenstone (Dutton, personal communication, 1962).

Any work which could demonstrate the stratigraphic position of the Florence greenstone and its equivalence with the Quinnesec Formation of the Menominee District might well resolve problems which have existed in the area for over 100 years. Another means of dating the Quinnesec Formation would involve radiometric methods. If reliable absolute ages can be obtained from the formation, then the stratigraphic succession can be established with certainty. The need for further work on the Quinnesec Formation cannot be overemphasized.

#### THE GRANITIC COMPLEX

Only in the last 15 years have detailed areal studies been undertaken in the granitic complex of northeastern Wisconsin. Because of the absence of sufficient radiometric dates, and the unknown age of the Quinnesec Formation, most recent workers have attempted to establish only relative age-relationships for the rock units mapped. The main contribution of these studies has been in demonstrating that mappable rock units can be recognized within the Precambrian complex. Clearly, this is only the first step in synthesizing the geologic history of the region and it is still essential that absolute ages of these units be established as soon as practicable.

The following brief review of recent studies of Precambrian rocks in northeastern Wisconsin (although possibly not complete) suggests the present stage of knowledge in the region. Areas investigated recently are shown in figure 2.

Work by Lyons (1947) was essentially of a reconnaissance nature, though more detailed study was carried out in the Niagara area. As a result of this investigation he distinguished the following rock types:

- Youngest: Quartz diorite
- Porphyritic granite
- Biotite-hornblende-quartz diorite
- Plagioclase-hornblendite
- Oldest: Basalt

The geographical distribution of these rocks was given by Lyons in Emmons et al. (1953). Lyons believed the major structure in northeastern Wisconsin to be a fault, striking a little north of west, extending westward from the Menominee River at Niagara. Upward movement of the southern block was inferred and attributed to emplacement of the Wisconsin granitic mass (quartz diorite).

Prinz (1958) re-examined the northern part of Lyons' area and extended the mapping into Michigan. He did not, however, find evidence for the fault mapped by Lyons. As a result of detailed study, Prinz gave the following igneous succession:

- Youngest: Diabase dikes
- Gabbro sills
- Hoskin Lake Granite
- Marinette Quartz Diorite
- Oldest: Quinnesec Formation
- Age relations unknown: Pyroxenite and serpentinite

The distribution of these units, except the diabase dikes, pyroxenite, and serpentinite, and their relationship to the sedimentary strata of the Menominee District are shown in figure 2. A correlation of terminology used by Lyons and Prinz is given in table 2.

TABLE 2  
*Correlation of the terminology used for the Precambrian  
 rocks of the Niagara area, Wisconsin*

Lyons, 1947	Prinz, 1958
Plagioclase-hornblendite	Diabase dikes
Quartz diorite	Gabbro sills (not present)
Porphyritic granite	Hoskin Lake Granite
Biotite-hornblende-quartz diorite	Marinette Quartz Diorite
Basalt	Quinnesec Formation

Prinz recognized sill-like bodies of metagabbro intrusive into the Quinnesec Formation. Within one of these sills he found a xenolith of "gneissic granite" and thus considered the gabbro sills younger than the Hoskin Lake Granite. Since the Hoskin Lake Granite was the only granitic unit mapped by Prinz, this assumption was probably reasonable. However, later work to the south (Cain, 1962) showed the presence of at least three granitic masses within a few miles of the gabbro sills. It cannot therefore be assumed that the xenolith of "gneissic granite" is necessarily Hoskin Lake Granite. As outlined in the sequel, Cain interpreted the xenolith as biotite gneiss, a unit older than the Hoskin Lake Granite. However it must be re-emphasized that the field relationships are rarely unequivocal in this area and interpretations have to be based on extremely meager evidence.

Mancuso (1957, 1960) mapped a large area of northeastern Wisconsin (fig. 2) and established the following succession:

- Youngest: Belongia Granite and High Falls Granite  
 Hager Rhyolite Porphyry  
 Baldwin Conglomerate and McCaslin Quartzite  
 Macauley Granite
- Oldest: Waupee Volcanics

The Waupee Volcanics were described as the oldest formation present and tentatively correlated with the Quinnesec Formation. A significant contribution of this study was the demonstration of two distinct ages of granitic intrusion: the McCaslin Quartzite lies nonconformably on the Macauley Granite and is intruded by the High Falls Granite. The major structure recognized by Mancuso is a syncline (outlined by quartzite) plunging to the west, which was intruded to the north and northeast by the High Falls Granite and to the south by the Belongia Granite.

Cain (1962) re-examined the southern part of the area described by Lyons (1947) and mapped a large part of the region between the areas studied by Prinz (1958) and Mancuso (1960). Several rock units established to the north by Prinz were traced south, and four other rock units were also recognized in the mapped area: biotite gneiss, Twelve Foot Falls Quartz Diorite, Newingham Granodiorite, and Amberg Granite (fig. 2). Rock units described by Cain and their probable age-relationships are:

- Youngest: Diabase dikes  
 Amberg Granite  
 Newingham Granodiorite  
 Hoskin Lake Granite  
 Metagabbro sills  
 Twelve Foot Falls Quartz Diorite  
 Marinette Quartz Diorite  
 Biotite gneiss
- Oldest: Quinnesec Formation

The biotite gneiss and Newingham Granodiorite are part of the unit mapped by Lyons (1947) as quartz diorite. Based on field and petrographic examination, Cain tentatively correlated the Amberg Granite with the High Falls Granite described by Mancuso (1960). As mentioned previously, the metagabbro sills were considered somewhat older than suggested by Prinz, but no conclusive evidence was obtained. The Twelve Foot Falls Quartz Diorite was named and studied in detail by Wadsworth (1962).

Dutton (personal communication, 1962) mapped areas of porphyritic granite in the Florence area which closely resemble the Hoskin Lake Granite. This type of rock is evidently widespread in distribution, since Lamey (1933) described porphyritic granite from the southern granitic complex of Michigan which is virtually identical to the Hoskin Lake Granite.

In addition to these regional reports, several smaller-scale studies have been made of the granite-greenstone contact areas near the Wisconsin-Michigan border. Work by Shapiro (1952), Prinz (1952), Froelich (1953), Thompson (1955), and Fulweiler (1957), for example, has clearly shown the Quinnesec Formation to consist of interstratified sediments, flows, and pyroclastics. Nevertheless, it may be seen from figure 2 that relatively little is known about the large Precambrian granitic and metamorphic complex of northeastern Wisconsin.

TABLE 3  
*Orogenies in the Lake Superior Region*  
(after Goldich et al., 1961)

Precambrian division	Orogeny	Approximate age in billion years
Late	Grenville	1.1
Middle	Penokean	1.7
Early	Algoman	2.5
	Laurentian	2.6?

Parts of the north central and northwestern regions of Wisconsin have also been mapped in considerable detail: the former by Weidman (1907), Turner (1940), Prucha (1946), and Emmons et al. (1953); the latter by Aldrich (1929), Leighton (1954), and Thiel (1956), for example. However, as in northeastern Wisconsin, many large areas remain unmapped. In contrast, similar terrane in Minnesota and Michigan has been studied much more extensively. The results of these investigations, which are extremely important to an interpretation of the geological history of Wisconsin, are summarized by Goldich et al. (1961), James (1958), and James et al. (1961). It is understood that two other U.S.G.S. publications will be available shortly: a report by Dutton on his work in northeastern Wisconsin, and a Professional Paper on the Menominee District by Bayley, Dutton, and Lamey, which includes a discussion of the Quinnesec problem. Precambrian correlations in Michigan, Minnesota, and Wisconsin were given by Marsden (1955) and James (1960).

Incorporated in the work of Goldich et al. (1961) are many radiometric dates from the Lake Superior Region. The approximate ages of the several orogenies recognized within this region are summarized in table 3. Other absolute ages from central Wisconsin (Abelson, 1959) suggest a Penokean age for at least part of the Wisconsin granitic complex. The few published dates available for northeastern Wisconsin (for greenstone, gneiss, and quartz diorite) seem not to be related to the geology but to reflect degrees of metamorphism (Abelson, 1960: 153-154). However, there is an obvious need to determine more absolute ages in northeastern Wisconsin before a proper evaluation of the radiometric data can be made.

## SUMMARY

In the absence of radiometric dates, the age of the northeastern Wisconsin granitic rocks can be determined solely from their relationship to the Quinnesec Formation or other stratigraphic unit. Unfortunately, the age of the Quinnesec Formation itself is not known. With the contributions by Dutton, however, this problem may well be capable of solution. Only a very small part of the Precambrian granitic complex has been mapped. Even in the mapped areas the relative ages of the units are not always clear, and few absolute dates are available. (Radiometric dates have been determined from the area mapped by Prinz, 1958, but may not be quoted). Despite these limitations, however, work to date has demonstrated that rock units can be mapped within the "undifferentiated Precambrian" of northeastern Wisconsin just as they have in Minnesota and Michigan. In an interpretation of the geologic history of the Lake Superior Region, Wisconsin is a large, important, but relatively unknown component. Detailed information is therefore needed about the geographical distribution of rock units, their relative and absolute age, petrography and petrogenesis, deformational history, etc. A few such comprehensive investigations are currently being carried out, and it is hoped that others will soon be initiated.

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