

HURONIAN STRATIGRAPHY OF THE MCGREGOR BAY AREA, ONTARIO: RELEVANCE TO THE PALEOGEOGRAPHY OF THE LAKE SUPERIOR REGION

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ABSTRACT

Mapping in the McGregor Bay area of Ontario has shown the presence of a sequence of formations which closely resembles that of the original Huronian of the Bruce Mines-Blind River area. Iron-rich siltstones and argillites above the Lorrain formation are correlated with the lower part of the Animikie iron-formations of the Port Arthur region of Lake Superior and the north central United States. The oldest Proterozoic rocks of the region south of Lake Superior are considered to be correlatives of the Cobalt group of the north shore of Lake Huron.

INTRODUCTION

In the region north of Lake Huron and Georgian Bay, Huronian rocks extend for some 240 mi between Sault Sainte Marie and the Cobalt area northwest of Lake Timagami. This region may conveniently be subdivided into three areas: the Bruce Mines-Blind River area, which includes the "original" Huronian; the Cobalt area; and the more southerly, wedge-shaped area extending from Sudbury to McGregor Bay and Cutler. The age of the rocks in the third area has been the subject of much controversy, but recent work by Ginn (1958, 1965), Card (1965), Frarey (1965), and Young, Casshyap, and Church (1965) indicates that the Precambrian rocks of this area, including the "Sudbury Series" and possibly also the underlying volcanic rocks, are part of the Huronian system.

The present study is concerned with the Huronian rocks of the McGregor Bay area (Fig. 1). During the summers of 1964 and 1965 an area of approximately one hundred square miles was mapped. The results of this work are summarized in Fig. 1. The purpose of this note is to describe iron-rich sedimentary rocks and associated formations that occur stratigraphically above the Huronian Lorrain formation in the McGregor Bay area, and to comment on the possible stratigraphic significance of these formations in relation to the Proterozoic rocks of the north central United States.

STRATIGRAPHY

The Precambrian stratigraphy of the McGregor Bay area is almost identical with that of the Bruce Mines area (Collins 1925; Frarey 1962). The major differences are that most of the formations in the McGregor Bay area are thicker than their counterparts in the type area, there is no unconformity between the Gowganda formation and the underlying Serpent formation, and two previously undescribed formations occur stratigraphically above the Lorrain formation.

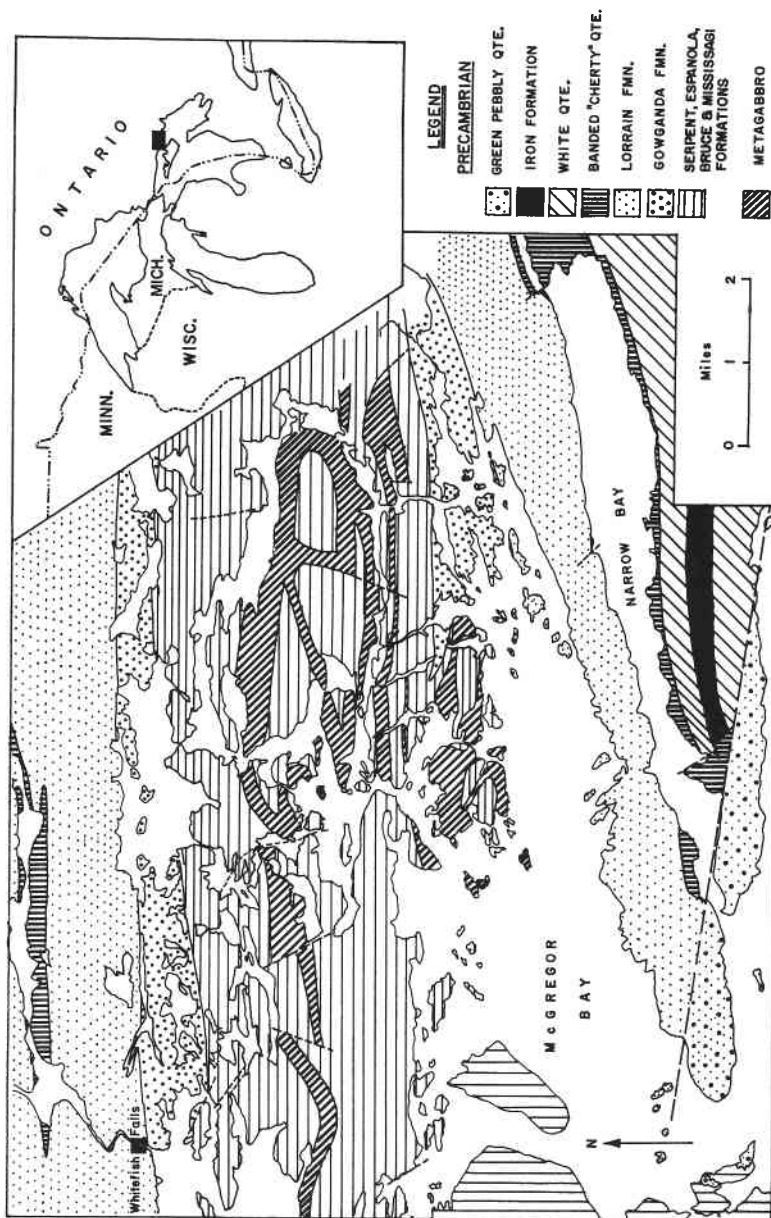


FIG. 1. Sketch map to show the distribution of Proterozoic formations in the McGregor Bay area.

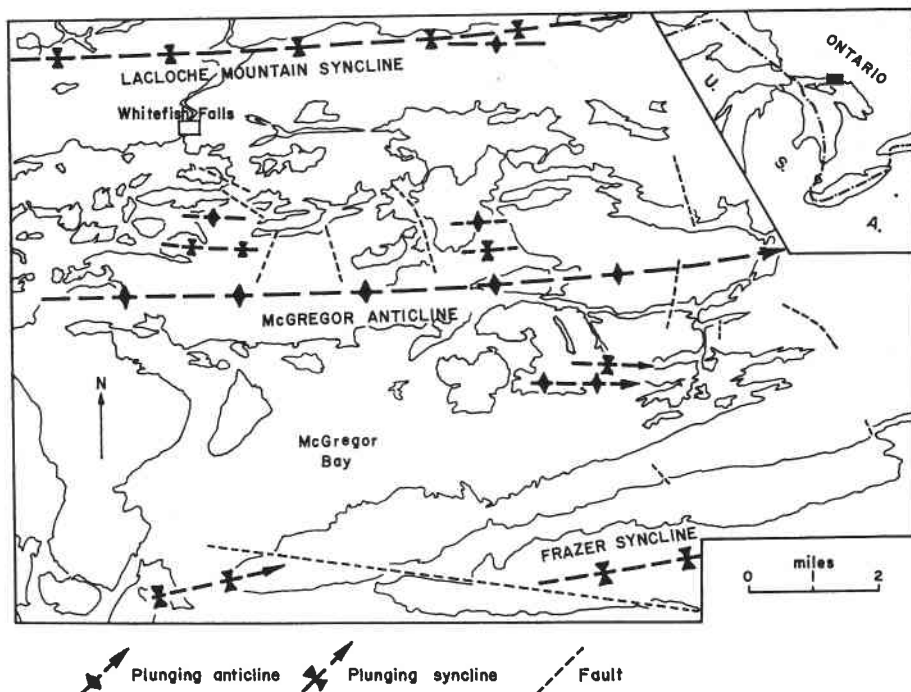


FIG. 2. Major structures in the Proterozoic rocks of the McGregor Bay area.

The major structural elements of the McGregor Bay area are shown on Fig. 2. The Huronian rocks have been tightly folded about east-west axes so that dips are generally of the order of 80 degrees. The dominant structure is an easterly plunging anticline (the McGregor anticline). There are two complementary synclines, the Lacloche Mountain syncline to the north, and the Frazer syncline to the south. These structures were defined on the basis of structural analysis and abundant sedimentary younging criteria such as cross bedding, graded bedding, ball and pillow structures, and ripple marks. Numerous smaller scale folds are also present in the area and the rocks are cut by many small faults which generally trend some 20 degrees east or west of north. Locally there is evidence of polyphase folding. The primary folding is of greater importance than the faulting in controlling the distribution of rock units. The sequence of Precambrian formations in the McGregor Bay area is listed in Table I.

Gradational junctions between the Lorrain formation and the overlying banded "cherty" quartzite are exposed at the east end of Narrow Bay and at several places on the north coast of the bay. Similar contacts between the "cherty" quartzite and the white quartzite above are exposed on the south side of Narrow Bay at its eastern end. Abundant ball and pillow structures in the "cherty" quartzite and cross beds in all three formations consistently indicate "tops" to the south. The absence of a fold axis in the Narrow Bay area is also

TABLE I
Proterozoic formations of the McGregor Bay area

Group	Formation	Approx. thickness* (ft)	Dominant lithologies
Animikie?	Green pebbly quartzite†	2600	Green vitreous quartzite, pebble conglomerate
	Iron-formation†	800	Quartzite, hematite-rich siltstone, and argillite
	White quartzite†	1900	White vitreous quartzite
Cobalt	Banded "cherty" quartzite	3800	Buff and green siltstone and argillite
	Lorrain	6000	White vitreous quartzite, arkose, and subarkose
	Gowganda	2900	Polymictic boulder conglomerate, argillite, siltstone, subarkose
Quirke	Serpent	1950	Subarkose, siltstone, limestone
	Espanola	1300	Calcareous siltstone and sandstone, limestone
	Bruce	600	Polymictic boulder conglomerate chert-like siltstone
Hough	Mississagi	2600	Subarkose and protoquartzite, argillite

*All thicknesses are maximum thicknesses.

†A paper in preparation includes formal names for these formations.

indicated by the presence of S-shaped minor folds that plunge consistently eastwards throughout the thickness of the "cherty" quartzite. Definition of the Frazer syncline is based on dip of the beds and younging criteria in the form of cross bedding and ripple marks. Exposure is excellent and conformable junctions between the white quartzite and iron-formation are visible. The stratigraphic relations between the pebbly green quartzite and the other Huronian formations are not known, since it occurs only in fault contact with these rocks or as inliers in the Paleozoic rocks.

Of particular interest are the iron-rich sediments in the core of the Frazer syncline. There are several iron-bearing units, ranging in thickness from 3 to 70 ft, and separated by greater thicknesses (up to 150 ft) of cross bedded, white, pink, and purple quartzite. The iron-bearing sediments are dark purple in color and consist of finely bedded siltstones and argillaceous layers, sometimes with a distinct slaty cleavage. The iron is in the form of specular hematite, which, together with minor amounts of sericite, fills the interstices between well-rounded and sorted quartz grains. Collins (1925, p. 132) described a similar occurrence in the upper part of the Lorrain formation of the Bruce Mines area and proposed that the iron-bearing units at Frazer Point were of the same age. The stratigraphic relations described above preclude such an interpretation, for the iron-rich rocks of the Frazer Point area occur in a quartzite which is younger than the Lorrain formation and is separated from it by two formations, the banded "cherty" quartzite and the white quartzite. No similar iron-rich beds have been observed in the Lorrain formation in other parts of the map area.

CORRELATION

In the absence of suitable fossils, perhaps the most reliable criteria that can be used to establish approximate time correlation in Precambrian rocks of widely separated regions are "exotic" lithologies such as tillites or iron-formations which are products of unusual climatic or chemical regimes. It is suggested that the iron-rich sediments of the McGregor Bay area may be correlated with the Gunflint iron-formation of the Port Arthur region of Lake Superior. The ferruginous sediments of the McGregor Bay area differ markedly from the typical Animikie iron-formations in that the silica in the latter is usually in the form of chert or recrystallized chert (Moorhouse, personal communication). However, similar clastic iron-bearing rocks occur at the base of, or immediately underlying, iron-formations in the northern United States, thought to be equivalent to the Gunflint formation (James *et al.* 1961, pp. 37, 39, 133, 134, 155). Boyum (1962, p. 43) stated that the "primary clastic facies (of the Negaunee iron-formation) are found principally in the lower half of the iron-formation." If this correlation is accepted, then the Animikie group is younger than the Cobalt group. Neither the unconformity at the base of the Animikie group in the Port Arthur region (Moorhouse 1957) nor the unconformity at the base of the Cobalt group (Collins 1925; Frarey 1959, 1961, 1962) has been observed in the McGregor Bay area where an unbroken succession of Proterozoic rocks occurs.

Correlation of the Proterozoic rocks of the Port Arthur region (Animikie group) with the type Huronian of the north shore of Lake Huron has always been uncertain (Moorhouse 1957; Stockwell 1963) since there are no striking lithological similarities between the sediments of the two areas and they are separated by Archean rocks.

In the Port Arthur region, rocks of the Animikie group lie with profound unconformity on Archean rocks, whereas iron-formations in northern Minnesota, Wisconsin, and Michigan, thought to be approximately equivalent in age to the Gunflint formation of the type Animikie of Ontario (Leith, Lund, and Leith 1935; Hurley *et al.* 1962), are underlain by older Proterozoic rocks, consisting mainly of quartzite and dolomite. The thick sequence of sediments in which the iron-formations occur was called "Huronian" by earlier workers in the Michigan area and this term persisted for over a hundred years. James (1958) pointed out the weakness of the correlation of the American succession with that of the Huronian of Ontario and used the term "Animikie Series" to describe the Michigan rocks. However, apart from the presence of iron-formation in both areas, correlation of the American sections and the type section of the Animikie is still weak.

If the iron-bearing sediments of the McGregor Bay area are approximate correlatives of the Gunflint formation of the Port Arthur region and the American iron-formations, then it is probable that the underlying formations of the American sections may be correlated with the Huronian of the type area. (Table II). The correlation is still far from perfect, but there are three strong points in its favor.

TABLE II
Correlation of Proterozoic formations between Michigan and McGregor Bay, Ontario

Dickinson County, Michigan (James <i>et al.</i> 1961)	Marquette District, Michigan (Boyum 1962)	McGregor Bay, Ontario (this paper)	Port Arthur, Ontario (Moorhouse 1957)
Menominee group	Menominee group	Animikie group?	Animikie group
Vulcan iron-formation	Negaunee iron-formation	Iron-formation	Gunflint iron-formation
Felch formation	Siamo slate	White quartzite	Kakabeka conglomerate
	Ajibik quartzite		
Slight unconformity	Slight unconformity		Profound unconformity
Randville dolomite	Kona dolomite	Banded "cherry" quartzite	
Sturgeon quartzite	Mesnard quartzite	Lorrain quartzite	
Fern Creek formation		Gowganda formation	
Profound unconformity	Profound unconformity		
		Quirke group	
		Serpent formation	
		Espanola formation	
		Bruce conglomerate	
		Hough group	
		Mississagi formation	

- (1) The presence of iron-bearing strata.
- (2) The presence of a thick, ripple marked, vitreous quartzite that is green and sericite-rich near its base (Sturgeon quartzite and Lorrain quartzite).
- (3) The presence of glacial deposits (Fern Creek formation and Gowganda formation).

The Fern Creek formation of Michigan contains tillite (Pettijohn 1943) and occurs as isolated patches related to topographic relief of the surface on which it accumulated. The local nature of the Fern Creek formation is in great contrast to the extensive occurrences of Gowganda formation of the north shore of Lake Huron. In some places the Sturgeon quartzite overlies the Fern Creek formation, but in many the quartzite lies directly on the older basement gneisses. There is a striking similarity between the stratigraphic relations of these formations in Michigan and the relations of their suggested correlatives in the Cobalt area of Ontario. Schenk (1965) described a pre-Gowganda topography on which the glacial sediments were deposited and Thomson (1957) noted that the Lorrain formation either rested on the Gowganda formation, or directly on the basement rocks. Paleocurrent work by Pettijohn (1957), McDowell (1957), Pienaar (1963), Schenk (1965), Casshyap (personal communication), and the writer, indicates that the Huronian rocks of the north shore of Lake Huron were derived from a source that lay to the north of the present outcrops. Thus the stratigraphic relations of the Huronian rocks of the Cobalt area are probably indicative of accumulation at, or close to, the margin of the Huronian basin of sedimentation. Similar relationships in the Michigan area, including the absence of pre-Cobalt group Huronian sediments, indicate the existence there of a positive area in pre-Cobalt times. Paleocurrent analysis of Precambrian quartzites in the region south of Keweenaw Peninsula (Pettijohn 1957, Fig. 1) revealed a radial pattern of sediment dispersal which may indicate the presence of a land mass in that area in Huronian times. A study of the directional sedimentary structures and petrology of the rocks of the region south of Lake Superior led Hamblin (1961) to suggest the presence of a land mass (the northern Michigan high lands) which persisted from late Keweenawan to Cambrian times. Thus there is much evidence to suggest the existence, in this region, of a topographic high which, with occasional inundation by shallow waters, persisted from early Huronian to late Cambrian times, a period of some 1 600 million years. The presence of this highland area is significant in that it caused the only known exception (Pettijohn, personal communication) to the relatively simple pattern of southerly transport of the Proterozoic and early Paleozoic sediments of the northeastern part of the North American continent.

This report is part of a continuing study of the stratigraphy, structure, and sedimentology of the Proterozoic rocks of the area north of Manitoulin Island, Lake Huron.

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