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THE GEOLOGY OF THE LOWER PROTEROZOIC McCASLIN FORMATION, NORTHEASTERN WISCONSIN

by

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ABSTRACT

The McCaslin Formation of northeastern Wisconsin overlies the Waupee Volcanics and has been intruded by the Hager Rhyolite Porphry and High Falls Granite of the Wolf River Batholith. The McCaslin Formation is at least 1,220 m thick, consisting of a thin, basal quartz-pebble metaconglomerate and a thick metamorphosed orthoquartzite. The formation was metamorphosed to the hornblende hornfels facies by the 1,500 Ma old Wolf River Batholith. The McCaslin Formation forms a major syncline plunging 30° to the S. 20° W. The southern branch of the McCaslin range consists of overturned quartzite.

The McCaslin Formation appears to have been deposited as part of a braided alluvial system. The sedimentation was influenced by the lack of land vegetation, intense weathering, and probably aeolian conditions in the source areas. Paleocurrent data show that the direction of sediment transport was mostly from west to east with substantial local variation. Clast lithologies and heavy minerals indicate multiple sediment sources. The tectonic environment was generally stable with slight but steady subsidence.

The McCaslin Formation may correlate with several other quartzites in the region, including the Baraboo, Waterloo, Barron, Flambeau, and Sioux Quartzites. Radiometric ages on related igneous rocks indicate deposition of these formations during the Early Proterozoic between approximately 1,760 and 1,630 Ma.

Minor radioactivity of the McCaslin Formation is due to placered zircon grains. The metaconglomerate is probably too young to contain Elliot Lake-type placered uranium. However, since the McCaslin-Waupee contact is not exposed and has not been studied, an unconformity-type uranium deposit can not be ruled out.

INTRODUCTION

The McCaslin Formation (Mancuso, 1960) is located in northeastern Wisconsin in parts of Forest, Oconto, Marinette, and Langlade Counties (fig. 1). The main topographic features are McCaslin Mountain, Thunder Mountain, and Deer Lookout Tower Hill. Eastward the range splits into two ridges, informally referred to as the northern and southern branches.

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The McCaslin Formation is underlain by the Waupee Volcanics which consists of basalt, andesite, rhyolite, and interflow metasedimentary rocks (Mancuso, 1960; Lahr, 1972). The McCaslin Formation has been intruded by the Wolf River Batholith, which in the McCaslin area consists of the Hager Rhyolite Porhyry and High Falls Granite.

LITHOLOGY

The total thickness of the McCaslin Formation is difficult to evaluate because of extensive glacial cover. The basal contact with the Waupee volcanics is not exposed although the two crop out within 30 m of one another. The thickness of the McCaslin Formation varies from 1,220 m at Thunder Mountain to 610 m across the northern branch (Olson, 1982). The varying thickness may be due to erosion of the McCaslin prior to emplacement of the Hager Rhyolite Porphry.

The main rock types comprising the McCaslin Formation are quartzite and a basal metaconglomerate. The metaconglomerate, best exposed on the northern side of the range, is generally thin and lenticular. It becomes interlayered with cross-bedded quartzite upward in the section and eventually disappears about 300 m from the base. Approximately 73 percent of the pebbles counted were white vein quartz (fig. 2). The remainder included iron-formation, 18 percent; white chert and quartzite, 7 percent; and jasper 2 percent. In general, the pebbles decrease in size from 3 cm at Ada Lake in the west to 0.2 cm at Thunder Mountain in the east. The average size also decreases upwards through 85 m of section at Ada Lake from 3.0 cm to 1.5 cm.

The majority of the quartzite is light maroon in color due to disseminated hematite. Original grain boundaries are visible only on the extreme western end where the quartz has not been significantly recrystallized by contact metamorphism.

Much of the quartzite is cross-bedded (fig. 3). A total of 123 crossbeds was measured in the field. Approximately 25 percent are classified as tabular or planar and 75 percent as trough. The cross-beds range between 2.5 and 61 cm in thickness, both types averaging about 12 cm. The upper part of the section contains very little cross-bedding. This may be due to changes in the depositional environment or it may have been obscured by contact metamorphism of the Wolf River Batholith.

A few silty layers, up to 3 cm thick, are present in the McCaslin Formation, however these comprise only a very small percentage of the total exposure. Asymmetrical ripple marks are present in one outcrop along the southern branch. These trend northeast-southwest with an apparent current direction from the southeast. The ripple index is about 9, indicating subaqueous deposition.

Cyclicity is common in the bedding and cross-bedding of the quartzite of the McCaslin Formation, with an upward decrease in grain size and scale of cross-bedding. In general, light-colored coarse beds with large-scale crossbeds alternate with darker colored, finer-grained beds with small-scale crossbeds.

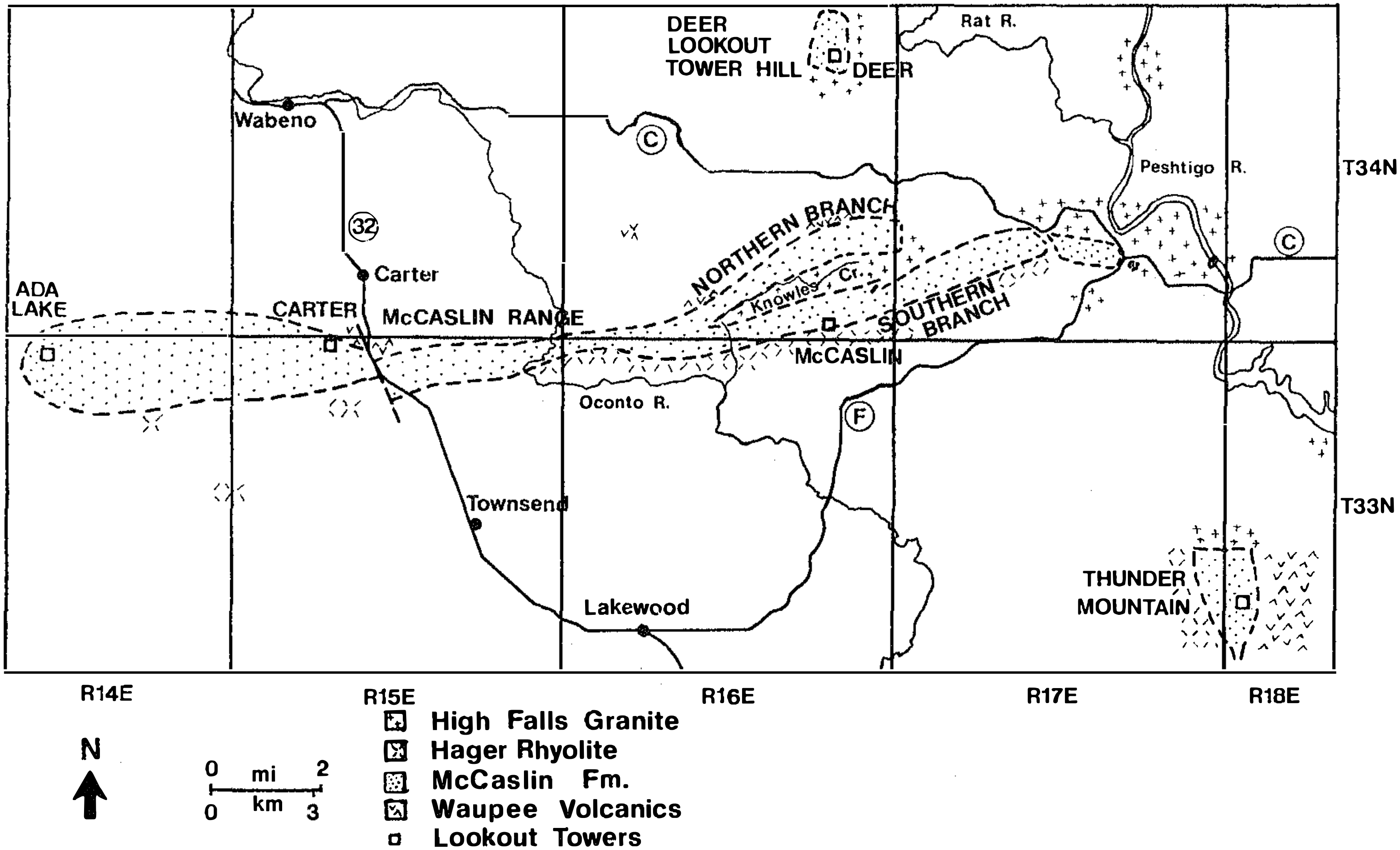

FIGURE 1.--General location map of McCaslin Formation.

FIGURE 2.--Metaconglomerate at Carter Lookout Tower (NE¼ sec. 5, T. 33 N., R. 15 E.). Note predominance of vein quartz pebbles.

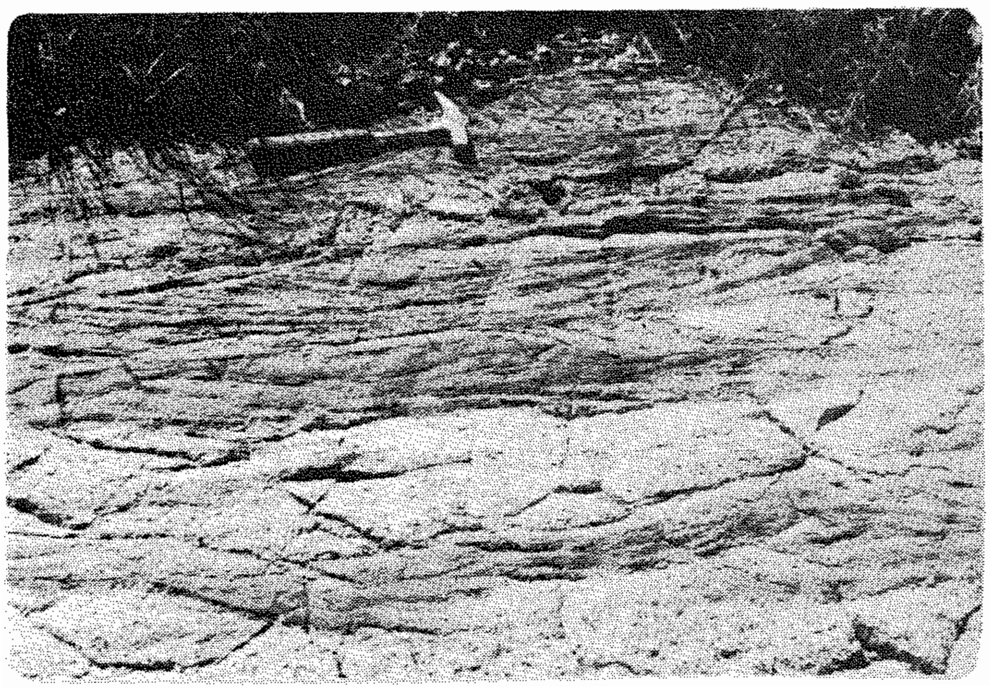

FIGURE 3.--Large scale trough cross-bedding in quartzite at Thunder Mountain (SE¼ sec. 30, T. 33 N., R. 18 E.).

STRUCTURE

The McCaslin Formation generally dips to the south along most of the ridge including the northern branch (fig. 4). However, along the southern branch, the bedding dips to the north and is overturned. Beds at both Thunder Mountain and Deer Lookout Tower Hill dip to the west. A pi diagram of 242 poles of bedding shows the girdle of a syncline plunging 30 degrees to the S. 20° W. (fig. 5). The axis of the syncline lies between Thunder Mountain and McCaslin Mountain.

The overturning of the southern branch is a secondary feature in the syncline (fig. 6). The overturned orientation of the bedding was determined on the basis of overturned trough cross-bedding north of the McCaslin Mountain Lookout Tower. The presence of quartz pebbles in this outcrop suggest it is proximal to the basal metaconglomerate. There may be a fault related to the intrusion of the High Falls Granite between the northern and southern branches. The location of the fault zone is marked by quartzite breccia recemented by white vein quartz as well as a lineament observable on aerial photographs. The zone trends northeast and appears to cut the eastern edge of the northern branch.

A major fault, oriented north-northwest, occurs south of Carter (Mancuso, 1960). It is a right lateral fault. The Waupee-McCaslin contact is offset about 300 m across the fault. The quartzite along the fault has also been recemented by white vein quartz.

Deer Lookout Tower Hill appears to be separated from the McCaslin Range by a major fault which strikes approximately east-northeast, but the direction of displacement is unknown. The fault trace appears as a lineament on aerial photographs and as a linear series of magnetic highs and lows on an airborne magnetic survey.

Another smaller reverse fault is also present at Deer Lookout Tower Hill, trending north-northeast. The Waupee-McCaslin contact is repeated indicating dip slip movement with the western block uplifted relative to the eastern block.

PETROGRAPHY

Seventy samples of the McCaslin were studied in thin section. All thin section chips were stained for alkali feldspar and plagioclase. Twenty-five thin sections were point counted along random traverses perpendicular to bedding.

There are three types of sand-sized rock fragments in the McCaslin Formation. These include recrystallized chert, quartz sandstone, and iron-formation composed of banded hematite and chert. There are three types of quartz present in the sand fraction. These include monocrystalline or common quartz, recrystallized chert, and recrystallized sandstone grains.

Muscovite occurs as laths which may be poikiloblastic enclosing the quartz, especially near faults and granite intrusions due to the shearing and higher metamorphic grade in these areas.

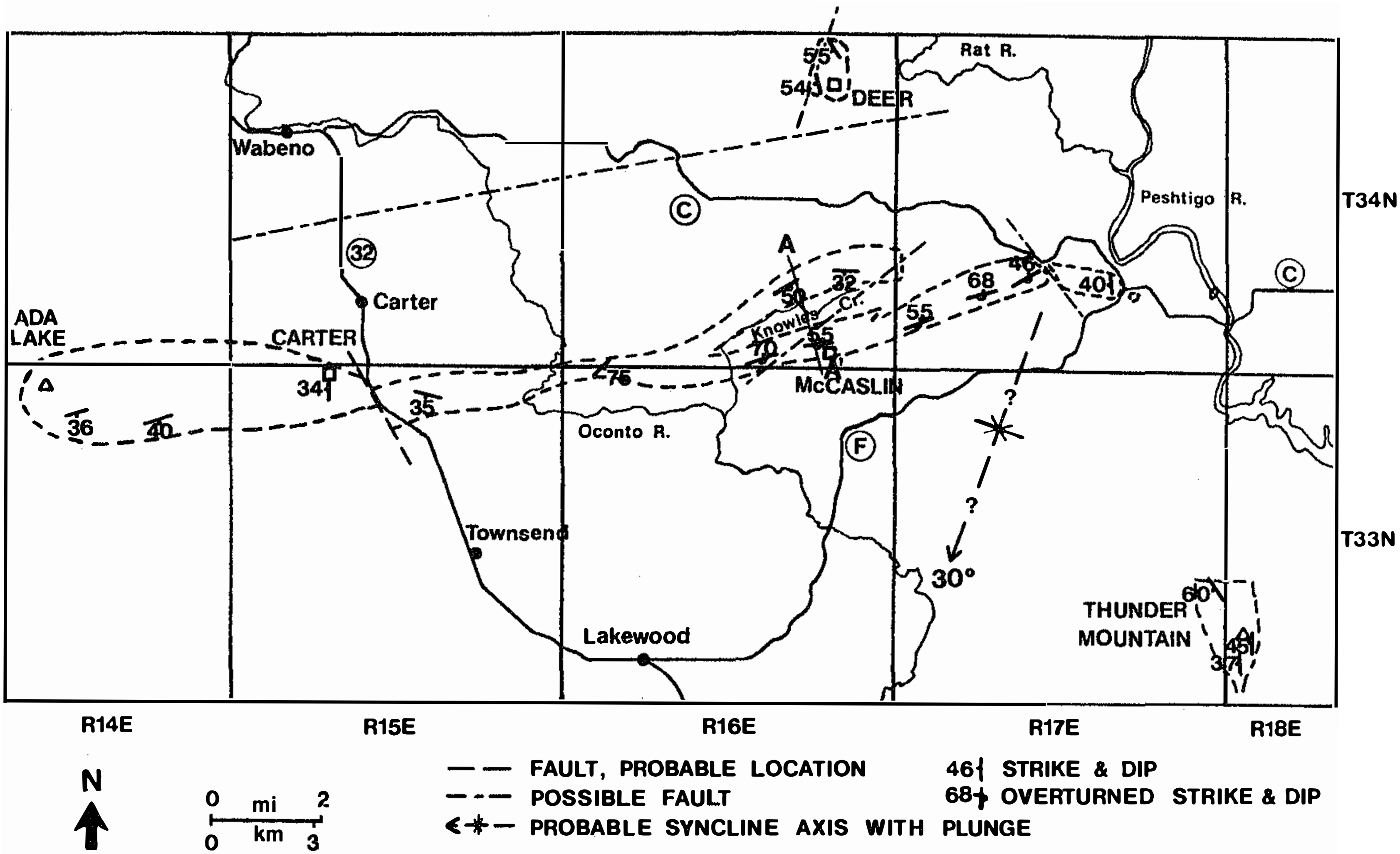

FIGURE 4.--Structure of the McCaslin Formation.

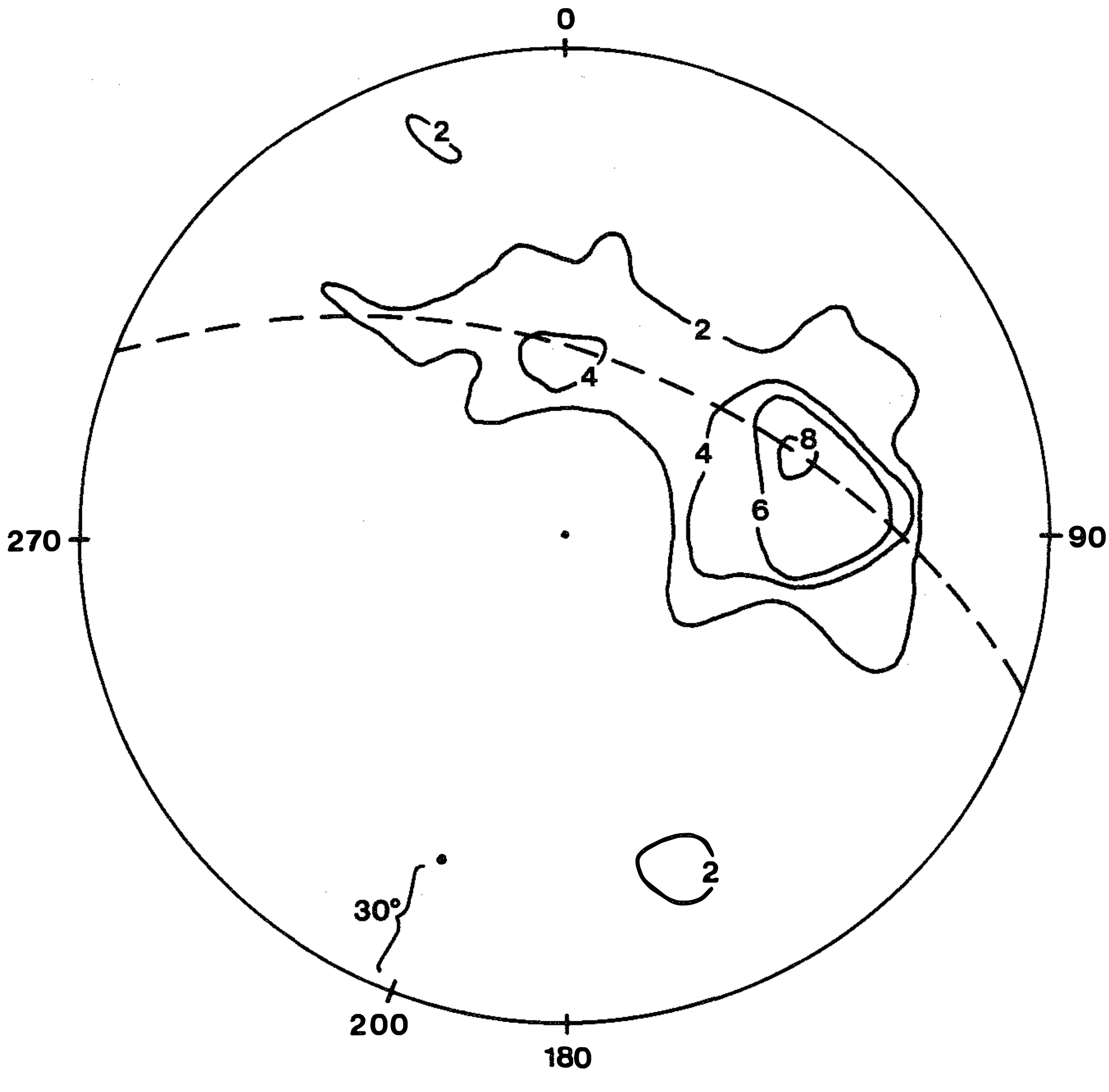

FIGURE 5.--Contour diagram of poles of bedding. 242 total measurements, contour interval 2%. Syncline plunges 30° at azimuth 200°.

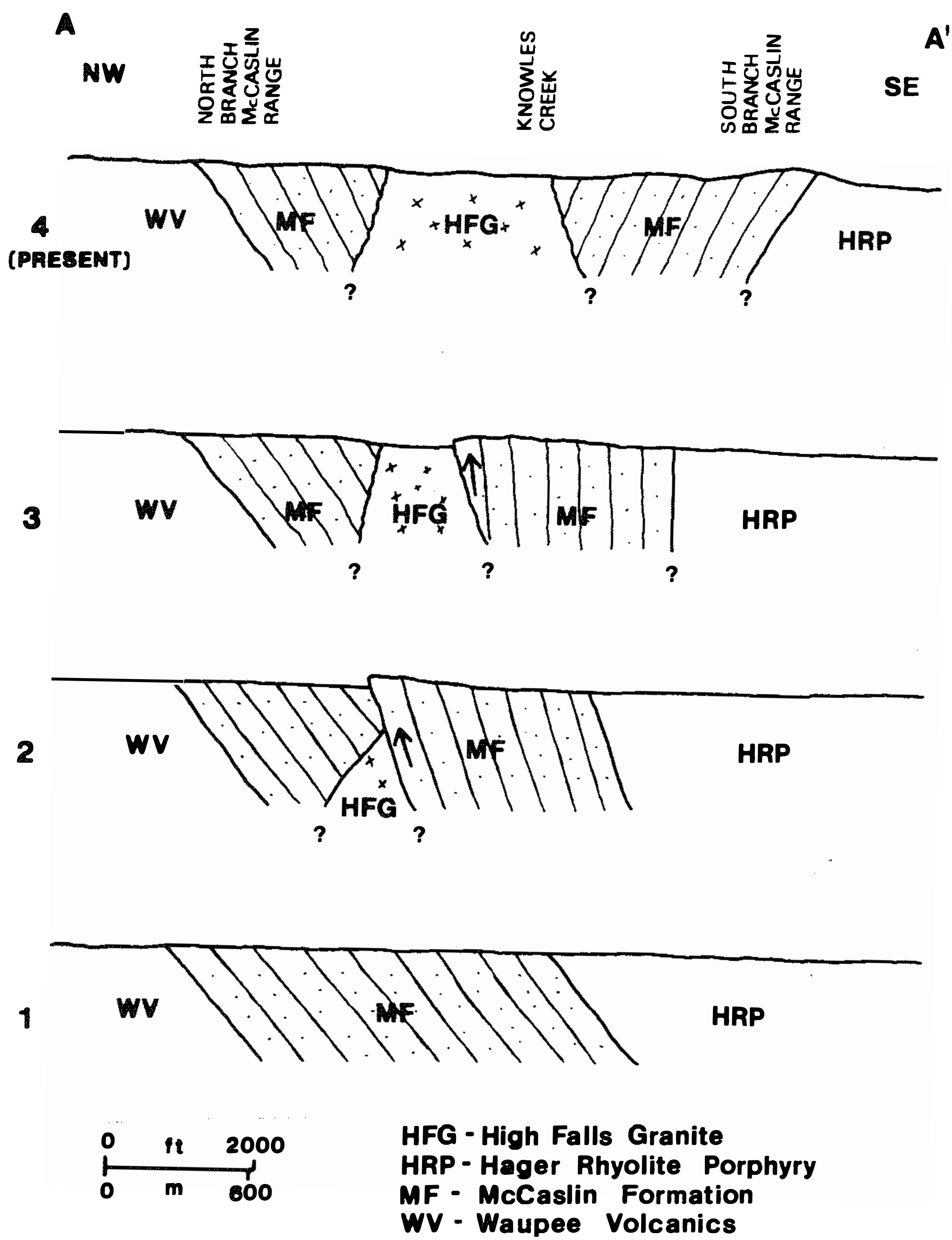

FIGURE 6.--Hypothetical cross sections showing possible overturning of McCaslin and intrusion of High Falls Granite.

Epidote occurs near Ada Lake at the western end where the metamorphic grade is lowest. It is present as irregular, secondary grains in a micaceous matrix.

Feldspar only occurs in an outcrop near the Peshtigo River where a 5 m block of quartzite has been surrounded by High Falls Granite. Albite, microcline, and perthite are present. The microcline and perthite are less altered than the plagioclase, and poikiloblastic around quartz grains. Apparently potassium was supplied to the quartzite by the granite, enabling the formation of the feldspar at the expense of andalusite.

Chloritoid is found in samples from Deer Lookout Tower Hill Thunder Mountain, and the northern branch. It is pleochroic green to blue, twinned, and forms needles and laths.

Andalusite occurs in varying amounts throughout most of the area. It commonly shows signs of alteration to sericite and probably formed from metamorphism of the original interstitial clay.

Andradite appears in samples from Deer Lookout Tower Hill, Thunder Mountain, and the southern branch. It commonly has alteration rims of chlorite.

Sillimanite occurs in quartzite at Deer Lookout Tower Hill and Thunder Mountain. It typically forms needles, generally radiating from grain contacts.

Only two minerals are found as matrix in the quartzite. Sericite or fine-grained, slightly impure muscovite, appears as tiny individual laths less than 30 microns long. Kaolinite, identified by x-ray analysis, is similar in appearance to sericite but has lower birefringence. Minor amounts are present locally as small laths. The kaolinite is probably not primary, possibly forming by alteration of pyrophyllite. The pyrophyllite reported by Motten (1972) and Miller (1980) was not observed in this study.

The only mineral which can be identified as cement is silica. It is observable as quartz overgrowths in samples from the western end of the outcrop area. Elsewhere recrystallization has obscured the original grain boundaries.

Fifteen heavy mineral mounts from the McCaslin Formation were also studied. At least 300 nonmagnetic, non-opaque grains were counted for each. The heavy mineral suite can be divided into detrital and metamorphic groups. Those which show evidence of abrasion such as rounding are detrital; the rest are considered metamorphic.

The most abundant detrital heavy mineral is zircon. Zircons were divided into six categories based on the presence of zoning and degree of roundness. On the whole, unzoned zircons are more numerous, averaging 61 percent. The angular categories include idiomorphic grains, broken grains, and those with euhedral overgrowths and constitute 76 percent of the total. The subrounded groups comprise 21 percent with the rounded categories making up about 3 percent of the total.

Detrital red rutile is uncommon, making up less than 1 percent of the total heavy mineral suite. Tourmaline is rare; it generally shows brown-green pleochroism and occurs as broken crystals. The ZTR Index (Hubert, 1962) of the detrital heavy minerals is 100 percent, indicating a very mature suite. Opaque minerals include magnetite and hematite. Pyrite also occurs but appears to be secondary.

The metamorphic heavy minerals include andalusite, andradite, sillimanite, epidote, and clinozoisite. Yellow rutile is generally associated with hematite in thin section, and probably resulted from the separation of titanium and iron from ilmenite and leucoxene during weathering and metamorphism.

Almost all of the McCaslin thin sections can be classified as quartzite or quartzose metaconglomerate. On a ternary sandstone classification diagram (Pettijohn, Potter, and Siever, 1973), these would plot at the quartz corner. There are no feldspar or rock fragments present in the sand fraction. Assuming the sericite, andalusite, and sillimanite represent original clayey matrix, almost all the samples would be classified as metamorphosed quartz arenites. Only one fine-grained sample, containing more than 15 percent matrix, would be classified as a quartz wacke.

METAMORPHISM

The contact metamorphism is a result of the intrusion of various phases of the Wolf River Batholith. The only two metamorphic facies present in the McCaslin are the hornblende hornfels facies, and the albite-epidote hornfels facies which is essentially low pressure greenschist facies.

Metamorphism resulted from contact with the Hager Rhyolite Porhyry as well as the intrusion of the High Falls Granite. McCaslin outcrops adjacent to the Hager contain sillimanite and andradite, indicating it was very hot, possibly equal in temperature to the High Falls Granite.

The lowest metamorphic grade is found at Ada Lake where epidote, siderite, and andalusite occur. The majority of the quartzite contains some andalusite with chloritoid and andradite present locally. Sillimanite represents the highest grade of metamorphism, and occurs at Deer Lookout Tower Hill, Thunder Mountain, and near the Oconto River. The Sillimanite needles typically formed at the expense of andalusite.

SEDIMENTATION

Rose diagrams of 113 paleocurrent measurements, corrected for structural dip by a two-tilt solution (Ramsay, 1961) are shown in figure 7. After rotation of bedding back to horizontal, the mean dip of inclination of the cross-bedding was 21 degrees, decreasing slightly upward in the formation. Although most of the outcrops have a high variance, the calculated vector means are subparallel to the east. The overall direction of sediment transport is interpreted to have been generally from west to east with substantial local variation.

The overall characteristics of the McCaslin Formation include cyclical, small-scale trough and planar cross-bedding, poor to moderate sorting, thin discontinuous conglomerate, rare asymmetrical ripple marks, and compositional maturity. Silt and clay are scarce and herringbone cross-bedding is totally

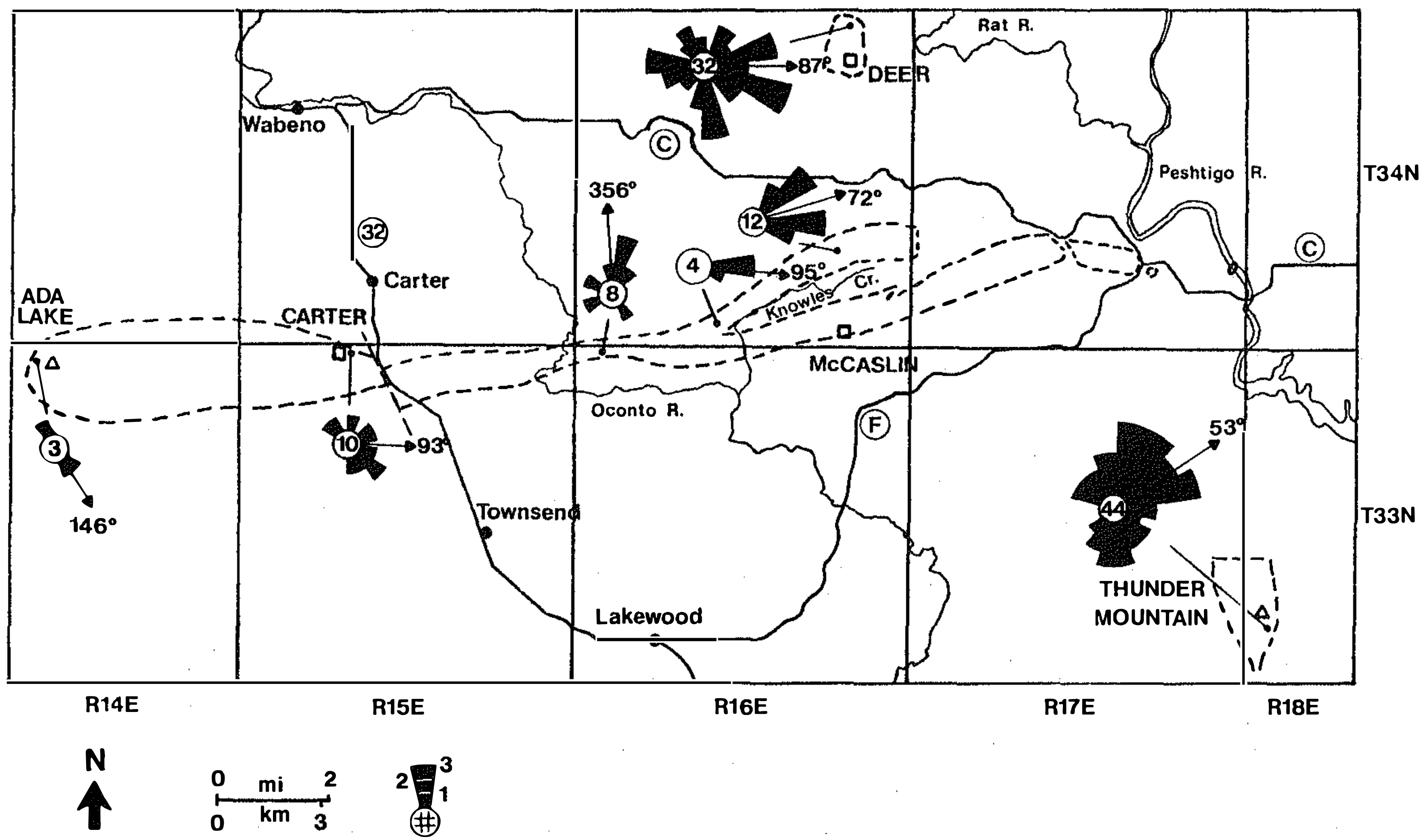

FIGURE 7.--Paleocurrent plots of cross-bedding. Number in center is number of readings, arrow is vectorial mean.

absent. These features seem to best fit a braided stream model. Most pre-Silurian streams were braided (Cotter, 1978). The absence of vegetation restricted the formation of overbank deposits and also permitted extensive movement of sand by the wind, thus aiding in production of a mature sand. Most likely the McCaslin Formation was deposited in a braided stream environment although aeolian processes were probably active over the alluvial plain.

However, there are several features of the McCaslin Formation which do not easily fit the braided stream model. Braided streams typically have an overall unimodal paleocurrent distribution. The paleocurrent distribution of the McCaslin is somewhat unidirectional, but there is a considerable amount of variance. One possibility may be a tidal influence in a sea at the edge of the alluvial plain. However, features typical of tidal marine environments such as herringbone cross-strata and associated carbonates and shales are not present. Other possible causes for the lack of unimodality include the variability inherent in braided stream cross-bedding (Smith, 1972) and local irregularities in the Waupee topography at the time of deposition.

There are six types of braided stream models (Miall, 1977). The McCaslin Formation most resembles the Donjek River model which occurs in the more distal reaches of alluvial fans (Rust, 1975). The Donjek characteristics are somewhat variable, but generally cyclic with an upward decrease in grain size, bed thickness and scale of sedimentary structures. Poorly-bedded gravel comprises between 10 and 90 percent of the Donjek with small-and large-scale cross-beds in the sandy layers. In summary, the McCaslin Formation was probably deposited by a series of braided streams moving over a broad alluvial plain on a fairly stable but subsiding continental margin.

PROVENANCE

Since the dominant paleocurrent direction is generally from the west towards the east, the source area was probably located to the west, although sediment also could have been supplied from the north and south. Multiple sources of sediment are indicated by the various types of pebbles in the metaconglomerate as well as the various sizes and amounts of rounding of zircon grains. Iron-formation and chert pebbles indicate weathering and erosion of sedimentary rocks. The rutilated quartz and vein quartz pebbles are probably igneous, and the quartzite pebbles probably came from a metamorphic terrane. A possible source of the iron-formation is the Black River Falls iron-formation located approximately 200 kilometers to the southwest. Quartz-rich metasedimentary rocks occur in the Waupee Volcanics (Lahr, 1972) and may have produced some of the quartz sand. The quartz sand could have been reworked from an older sedimentary source, but because of metamorphism and recrystallization, multiple overgrowths can not be detected. Nevertheless, the overall compositional maturity and high ZTR Index indicate some reworking of older sands may have occurred.

CORRELATION AND AGE

The McCaslin Formation must be older than the Wolf River Batholith, dated at 1,500 Ma (Van Schmus, Thurman, and Peterman, 1975). However, the Waupee Volcanics which underlie the McCaslin have not been dated, therefore a maxiumu age for the McCaslin has not been determined.

The McCaslin Formation was previously correlated with the Baldwin Conglomerate because of similarities in stratigraphic position and litologic type (Mancuso, 1960). The Baldwin Conglomerate crops out near Mountain, 23 km south of McCaslin Mountain Lookout Tower. Like the McCaslin, it overlies the Waupee Volcanics and underlies the Hager Rhyolite Porphyry. The Baldwin is a poorly sorted metaconglomerate with angular to subrounded clasts of quartz, Waupee, and feldspar in a matrix of quartz, feldspar and mica.

Anderson (1978) concluded that the Baldwin and McCaslin Formations were not deposited simultaneously. The Baldwin has primarily subangular clasts of rock fragments suggesting a close source area with fairly high relief. In contrast, the McCaslin has mainly rounded quartzite and quartz pebbles indicating a more distant source and lower relief. The radioactivity of the Baldwin is also higher as a result of more immature rock fragments.

Sims and Mudrey (personal communications, 1981, and as shown in Morey and others, 1982) suggest a possible origin for the Baldwin. They believe there is evidence of shearing along an east-northeast trending zone in the Waupee Volcanics. The Baldwin may be a breccia deposited along the edge of this zone, which was later lithified and covered by the Hager Rhyolite Porphry. Therefore the Baldwin Conglomerate may have been deposited at approximately the same time as the McCaslin Formation, but they are not lithologic correlatives.

There are several Precambrian quartzites in the Lake Superior region which have been studied most recently by Ojakangas and Morey (1982). These include the Bessemer Formation, the Sibley Group, the Puckwunge Formation, and the Nopeming Formation. These quartzites range in age from 1,100 to 1,340 Ma and are all younger than the McCaslin. Other older quartzites in the region have also been correlated, namely the Sioux, Flambeau, Barron, Baraboo, and Waterloo Quartzites (Dott and Dalziel, 1972; Weber, 1981; and Campbell, 1982). The ages of these quartzites have been placed between 1,630 and 1,760 Ma on the basis of radiometric dating of associated igneous rocks (Van Schmus, 1978). These erosional remnants may represent a single sheet or at least more extensive deposits.

The McCaslin resembles this older group of quartzites and may be correlative with them. The sedimentation, metamorphism, regional structure, and compositions are all similar. Compositional similarities consist of clast lithologies, the types of quartz sand grains, the heavy mineral suites, and the phyllosilicates (table 1).

Sedimentation of these quartzites also appears to have occurred under analogous conditions since the quartzites are all fairly thick. The environments of deposition of the Flambeau (Campbell, 1982), the Baraboo and Waterloo (Dott, in press), and the McCaslin appear to be fluvial. The Barron (Campbell, 1982) and Sioux (Weber, 1981) are possibly a combination of fluvial and marine. Both fluvial and marine environments may have occurred at different times in different areas.

The McCaslin has the highest metamorphic grade of the quartzites under consideration, reaching the hornblende hornfels facies. Generally the other quartzites have been subjected to regional metamorphism, ranging from greenschist to lower amphibolite facies (Dott, in press). The high grade of the McCaslin results from contact metamorphism of the Wolf River Batholith. This

TABLE 1.--Comparison of composition of McCaslin Formation with other Proterozoic quartzites. Information compiled from Dott and Dalziel, 1972; Campbell, 1982; and Weber, 1981. Listed in order of decreasing abundance

	McCaslin	Baraboo	Barron	Sioux	Flambeau
Pebble Types (>2 mm)	Vein quartz Jasper Chert Iron-formation	Vein quartz Chert Jasper	Vein quartz Quartzite Jasper Slate	Vein quartz Chert Jasper Iron-formation Rhyolite Quartzite	Vein quartz Chert Rhyolite Iron-formation
Sand Types (<2 mm)	Strained Unstrained	Strained Polycrystalline Chert	Unstrained Strained Polycrystalline Chert	Strained Polycrystalline Unstrained Chert	Strained Polycrystalline Chert
Heavy Minerals	Hematite Zircon Rutile Pyrite Tourmaline	Zircon Magnetite Pyrite Rutile Barite	Zircon Ilmenite Leucoxene Rutile Apatite	Zircon Rutile Tourmaline Magnetite Hematite	Magnetite Hematite Zircon Tourmaline
Phyllosilicates	Muscovite Kaolinite	Muscovite Pyrophyllite Kaolinite	Kaolinite Illite	Pyrophyllite Muscovite Illite	Muscovite

may have been superimposed on an older low grade regional metamorphism similar to the other quartzites, however evidence of only one metamorphic event can be observed in the McCaslin.

The deformation of some of the quartzite units is also remarkably similar. The Baraboo, Waterloo, and McCaslin form asymmetrical synclines oriented northeast-southwest. The Flambeau Quartzite also forms a syncline, opening to the northwest. In contrast, the Barron is almost flat, dipping slightly to the north, and the Sioux is very gently folded, generally dipping to the south and southwest.

The McCaslin Formation appears to correlate with the Baraboo, Waterloo, Barron, Flambeau, and Sioux on the basis of maturity, depositional environment, degree of metamorphism and style of deformation. If the McCaslin is correlative with the other quartzites, it may be between 1,630 and 1,760 Ma or Early Proterozoic in age.

TECTONIC SETTING

The overall tectonic setting must have been fairly stable to produce a thick extensive deposit of quartz sand. However, some basin subsidence or uplift would be necessary to enable these thick formations to develop. The primary aluminum-rich clay minerals such as pyrophyllite and kaolinte indicate intensive chemical weathering typical of a warm, humid climate with fairly low relief. This combination would permit weathering and leaching of less stable constituents such as feldspar. The lack of land vegetation would have allowed the resulting fine material to be removed by wind or water action.

The paleocurrent patterns for the six possibly correlative (?) units appear to surround a fairly extensive highland located in east-central Minnesota and central Wisconsin (fig. 8). Broad coalescing alluvial fans may have developed on the flanks of this highland with a sandy coastal plain along the edge of the alluvial plain.

Marine transgression may have started with the deposition of the quartzites. Black slates and iron-formation-bearing dolomite overlie the Baraboo (Dott, 1982). The Sioux Quartzite has been interpreted as fluvial in the lower two-thirds and marine in the upper third (Weber, 1981). The later deformation of these quartzites marks the end of the stable tectonic setting.

URANIUM POTENTIAL

Interest in the uranium potential of the McCaslin developed in 1955 with the discovery of uraniferous conglomerate east of the McCaslin Mountain Lookout Tower (Kalliokoski, 1976). Attempts to find similar conglomerate in this area have been unsuccessful. The uraniferous samples could have originated in the conglomerate along the northern branch, or they may be part of the glacial drift.

Exploration in the McCaslin area began with geochemical and geophysical reconnaissance during 1957 (Kinneman and Illsley, 1962). Anderson (1978) included the McCaslin in his radiometric survey of Middle Precambrian quartzites in Wisconsin. Western Nuclear drilled three test holes into the McCaslin in 1978. The cuttings were studied by Miller (1980) who concluded that zircons were the cause of radiation in the McCaslin.

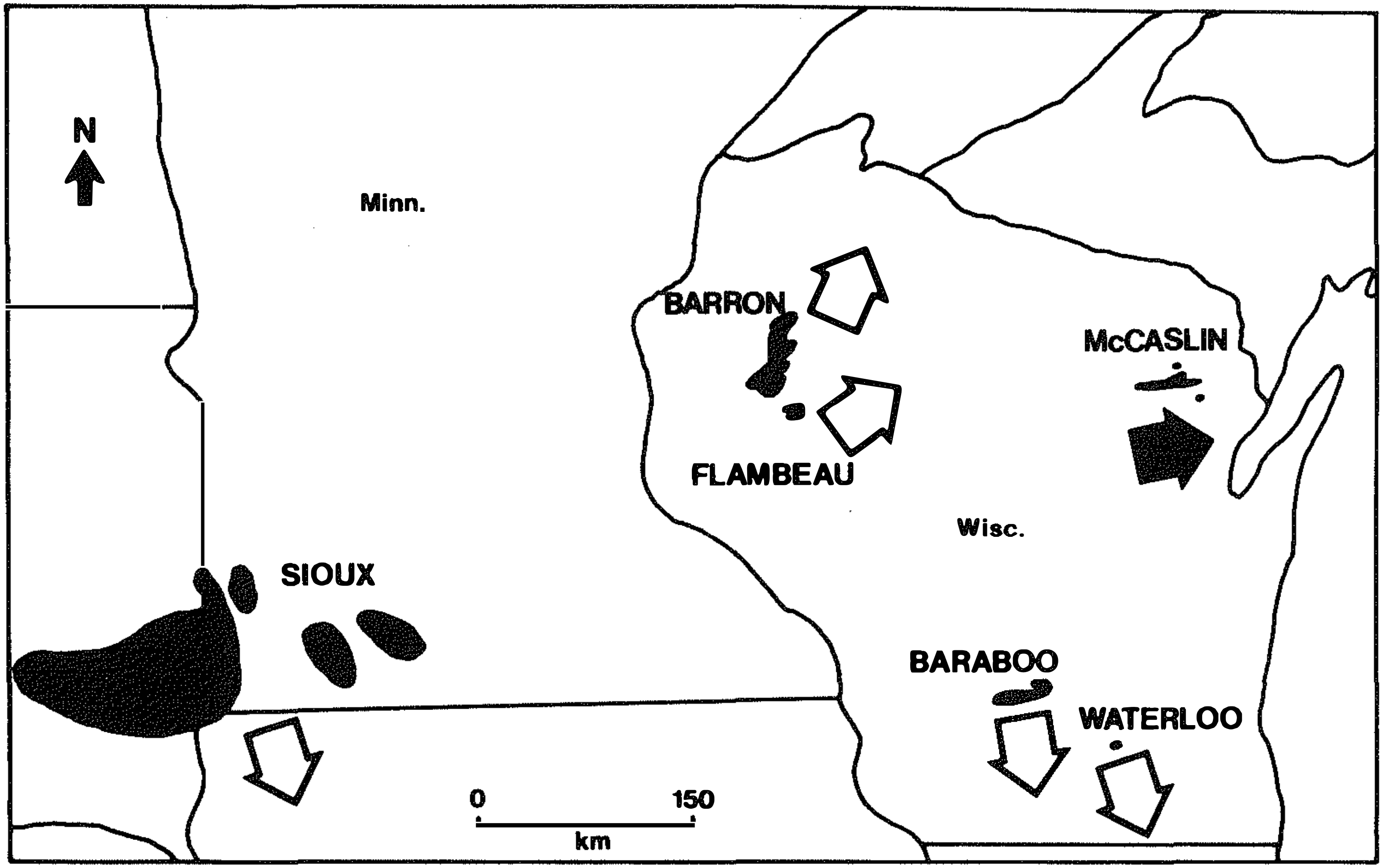

FIGURE 8.--Location of Proterozoic orthoquartzites and their dominant paleocurrent directions.

Airborne radiometric and magnetic surveys were flown over most of the McCaslin area during August, 1980. Flight lines and contour maps were made available to the author by the U.S. Geological Survey. Radioactive anomalies appear to be scattered randomly throughout the area. Many are related to the Hager Rhyolite Porphry and High Falls Granite, but some seem to be associated with the McCaslin-Waupee contact.

A ground survey of the McCaslin during this investigation disclosed that the conglomerate is more radioactive than the quartzite. Uranium and thorium analyses of nine samples were also conducted by the USGS. The overall amount of thorium ranges between 3.3 and 99.9 ppm, and uranium between 1.31 and 9.45 ppm (Olson, 1982). The highest thorium reading is from the southern side of Deer Lookout Tower Hill. The highest uranium value is from a sample just north of the McCaslin Mountain Lookout Tower.

Luxophotographs (alpha-prints) were also made on samples of the McCaslin. The results show that the source of radioactivity in the McCaslin is probably zircon grains.

A uranium deposit could still conceivably be found at the base of the McCaslin which is not exposed and was not reached in the test holes. A quartz-pebble conglomerate-type deposit is unlikely if the McCaslin is younger than 2,000 Ma. Oxygenation of the atmosphere at about this time could have prohibited subsequent deposition of placered uraninite and pyrite (Kalliokoski, 1976). The potential for an unconformity-type deposit appears more likely. The regolith along the McCaslin-Waupee contact, if present, could supply uranium and act as a host for deposition. The uranium potential of the McCaslin cannot be fully analyzed until this unconformity is studied.

SUMMARY AND CONCLUSIONS

The McCaslin Formation is at least 1,220 m thick and is composed of a basal metaconglomerate and an overlying quartzite. It is a mature quartz arenite derived from multiple sources. The pebbles are predominantly vein quartz, with lesser amounts of iron-formation, chert, quartzite, and jasper. The detrital non-opaque heavy mineral suite is very mature, primarily composed of zircon with trace amounts of red rutile and tourmaline. Most zircons are angular to subrounded, but some are very well rounded. Opaque minerals include hematite and magnetite. The euhedral pyrite is probably not detrital.

The McCaslin has been metamorphosed to the hornblende hornfels facies by the intrusion of the Wolf River Batholith. Principal metamorphic minerals include andalusite, andradite, sillimanite, chloritoid, and epidote. The structure is that of a syncline plunging moderately to the south-southwest. The southern branch of the McCaslin Range is overturned.

The environment of deposition was probably a braided stream with the overall paleocurrent direction from west to east. The tectonic setting was fairly stable but with continued slow subsidence. Deposition probably occurred on broad alluvial fans along the flank of an extensive highland.

On the basis of lithology, the McCaslin may correlate with the Baraboo, Waterloo, Barron, Flambeau, and Sioux Quartzites. If correlative, it is probably between 1,630 and 1,760 Ma, or Early Proterozoic in age.

The source of the minor radioactivity within the McCaslin is most likely zircon grains. The McCaslin may be too young for a quartz-pebble conglomerate-type of uranium deposit. However, there is some potential for an unconformity-type deposit at the base of the formation since it is not exposed and therefore has not been studied.

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