

University of Wisconsin—Extension

GEOLOGICAL AND NATURAL HISTORY SURVEY
Meredith E. Ostrom, State Geologist and Director

**GUIDEBOOK TO THE GEOLOGY AND MINERAL DEPOSITS
OF THE CENTRAL PART OF JACKSON COUNTY
AND PART OF CLARK COUNTY, WISCONSIN**

**Prepared in cooperation with the U.S. Geological Survey
and the Inland Steel Company**

for the

19th Annual Institute on Lake Superior Geology

Madison, Wisconsin, 1973

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PART OF CLARK COUNTY, WISCONSIN

by

Harry Klemic, U.S. Geological Survey, Washington, D.C. 20244
John M. Ohlson, Chief Geologist, Inland Steel Co., Ishpeming, Michigan

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GEOLOGY AND MINERAL DEPOSITS OF THE CENTRAL PART OF
JACKSON COUNTY AND PART OF CLARK COUNTY, WISCONSIN^{1/}

by
Harry Klemic^{2/} and John M. Ohlson^{3/}

INTRODUCTION

This field trip is designed to provide an introduction to the general geology and the economic geology of the central part of Jackson County and part of Clark County. It includes a visit to the Jackson County Iron Company's modern magnetic taconite mine and agglomeration plant, examination of outcropping Precambrian features, Upper Cambrian strata, and various local physiographic features.

The trip will include visits to Stops 1 through 9 (Figure 1), if time permits. Additional places of interest are shown as localities 10 through 27 on the maps and are described briefly in the text.

The general geology of the northern part of this area and of the adjoining area to the north has been described by Wiedman (1907). Ostrom (1966) and Ostrom, Davis, and Cline (1970) have made excellent descriptions and correlations of the Upper Cambrian strata that cover much of west-central Wisconsin and extend into Jackson and Clark Counties. Potter and Pryor (1961) discussed the clastic sedimentation of the Paleozoic rocks of this general area and noted the presence of phosphatic material in the Cambrian rocks.

The modern mining and beneficiation facilities of the Jackson County Iron Company have been described by Skillings (1970). An occurrence of wavellite in Jackson County was described by Klemic and Mrose (1972). The senior author is indebted to the Jackson County Iron Company for information concerning the iron deposits. The cooperation of many others in providing information and access to their property is gratefully acknowledged. Much unpublished information concerning the local geology was also obtained from the Wisconsin Geological and Natural History Survey.

Most of Jackson County and parts of Clark County are in the "driftless area", but thin gravel deposits interpreted to be glacial drift or outwash from glacial deposits are present in many places east of the Black River.

^{1/} Publication authorized by the Director, U.S. Geological Survey.

^{2/} U.S. Geological Survey, Washington, D.C. 20244.

^{3/} Chief Geologist, Inland Steel Co., Ishpeming, Michigan.

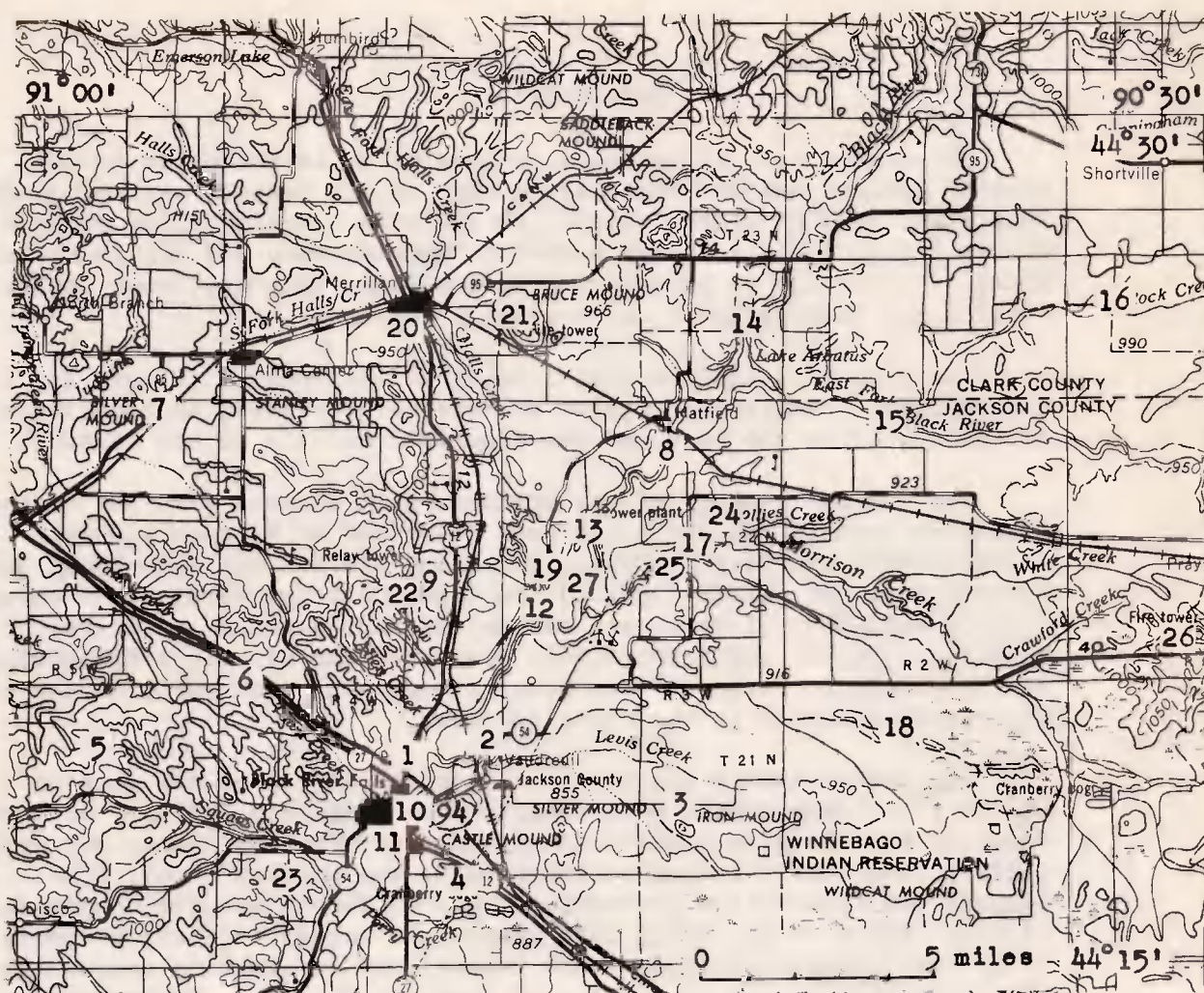


Figure 1. Field trip stops and other localities of geologic interest in Jackson and Clark Counties, Wisconsin. Base by U.S. Geological Survey, 1:250,000, Eau Claire, 1964.

Exposures of Precambrian rocks in Jackson County and in the southern part of Clark County are largely limited to the valley of the Black River and its tributaries. A few mounds of Precambrian iron-formation and associated schists and some quartzite knobs occur as windows in the Upper Cambrian sedimentary strata which form the bedrock over most of the area.

The exposed Precambrian rocks consists mainly of paragneisses, schists, phyllites, quartzites, and, locally, iron-formation. Granite and associated rhyolite and aplitic dikes, and gabbroic, dioritic, and doleritic dikes are exposed in many places.

The gneisses are mostly of granitic to granodioritic composition, and are metamorphosed sedimentary and volcanic rocks. Thin chloritic layers of greenstone in the gneisses may be sills or volcanic rocks. The foliation of the gneisses generally dips steeply and in some places the gneisses are highly contorted migmatites. In most places the weathered zone at the top of the Precambrian rocks is relatively shallow, and it appears that there was little or no saprolitic zone at the top of the Precambrian at the time of deposition of the basal Upper Cambrian sediments.

Sandstone strata of Late Cambrian age, totaling more than 400 feet in thickness in places in Jackson and Clark Counties, rest unconformably on the Precambrian rocks. In most of the area east of the Black River, however, the sandstone cover is less than 200 feet thick. In ascending order, the Cambrian formations include the Mount Simon and Eau Claire Sandstones and the Wonewoc and Lone Rock Formations of Ostrom (1966). These units are described in Figure 2.

The Cambrian formations dip very gently (less than 1°) southwest. Except for minor features related to the sedimentary processes involved in gradual transgression and regression of seas in a marine-shelf sediment zone, these formations are conformable with each other. Most of the rocks are quartz arenites which are weakly cemented, very porous and permeable, and which have been intensively leached. Loose sand accumulated by the disintegration of the sandstone mantles large areas and conceals formational contacts in most places.

Deposits of river gravel derived largely from glacial deposits north of the area are a few tens of feet thick on some terraces along the Black River.

STOPS OF GEOLOGIC INTEREST

STOP 1: Upper part of Mount Simon Sandstone.

Location: Black River Falls quadrangle. West side of U.S. Rte. 12 about 500 feet north of Interstate Rte, 94 (Figure 3).

The roadcut exposes flat-lying, thick- to medium-bedded, cross-laminated, poorly cemented, pale-gray to buff, medium- to fine-grained quartz sandstone with a few thin, white, clayey partings and minor

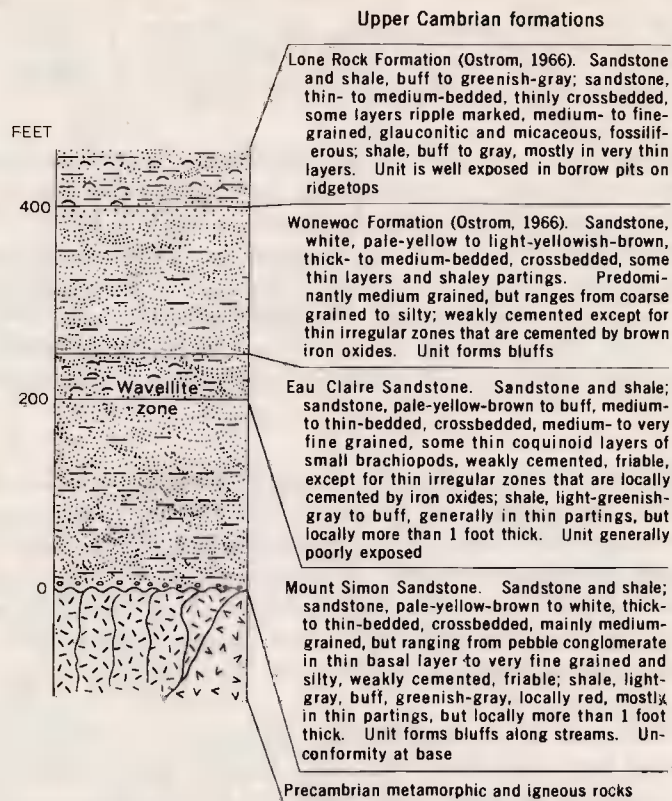


Figure 2.—Generalized stratigraphic section of Paleozoic sedimentary rocks near Black River Falls, Jackson County, Wis., showing the approximate position of the wavellite occurrence.

Data from Klemic and Mrose, 1972.

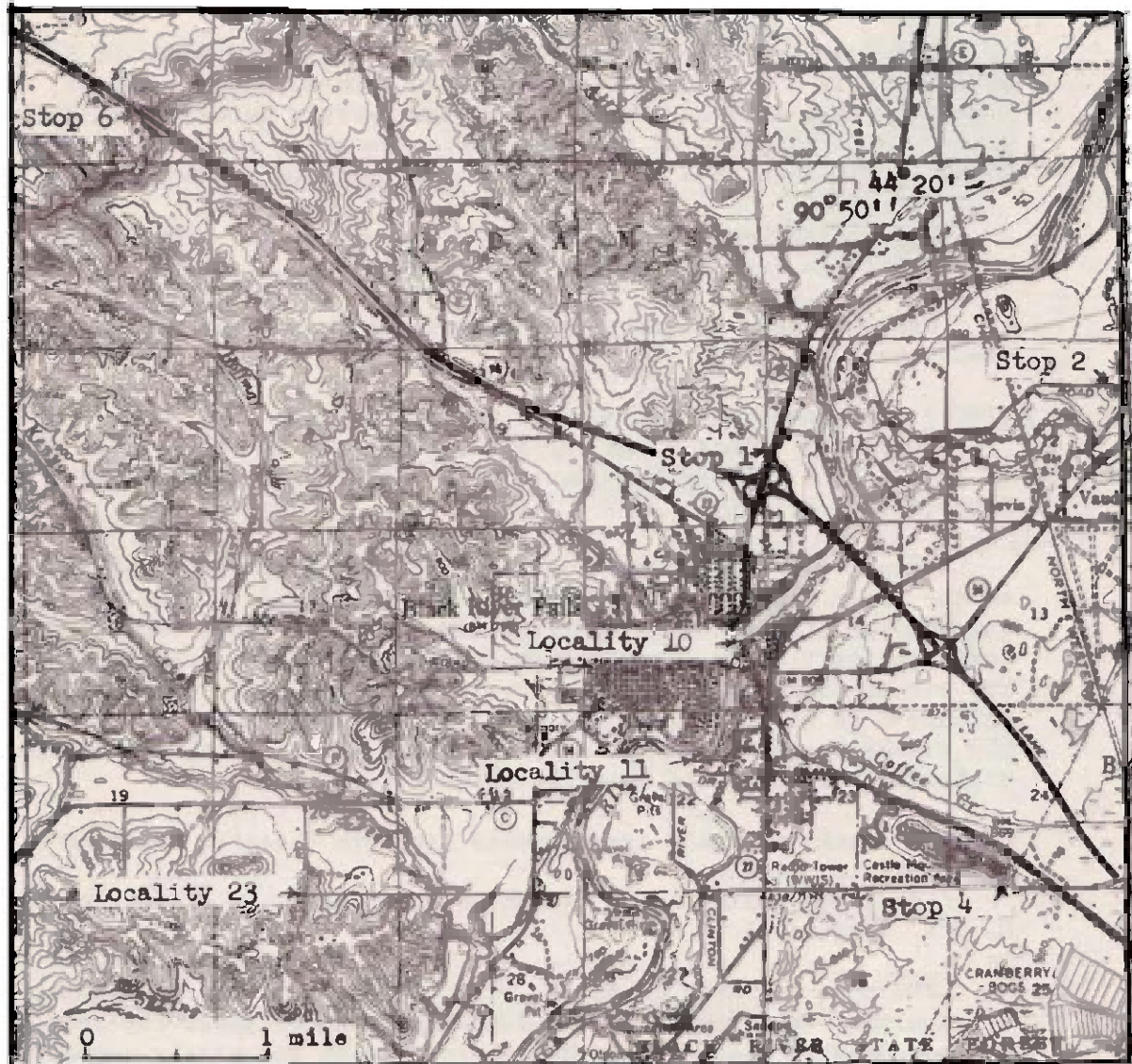


Figure 3. Black River Falls area: Stops 1, 2, 4, 6, and localities 10, 11, and 23. Base by U.S. Geological Survey, Black River Falls quadrangle, 1968, 1:62,500.

partings stained by iron oxide. The cross-beds dip southeast. No fossils noted here. This outcrop is typical of exposures of the upper part of the Mount Simon Sandstone west of the river. These beds are about 100 to 120 feet above the base of the formation as exposed near the Black River to the northeast and to the south. The lower part of the formation in most areas has thicker bedding and is slightly coarser in average grain size.

The forested mound $\frac{1}{2}$ mile to the east is Tilden Mound or Section 11 Mound. It is a monadnock of Precambrian iron-formation, schist, and phyllite. The relief on the Precambrian surface between the top of the mound and the surface of the Precambrian rocks on the west side of Black River is 170 feet in a horizontal distance of about 400 feet.

Unfoliated Precambrian granite crops out in the river valley locally between Tilden Mound and Interstate Rte. 94.

Castle Mound, $2\frac{1}{2}$ miles to the south-southeast is Upper Cambrian sandstone.

STOP 2: Precambrian monadnock of iron-formation.

Location: Black River Falls quadrangle in the NE $\frac{1}{4}$, sec. 12, T. 21 N., R. 4 W. near the junction of Levis Creek Road and West Bottom Road (Figure 3).

Precambrian iron-formation flanked and partially capped by remnants of the Upper Cambrian Mount Simon Sandstone extends 50 feet above the surrounding plain that is underlain by the Mount Simon Sandstone. The surficial part of the iron-formation contains both magnetite and martite. The strong magnetic anomaly associated with the mound of iron-formation extends both northwest and southeast of the mound. The extent to which the magnetic anomaly at the crest of the mound has been altered by lightning strikes is an interesting question.

STOP 3: Jackson County Iron Company magnetic taconite mine and agglomeration plant.

Location: Hatfield SW $7\frac{1}{2}$ -minute quadrangle, SE $\frac{1}{4}$, sec. 15, T. 21 N., R. 3 W. (Figure 4).

The open pit mine is at the site of Iron Mound, a monadnock of Precambrian iron-formation that formerly extended about 150 feet above the surrounding plain. Iron Mound was flanked and partly capped by the Mount Simon Sandstone. The uppermost part of the mound was approximately at the altitude at which the Eau Claire Sandstone (which overlies the Mount Simon Sandstone) formerly occurred.

Iron-formation here dips about 70° SW and is in an interval as much as 350 feet thick. This thickness may represent an isoclinally folded unit or it may be a faulted segment of a thick formation. It extends to below 650 feet above sea level. Quartz-chlorite schists border the iron-formation. Magnetite is the predominant iron-rich mineral, but some thin layers contain abundant specular hematite. The iron-formation has been metamorphosed to garnet-actinolite grade. Mafic dikes, granitic or aplitic dikes, and quartz veins cut the iron-formation. A zone of talc schist parallels the layering of the iron-formation near the center of the pit.

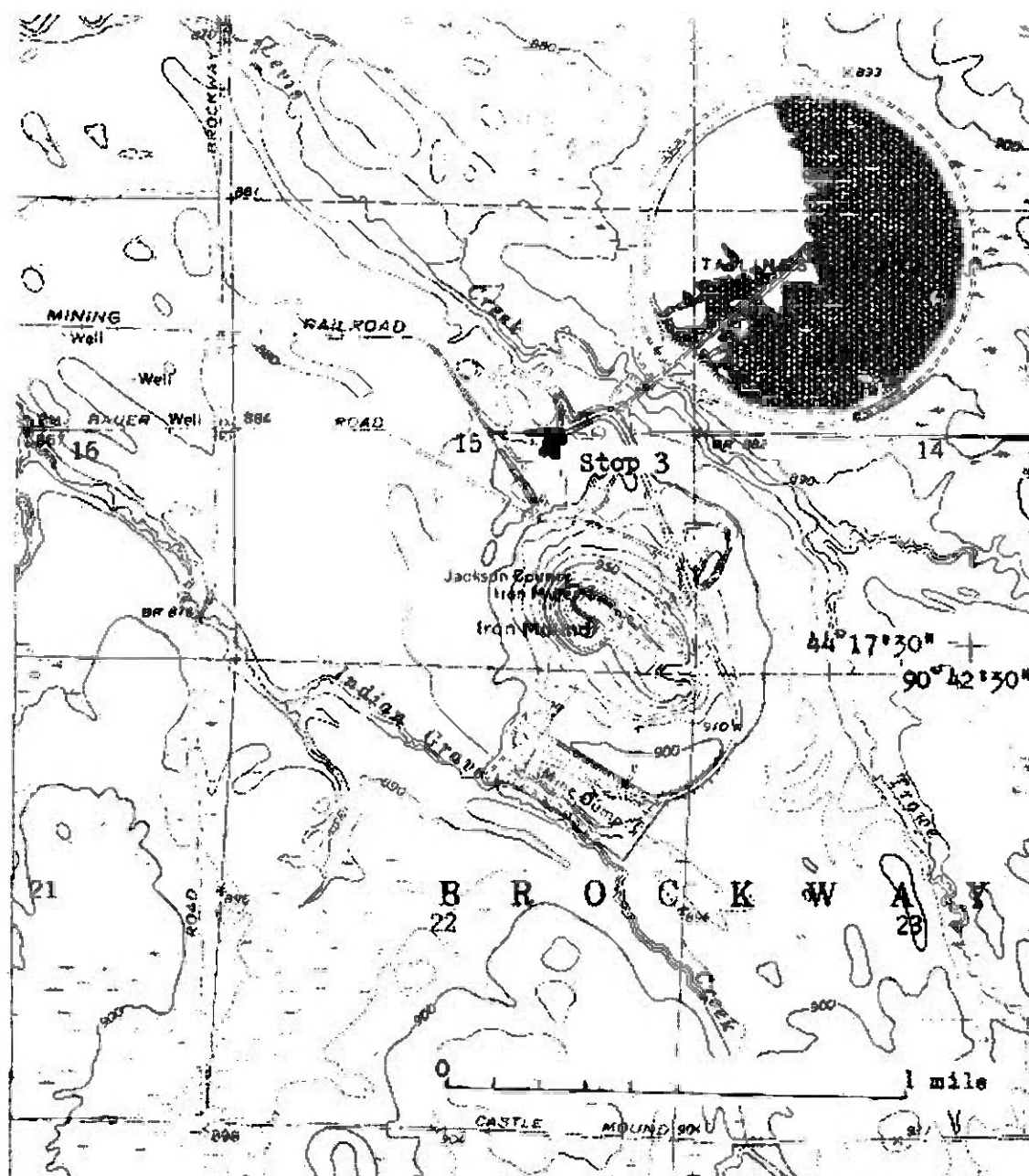


Figure 4. Jackson County Iron Mine area: Stop 3. Base by U.S. Geological Survey, Hatfield SW quadrangle, 1970, 1:24,000.

The ore averages 20 to 23 percent in recoverable iron. About 3 tons of crude ore are required to produce 1 ton of pellets containing 63.5 percent iron and 7 percent silica. The magnetite and gangue minerals are so finely interlocked that in order to obtain suitable iron ore concentrates, a final grind is made to a size at which 93.5 percent of the ore will pass through a 325-mesh screen. The magnetite is separated from the gangue minerals by magnetic separators. Twenty pounds of bentonite clay is added per ton of concentrate in a mixer. The mixture is fed to a balling mill in which the powdered concentrates are converted to pellets, about 85 percent of which are 3/8 to 5/8 inch in diameter. The pellets are dried and preheated and then are heated to 2500 degrees F. In this process, the magnetite is converted to hematite, and the finished pellets become hardened enough to withstand a compression of 800 lbs.

Pellet shipments in 1972 were 887,000 long tons. More details concerning the iron deposit and the mining, beneficiation, and pelletizing of the ores, tailings disposal, water supply, and environmental factors will be discussed at stop 3.

STOP 4: Eau Claire Sandstone and Woneewoc Formation of Ostrom (1966).
Location: Black River Falls quadrangle, SW $\frac{1}{4}$, sec. 24, T. 21 N., R. 4 W. East end of Castle Mound, 500 feet west of U.S. Rte. 12 on Castle Mound Road (Figure 3).

Castle Mound is an elongate ridge capped by the lower part of Woneewoc Formation of Late Cambrian age. The upper part of the Mount Simon Sandstone forms the basal part of the ridge from about 880 to 995 feet above sea level, and, except at the eastern end of the ridge, it is largely concealed by talus and soil derived from the overlying rocks. The Eau Claire Sandstone, which includes fossiliferous medium- to fine-grained sandstone, forms the strata at altitudes of 995 to 1025 feet above sea level. The fossils in the Eau Claire Sandstone are small white phosphatic brachiopod shells composed of fluorapatite. These distinctive white shells are characteristic of the Eau Claire Sandstone in the area west of the Black River. East of the river the formation has been intensively leached, and although the fossiliferous zones are present, the fossil shell remnants are generally stained by iron oxides. Commonly the shells have been completely removed and are represented by empty molds in the sandstone. A noticeable amount of glauconite is generally present in the formation. Close examination of specimens of the coquina of phosphatic brachiopod shells reveals that quartz grains in contact with the shell material have been partially dissolved, leaving flat surfaces that conform to the adjoining smooth shell surfaces. Empty molds of fossils also show this modification of the innermost layer of quartz grains. Remnants of the Eau Claire Sandstone capping low hills in the area to the east are generally stained and cemented by brown iron oxide and weather out as small platy fragments that contrast with the pale-colored and weakly cemented and nonfossiliferous rock of the underlying Mount Simon Sandstone. The Mount Simon and the Woneewoc, however, also contain iron oxide-cemented layers, but these are generally medium-grained sandstones.

STOP 5: Lone Rock Formation of Ostrom (1966).

Location: Black River Falls quadrangle, NW $\frac{1}{4}$, sec. 10, T. 21 N., R. 5 W. (Figure 5). Borrow pit on south side of Pine Creek Road near crest of hill.

The Lone Rock Formation of Late Cambrian age extends from near the 1120 foot contour to the crest of the hill. The formation consists mainly of light brownish-gray, medium- to thin-bedded, medium fine- to fine-grained cross-laminated sandstone and thin layers of shale. The sandstone is argillaceous and glauconitic. Some beds are abundantly fossiliferous, and worm trails, ripple marks, and mud cracks are well preserved in thin sandstone layers. The rock exposed here is typical of the rock in the Lone Rock Formation at other "shale pits" near the crests of ridges in both the Black River Falls and adjoining quadrangles.

The environment of deposition of the Lone Rock Formation was similar to that of the Eau Claire Sandstone. It was one in which shallow seas transgressed over lagoonal areas and in which marine life flourished in the littoral and neritic zones. Local concentrations of brachiopod shells in coquinalike layers resulted from the winnowing of sediments containing abundant shells and shell fragments.

The rocks have been extensively leached of calcareous and chitinous material, leaving fossil molds. Phosphatic brachiopod shells, however, have been more resistant to leaching, as indicated by the remaining white brachiopod shells.

The sandstone and shale of the Lone Rock Formation are extensively used for surfacing dirt roads and for fill at bridges and culverts in Jackson County because they are more cohesive and resistant to erosion than is most of the readily available rock of the underlying Cambrian sandstones in this general area. Soil developed on the Lone Rock Formation is rich in potash because of the presence of glauconite and clay and is rich in phosphorus from marine organisms. In comparison, poor soils occur on the Wonewoc and the Mount Simon, which consist largely of quartz sand.

STOP 6: Wonewoc Formation of Ostrom (1966).

Location: Black River Falls quadrangle, SE $\frac{1}{4}$, sec. 31, T. 22 N., R. 5 W. (Figure 3). On south side of Wisconsin Rte. 27, at roadside rest area and dirt road leading up hill to shale pit.

The Wonewoc Formation is well exposed in large roadcuts on the south side of Rte. 27 and on the north side of Interstate Rte. 94. More than 100 feet of beds of the Wonewoc Formation are visible in the face of the large roadcut to the north. The top of the formation is near altitude 1210 feet and is approximately at the top of the exposed rock face. The base of the formation is below road level and is probably near altitude 1040, at the base of the steep slope of the ridge.



Figure 5. Pine Creek Road area: Stop 5. Base by U.S. Geological Survey, Black River Falls quadrangle, 1968, 1:62,500.

The sandstone of the Wonewoc Formation is white, pale yellow to light brown, medium to thick bedded, cross-laminated, and predominantly medium grained, but includes coarse- to very fine-grained sand and minor amounts of clay. Some thin zones are cemented by brown iron oxides. A large channel in the sandstone is exposed in the lower part of the roadcut. The rock here is typical of that in the Wonewoc Formation throughout this general area. In some places, iron-oxide cement is more abundant. No fossils were found at this outcrop, but in some places vertical tubular markings may represent burrows made by marine creatures.

At Wildcat Mound east of Humbird, in the southern part of Fairchild quadrangle, and at several other localities, variegated sandstone colored and cemented by iron oxide is very distinctive in appearance and locally has been called "Zebra rock" because of the pattern of its markings.

Although the Wonewoc Formation forms bluffs and cliffs, the rock is generally only weakly cemented, and bedrock on the lower slopes of ridges and hills underlain by this formation is commonly concealed by loose sand and rubble from overlying beds.

STOP 7: Eau Claire Sandstone and Wonewoc Formation of Ostrom (1966).

Location: Black River Falls quadrangle, SW $\frac{1}{4}$, sec. 35, T. 23 N., R. 5 W. (Figure 6). At Silver Mound and in the field on the southwest of Silver Mound.

Fossiliferous and glauconitic sandstone beds of the Eau Claire Sandstone are well exposed in a small excavation on a prominence in the field southwest of Silver Mound, and loose fossiliferous Eau Claire Sandstone occurs at an altitude of 1025 feet on the south tip of Silver Mound near the highway.

Silver Mound is an important archeological locality. The mound is capped by the Wonewoc Formation. The lower part of the formation is largely concealed. The uppermost 100 feet or so of beds, however, is thoroughly cemented by silica, and the rock is a brittle quartzite. This rock was extensively used by prehistoric Indians for the manufacture of tools and weapons. Artifacts are numerous in the fields surrounding the southern part of Silver Mound, and artifacts and whitish flakes of quartzite from this locality are widespread in Jackson County.

Similar quartzite occurs in lesser amounts on a ridge several miles northwest of Silver Mound. The source of the silica that cemented the sandstone and the conditions under which it was deposited in the formation of the quartzite in this almost isolated occurrence require an explanation. There is no lack of silica in the Upper Cambrian strata of this general area, but most of it is in the relatively inert form of quartz sand. Therefore, some local chemical environment that differed from the general conditions must have made silica available in solution. Perhaps the chemical environment of the fossiliferous beds, particularly of the coquina layers, may have been the source of the silica. As previously described, the quartz sand grains in contact with the phosphatic brachiopod shells have been partially dissolved into hemispherical forms having their

Figure 6. Silver Mound area: Stop 7. Base by U.S. Geological Survey, Black Rock Falls quadrangle, 1968, 1:62,500.

flat surfaces against the shell surfaces. The chemical environment that produced this result in the Eau Claire and the Lone Rock, both of which are fossiliferous and contain phosphatic brachiopods, would have made available large quantities of silica in solution. Such silica-bearing waters percolating from the fossiliferous Lone Rock Formation may have deposited the silica cement in the Wonewoc Formation at Silver Mound.

Small zones of silicified sandstone a few inches thick, in the Mount Simon Sandstone near its contact with the Eau Claire Sandstone have been noted in several places in Jackson County.

STOP 8: Exposure showing complexities of Precambrian rocks. This stop also provides an opportunity to examine some economic uses of local geologic features and some of the problems and possibilities arising from the pressures of demands for their use.

Location: Hatfield 7 $\frac{1}{2}$ -minute quadrangle, SE $\frac{1}{4}$, sec. 3, T. 22 N., R. 3 W. At Black River, north of County Rte. K and south of dam at Lake Arbutus (Figure 7).

Because of load limitations at the bridge over the canal at Hatfield, it will be necessary to walk about 1 mile to the large exposure of Precambrian metamorphic rocks immediately below the unconformity at the base of the Upper Cambrian sandstone.

Lake Arbutus is an artificial lake impounded behind a dam built upon Precambrian bedrock in the valley of the Black River. Water level in the dam is maintained at or near the level of the unconformity at the top of the Precambrian. A canal a little more than 2 $\frac{1}{2}$ miles long has been cut in the Upper Cambrian sandstone to carry water to the penstocks of a small electrical power plant. The hydraulic head at the power plant is nearly 100 feet. This power plant is an important local nonpolluting source of electric energy.

Lake Arbutus has a surface area of slightly more than two square miles and is a popular recreation center, having two county parks and a State campsite on its shores. Hatfield, a small resort community on the west side of the lake, is in an area in which only about 10 to 30 feet of beds of Upper Cambrian Mount Simon Sandstone overlies the metamorphic and igneous Precambrian basement rocks. The community obtains its water supply largely from wells in the sandstone. A few wells extend into the Precambrian basement rocks.

Sewage from the community is disposed into the surficial mantle of sand and in the upper layers of the sandstone strata. Thus the possibility exists for pollution of the water supply. Should the local demand for water increase substantially, both the amount of waste requiring disposal and the possibility of pollution of the local ground waters would also increase. Alternative sources of water and improved facilities for sewage disposal will eventually be needed.

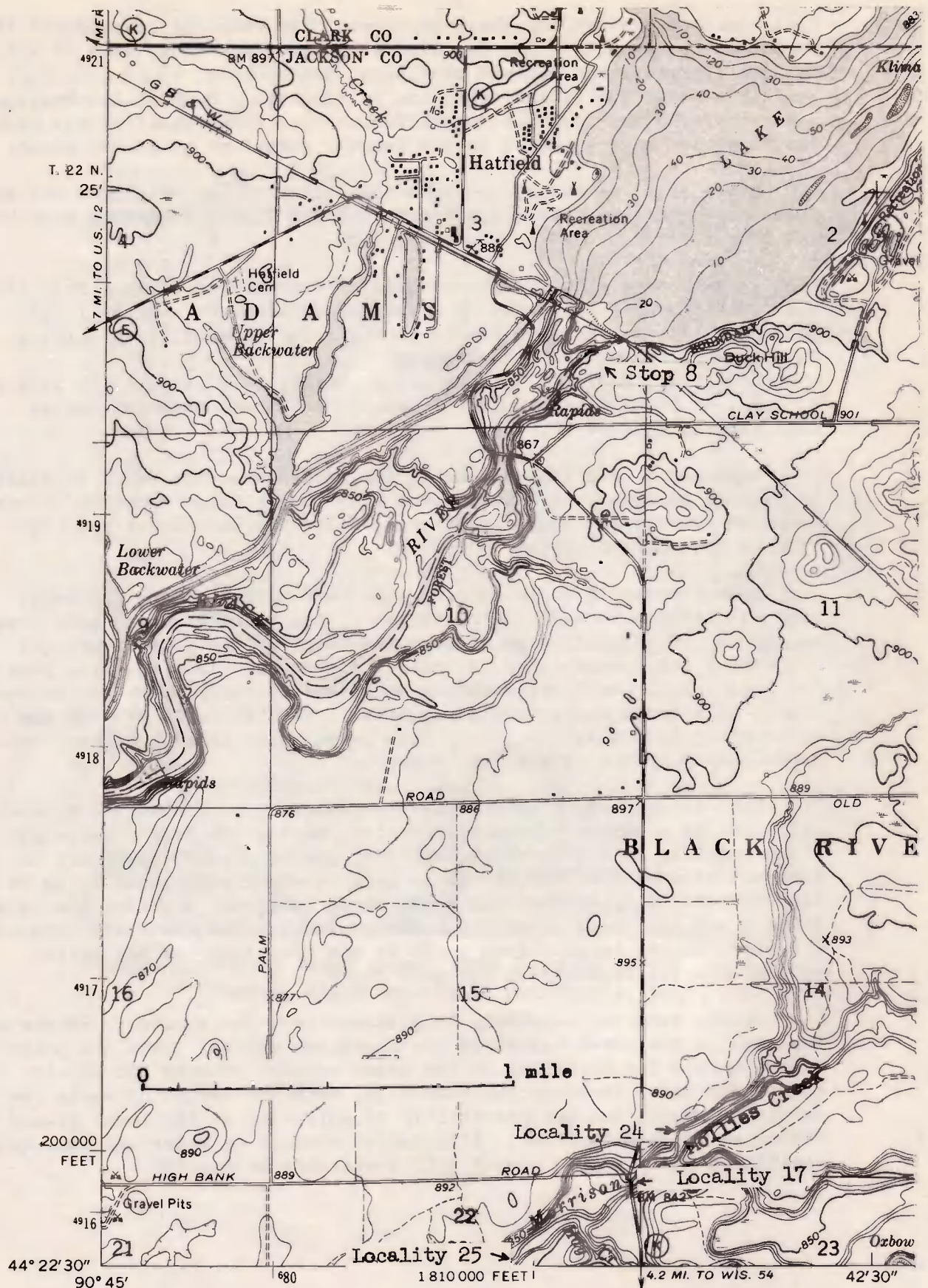


Figure 7. Lake Arbutus area: Stop 8 and localities 17, 24, and 25.

Base from U.S. Geological Survey, Hatfield quadrangle, 1970,
1:24,000.

The contact between the Mount Simon Sandstone and the underlying Precambrian rocks is at road level at the west end of the bridge where County Rte. K crosses the Black River $\frac{1}{2}$ mile southwest of the dam at Lake Arbutus. A thick bed of coarse-grained cross-laminated sandstone is exposed on the west side of the road, and Precambrian granitic gneiss crops out on the east side of the road. The channel of the Black River has been cut about 50 feet into the Precambrian rocks at the bridge.

Proceed east on County Rte. K, then go northeast on Clay School Road about 0.2 mile to a dirt lane on the west side of the road. Follow dirt lane to clearing in woods and turn north on path leading down into the river valley. Proceed northeast toward the foot of the dam.

This large exposure of bedrock shows some of the complexity of the Precambrian basement rocks. Granitic and chloritic gneisses, schists, and greenstones trend northwest and dip steeply northeast. A large northeast-trending metagabbro dike at the east end of the dam cuts the gneisses. Another large dike on the west side of the east channel of the river is more dioritic in composition. The intervening granite gneisses and chloritic sills are contorted in sinuous forms on which there is well-developed quartz rodding or slickensides that dip to the east. A few hundred feet southwest of the dam a prominent siliceous mass of metarhyolite(?) and the adjoining gneiss are cut by a contorted mafic dike or sill. An east-trending swarm of narrow steeply dipping unfoliated siliceous and chloritic dikes cut all the other rock types. Minor quartz-filled fractures cut the younger dikes and the other rock units. At one place on the west side of the river a quartz vein is more than three feet thick. Minor amounts of pyrite are evident in the rocks, and fine-grained pyrite is abundant in the youngest dike.

STOP 9: Wavellite occurrence in the Eau Claire Sandstone.

Location: Black River Falls quadrangle, SW $\frac{1}{4}$, sec. 23, T. 22 N., R. 4 W. (Figure 8), roadcut on East Snow Creek Road.

Wavellite ($\text{Al}_3(\text{PO}_4)_2(\text{OH})_3 \cdot 5\text{H}_2\text{O}$) occurs as thin botryoidal crusts, small spherical masses, and as cement in the sandstone at this outcrop and at several other places where this stratigraphic unit is exposed in this general area. The source of the phosphorus is believed to have been phosphatic fossil material such as the phosphatic brachiopod shells in the Eau Claire Sandstone.

The Wonewoc Formation which crops out on the west side of the road is weakly cemented, very porous and permeable sandstone. It is coarser in grain size than the underlying rock and is thoroughly leached. The Wonewoc-Eau Claire contact zone is favorable for the development of a perched water table in places where shale or clay is abundant in the Eau Claire.

Wavellite probably occurs in many places in Wisconsin where the Eau Claire Sandstone is present and where conditions for movement of ground water were comparable to those in this area. In addition, similar conditions for occurrences of wavellite in association with the Lone Rock Formation may exist. Wavellite, however, may be readily overlooked, particularly in cases where it contains surficial stains of iron oxides.

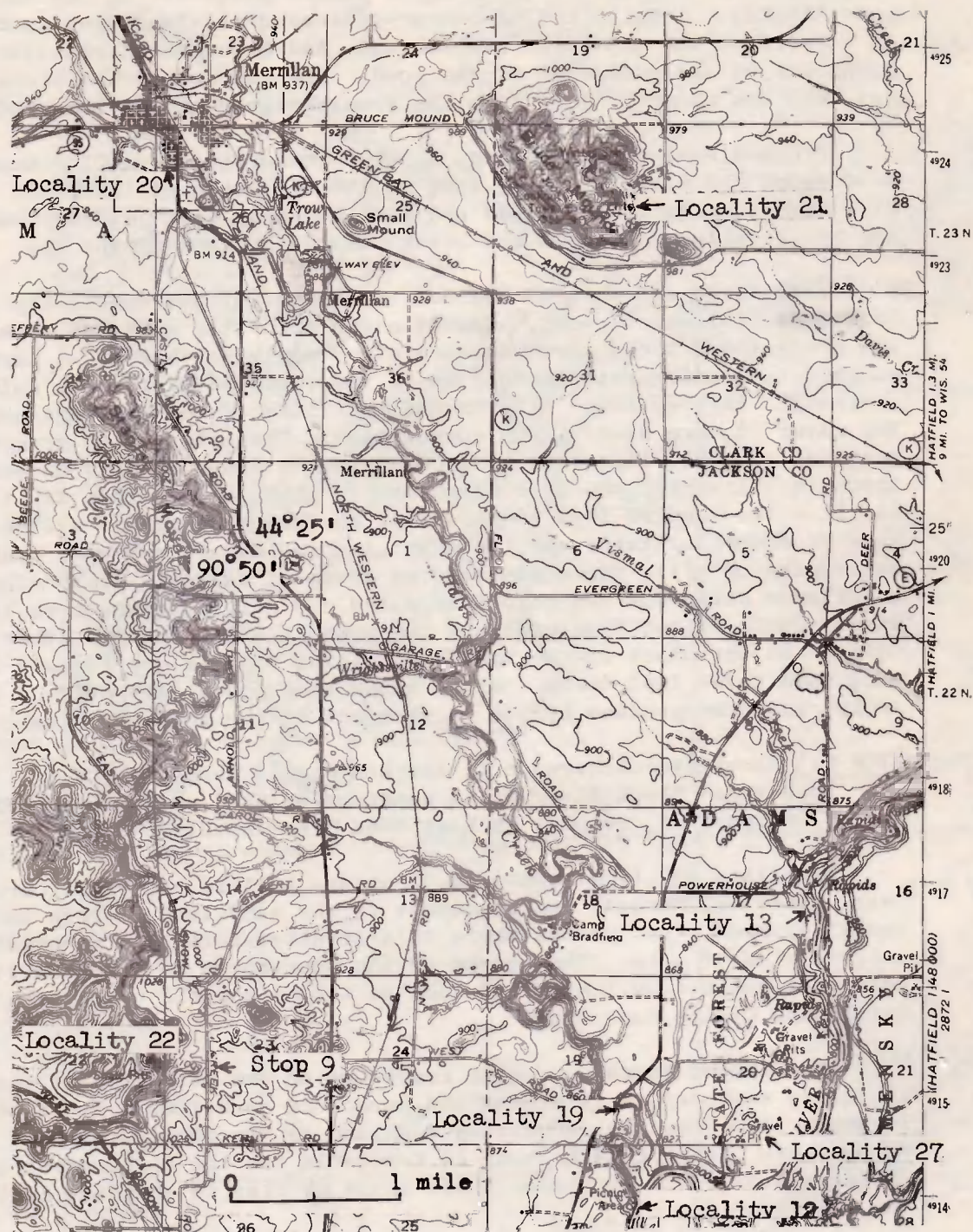


Figure 8. Merrillan area: Stop 9 and localities 12, 13, 19, 20, 21, 22, and 27. Base by U.S. Geological Survey, Black River Falls quadrangle, 1968, 1:62,500.

ADDITIONAL LOCALITIES OF GEOLOGIC INTEREST

Exposures of Precambrian rocks.

Locality 10: Black River Falls 15-minute quadrangle, SE $\frac{1}{4}$, sec. 15, T. 21 N., R. 4 W. (Figure 3). North of U.S. Rte. 12 at Black River Falls. Accessible from east end of bridge crossing Black River.

Unfoliated jointed granite at the Falls below the dam appears fresh, but much of the hornblende is altered to chlorite. Similar granite cuts iron-formation and rocks adjoining the iron-formation in the subsurface. Z.E. Peterman of the U.S. Geological Survey has determined that the rubidium-strontium ratios in these granites indicate an age of about 1,690 million years (U.S. Geol. Survey, 1972).

Locality 11: Black River Falls 15-minute quadrangle, NE $\frac{1}{4}$, sec. 22, T. 21 N., R. 4 W. (Figure 3). In the valley of Black River at the base of bluff of Mount Simon Sandstone. On south side of river.

Granitic gneiss and gray chloritic gneiss are cut by dolerite dikes. In contrast to the deep channel cut by the Black River in the Precambrian rocks below the dam at Lake Arbutus, the channel here is only about 10 feet down into the Precambrian rocks. The outcrops here may be concealed if water level is high.

Locality 12: Black River Falls 15-minute quadrangle, NE $\frac{1}{4}$, sec. 30, T. 22 N., R. 3 W. (Figure 8). West side of Black River near junction of Hall's Creek and river. Readily accessible by road to canoe landing. Path to south along bluffs leads to exposures of phyllite and gneiss beneath unconformity at base of Mount Simon Sandstone.

Weathered schist and phyllite at the base of cliffs of Mount Simon Sandstone are exposed a short distance upstream from the mouth of Hall's Creek; chloritic mafic intrusive rocks also occur in the creek valley.

Locality 13: Black River Falls 15-minute quadrangle, SE $\frac{1}{4}$, sec. 17, T. 22 N., R. 3 W. (Figure 8). West side of Black River about 0.4 mile southwest of power plant. Abandoned quarry near river.

Strikingly contorted dark gray and white hornblende gneiss of granitic to granodioritic composition and a fine-grained intrusive rock of gabbroic composition are exposed in the quarry face and are present in loose blocks. The composition of feldspar augen in the gneiss has not been determined.

Locality 14: Hatfield 15-minute quadrangle, NW $\frac{1}{4}$, sec. 25, T. 23 N., R. 3 W. (Figure 9). West side of Black River near French Island.

Pink granite typical of that in several localities along the Black River north of Lake Arbutus is well exposed along the river. The basal beds of the Mount Simon Sandstone crop out on the west side of the road.

Similar granite crops out at the abutment of the abandoned bridge on the east side of the Black River 0.2 mile south of Wisconsin Rte. 95 in the NW $\frac{1}{4}$, sec. 19, T. 23 N., R. 2 W.

Figure 9. Lake Arbutus area: Localities 14 and 15. Base by U.S. Geological Survey, Hatfield planimetric map, 1958, 1:48,000.

Locality 15: Hatfield 15-minute quadrangle, NW $\frac{1}{4}$, sec. 4, T. 22 N., R. 2 W. (Figure 9). North side of East Fork of Black River 250 feet east of the bridge.

Large outcrop of granitic and migmatitic gneiss cut by mafic and aplitic dikes. During periods of normal or low water level this outcrop is well exposed. Quartz rodding or slickensides on minor folds in the gneiss is similar to that in the outcrop near the dam at Lake Arbutus (Stop 8), but the rodding here plunges east at a low angle. The relative ages of the mafic and aplitic dikes at this locality have not been determined. Pink granite and small aplitic dikes crop out at several other places along the East Fork of the Black River.

Locality 16: Hatfield 15-minute quadrangle, SW $\frac{1}{4}$, sec. 20, T. 23 N., R. 1 W. (Figure 10). Brushy Ridge Road.

Quartzite, probably of Precambrian age, is exposed in a small roadcut on the south side of a tributary of Rock Creek. Quartzite zones in the Mount Simon Sandstone occur in a small knob on the north side of the east-trending road 0.8 mile north of this roadcut.

Locality 17: Hatfield 15-minute quadrangle, NE $\frac{1}{4}$, sec. 22, T. 22 N., R. 3 W. (Figure 7). Morrison Creek at County Rte. K.

Granite gneiss cut by mafic dikes is exposed beneath the bridge during periods of low or normal water level. Bluffs of the basal beds of the Mount Simon Sandstone and outcrops of the Precambrian metamorphic rocks and mafic and granitic intrusive rocks are exposed along Morrison Creek to the east of this locality.

Locality 18: Hatfield 15-minute quadrangle, NW $\frac{1}{4}$, sec. 9, T. 21 N., R. 2 W. (Figure 11). On north side of Battle Point Road.

Precambrian quartzite is exposed in a small quarry. The quartzite is brecciated and recemented by silica. Basal sandstone of the Mount Simon Sandstone includes fragments of the quartzite at the unconformity between the Precambrian and the Cambrian rocks.

Exposures of Cambrian rocks.

Locality 19: Black River Falls 15-minute quadrangle, SE $\frac{1}{4}$, sec. 19, T. 22 N., R. 3 W. (Figure 8). At bridge on County Rte. E crossing Hall's Creek.

Basal beds of Mount Simon Sandstone are exposed near stream level. The sandstone is thick bedded, cross-laminated, medium to very coarse grained, and has a thin pebbly layer at the base in places along the creek.

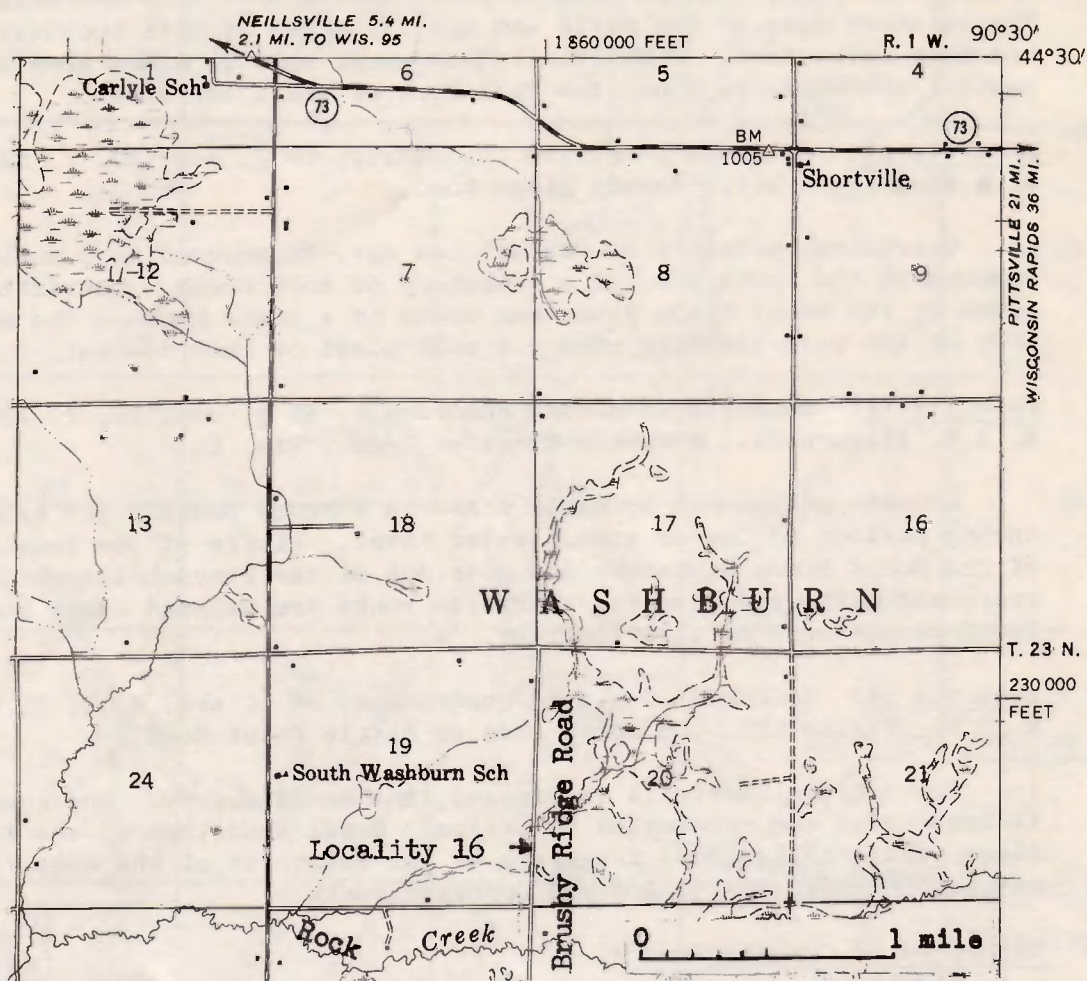


Figure 10. Shortville area: Locality 16. Base by U.S. Geological Survey, Hatfield planimetric map, 1958, 1:48,000.

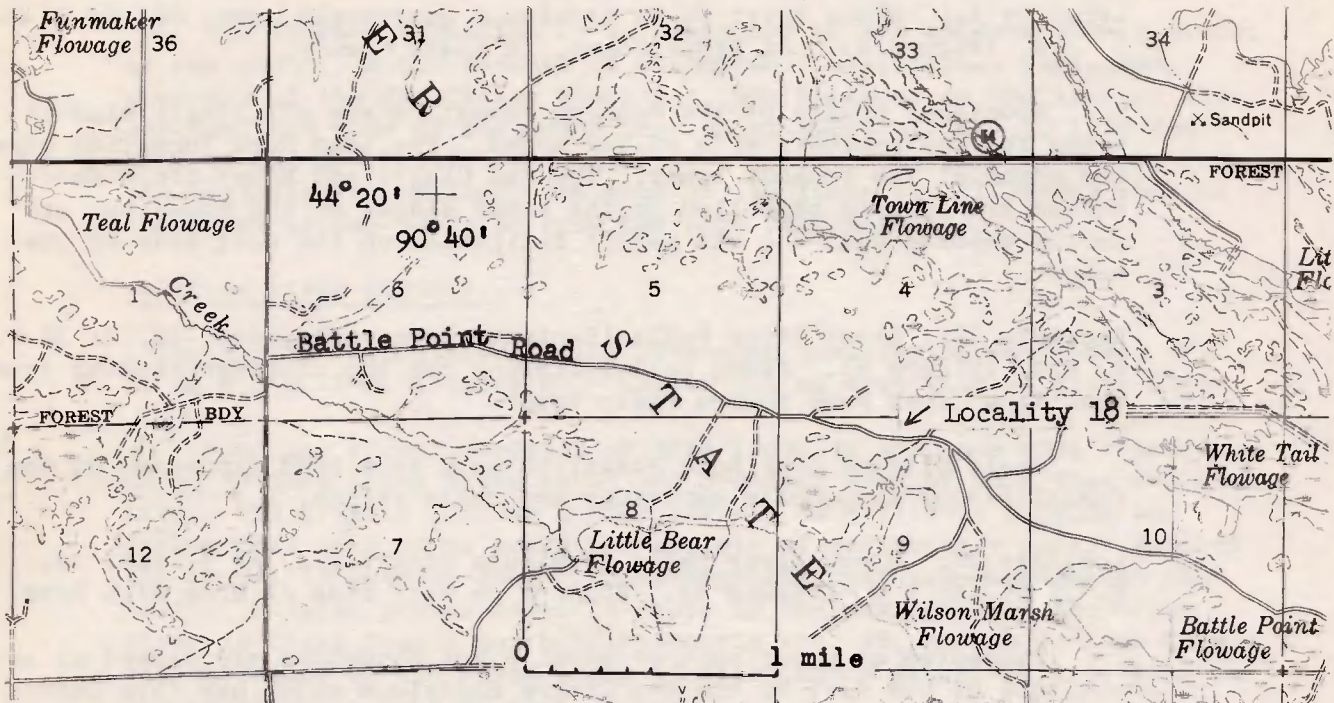


Figure 11. Town Line Flowage area: Locality 18. Base by U.S. Geological Survey, Hatfield planimetric map, 1958, 1:48,000.

Locality 20: Black River Falls 15-minute quadrangle, NW $\frac{1}{4}$, sec. 26, T. 23 N., R. 4 W. (Figure 8). At park on west side of U.S. Rte. 12 at south edge of Merrillean.

Thick-bedded sandstone of the Mount Simon Sandstone is well exposed at the dam on Hall's Creek where there is a scenic waterfall.

Locality 21: Black River Falls 15-minute quadrangle, sec. 30, T. 23 N., R. 3 W. (Figure 8). At Bruce Mound, in Clark County.

Prominent cliffs of the Wonewoc Formation are strikingly exposed along the southwestern side of the mound. The Lone Rock Formation caps the mound at the lookout tower. The Eau Claire and Mount Simon Sandstones are largely concealed on the lower slopes of the mound but are partly exposed near the ski resort facilities on the east side of the mound.

Locality 22: Black River Falls 15-minute quadrangle, sec. 22, T. 22 N., R. 4 W. (Figure 8). Along road following the top of ridge leading from West Snow Creek Road toward radio tower.

Shale pits in Lone Rock Formation have excellent exposures of the fossiliferous glauconite sandstone and shaly strata.

Locality 23: Black River Falls 15-minute quadrangle, NW $\frac{1}{4}$, sec. 29, T. 21 N., R. 4 W. (Figure 3). Roadcut on east side of Moss Hill Road.

Exposures of upper part of Mount Simon Sandstone are capped at an altitude of 940 feet by the Eau Claire Sandstone which has thin layers of coquina consisting of white brachiopod shells. A similar occurrence is at an altitude of 940 feet along Wold Road $1\frac{1}{2}$ miles to the west. Note the concentration of brachiopod shells along some of the cross laminae.

Locality 24: Hatfield 15-minute quadrangle, SW $\frac{1}{4}$, sec. 14, T. 22 N., R. 3 W. (Figure 7). On northwest side of Mollies Creek, at sharp bend about 1000 feet northeast of junction of Mollies Creek and Morrison Creek.

Thin basal beds of the Mount Simon Sandstone have a thin basal layer of quartz pebbles that resemble ventifacts. The underlying Precambrian gneiss and schist is deeply weathered to greenish-gray clay at the unconformity between the Precambrian rocks and the Cambrian sandstone.

Locality 25: Hatfield 15-minute quadrangle, NE $\frac{1}{4}$, sec. 22, T. 22 N., R. 3 W. (Figure 7). On south bank of Morrison Creek about 1600 feet southwest of mouth of Hay Creek.

Basal quartz conglomerate of the Mount Simon Sandstone is cemented by pyrite in small lenticular zones about 6 inches thick a few feet above normal water level. The streambank is slightly overhanging in places, and careful search may be required to find the pyritic conglomerate.

Locality 26: Hatfield 15-minute quadrangle, NE $\frac{1}{4}$, sec. 33, T. 22 N., R. 1 W. (Figure 12). Saddle Mound, north of Wisconsin Rte. 54.

The crest of the mound at the lookout tower is capped by about 60 feet of the Lone Rock Formation. Glauconitic sandstone is well exposed in a small abandoned quarry near the foot of the tower, and Ostrom's (1966) Birkmose Member of the Lone Rock Formation is exposed near the guard rail several hundred feet east of the tower.

The Wonewoc Formation is well exposed on the steep southern slopes of the mound. Minor amounts of weathered fossiliferous sandstone, probably of the Eau Claire Sandstone, can be found on the spur on the northwestern side of the mound near an altitude of 1100 to 1130 feet. Most of the Eau Claire Sandstone, however, is concealed by debris from the overlying formations, and some of the loose fossiliferous rock on the lower slopes is talus from the Lone Rock Formation.

Holocene river gravels.

Locality 27: Black River Falls 15-minute quadrangle, SE $\frac{1}{4}$, sec. 20, T. 22 N., R. 3 W. (Figure 8). Gravel pit on west side of Black River.

Sand and gravel deposits at this locality are on a wide terrace about 20 feet above river level and cover an area of more than one square mile. The gravels include a wide variety of siliceous igneous and metamorphic rock types and minor amounts of sedimentary rock. Most of the gravel is outwash from glacial deposits that are abundant to the north. Similar gravel deposits occur on the west side of the Black River in Clark County north of Wisconsin Rte. 95, and in Jackson County on both sides of the river south of Black River Falls, as indicated on the topographic maps of these areas.

During construction of Interstate Rte. 94, these deposits were important sources of sand and gravel, and they currently supply local needs.

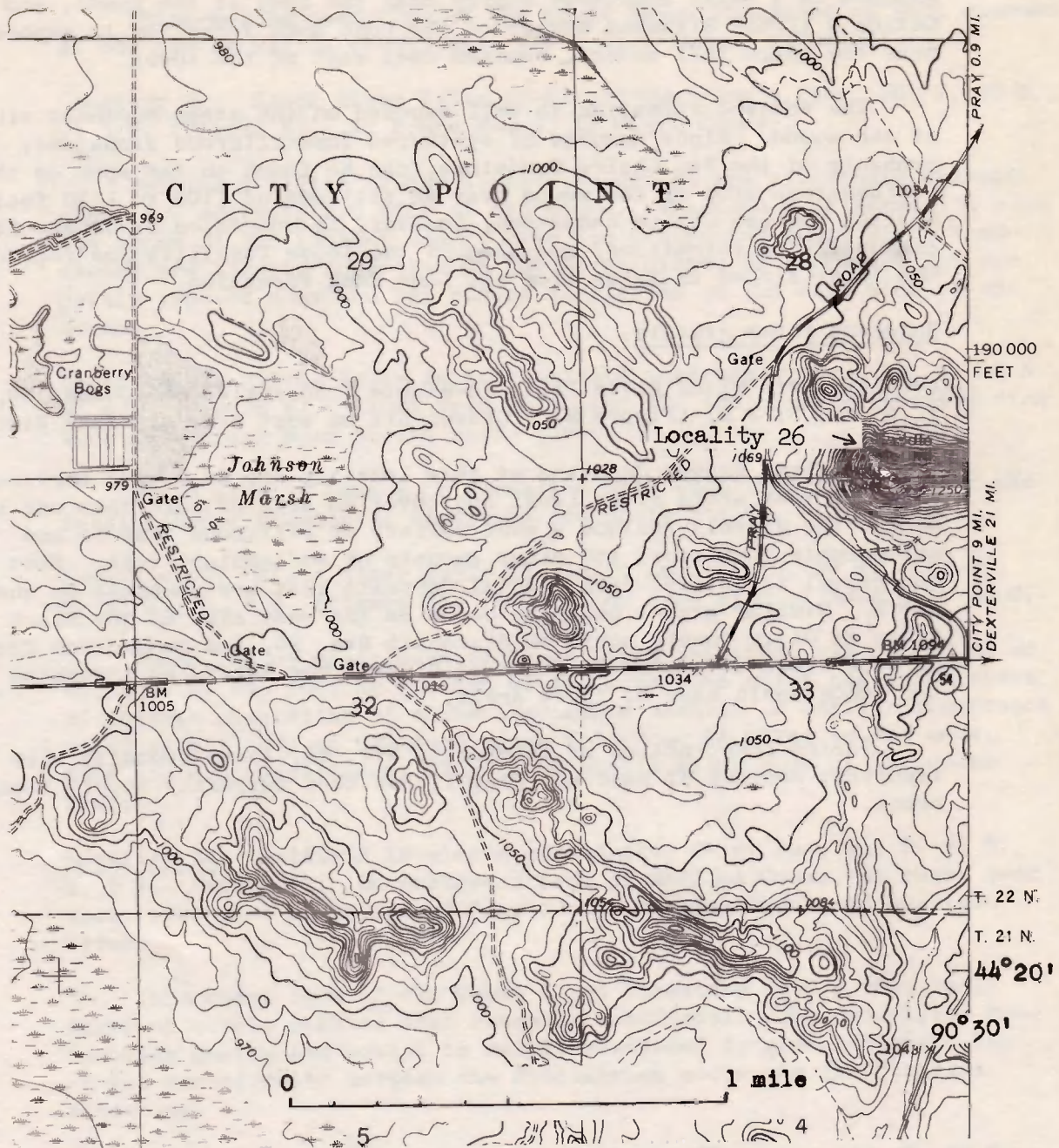


Figure 12. Saddle Mound: Locality 26. Base by U.S. Geological Survey, Hatfield SE quadrangle, 1970, 1:62,500.

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