THE NATURAL HISTORY OF PIKES PEAK STATE PARK, CLAYTON COUNTY, IOWA

edited by Raymond R. Anderson

Geological Society of Iowa

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Cover photograph: Photograph of a portion of the boardwalk trail near Bridal Veil Falls in Pikes Peak State Park. The water falls over a ledge of dolomite in the McGregor Member of the Platteville Formation that casts the dark shadow in the center of the photo.

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PIKES PEAK STATE PARK
CLAYTON COUNTY, IOWA

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THE NATURAL HISTORY OF PIKES PEAK STATE PARK: INTRODUCTION TO THE FIELD TRIP

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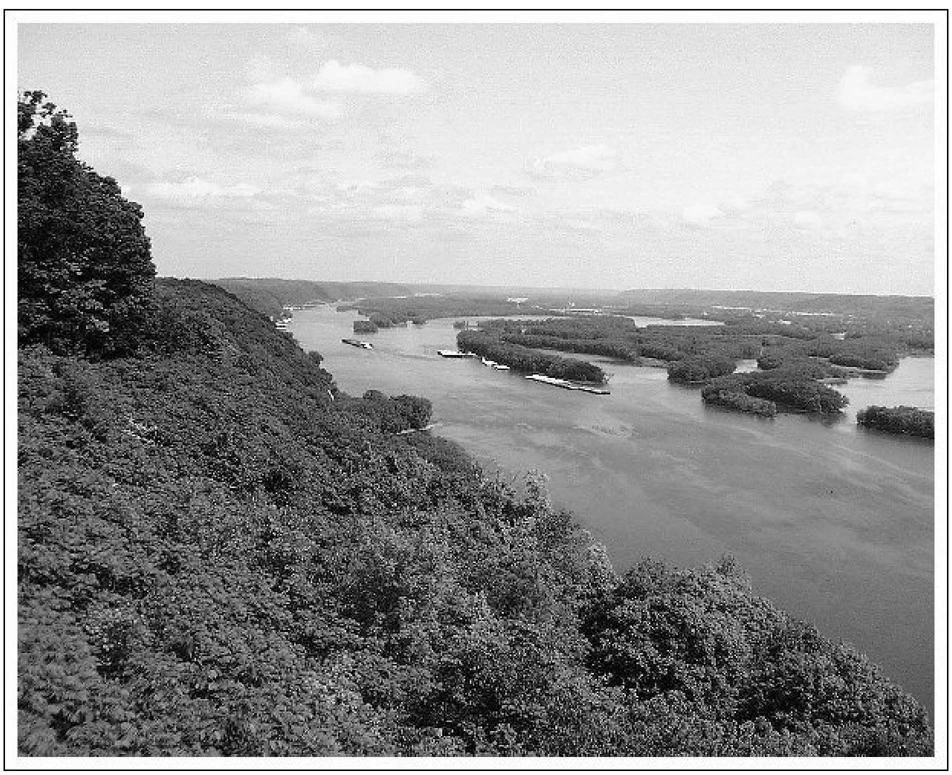
The northeast Iowa area around Pikes Peak State Park is one of the most beautiful and interesting regions of Iowa. The region is rich in history, with the precipitous rock bluffs recording a geologic history beginning nearly 530 million years ago and continuing today as erosion along the Mississippi River and its tributaries continue to expose more of the rock record. Many plant and animal communities have inhabited the region, changing and evolving with climatic and cultural changes. The long history of Native American residents is symbolized by the large number of mounds on ridge tops and in the valleys on high terraces, many shaped as animal effigies. The arrival of Father Marquette and Louis Joliet in the region in 1673 opened a new phase of rich and interesting history. Hunters, trappers, and miners were the earliest historic residents. The region became a part of the United States with the purchase of the Louisiana territory in 1803, and was explored by Zebulon Pike shortly thereafter. Military forts were constructed, towns established, and roads constructed. The length of this guidebook is a testimony to the natural bounty and colorful history of this region, with articles discussing the National Fish & Wildlife Refuge, Effigy Mounds National Monument, the Corps of Engineers construction of the Mississippi River lock and dam system, and Wisconsin's Wyalusing State Park across the river, as well as discussions of such special are residents as Andrew Clemens and the Ringling Brothers. Since the beauty of the area is difficult to display in black and white photography, we have also included two pages with color plates in this guidebook for the first time. The authors and I hope that you find the material in this guidebook and the field trip experience to be informative and interesting. And, be careful, there are many dangers to be encountered on the way to many of the field trip stops, but enjoy yourselves.

The Mississippi River looking north from Pikes Peak.



GENERAL GEOLOGIC SECTION AT PIKES PEAK STATE PARK

Brian J. Witzke
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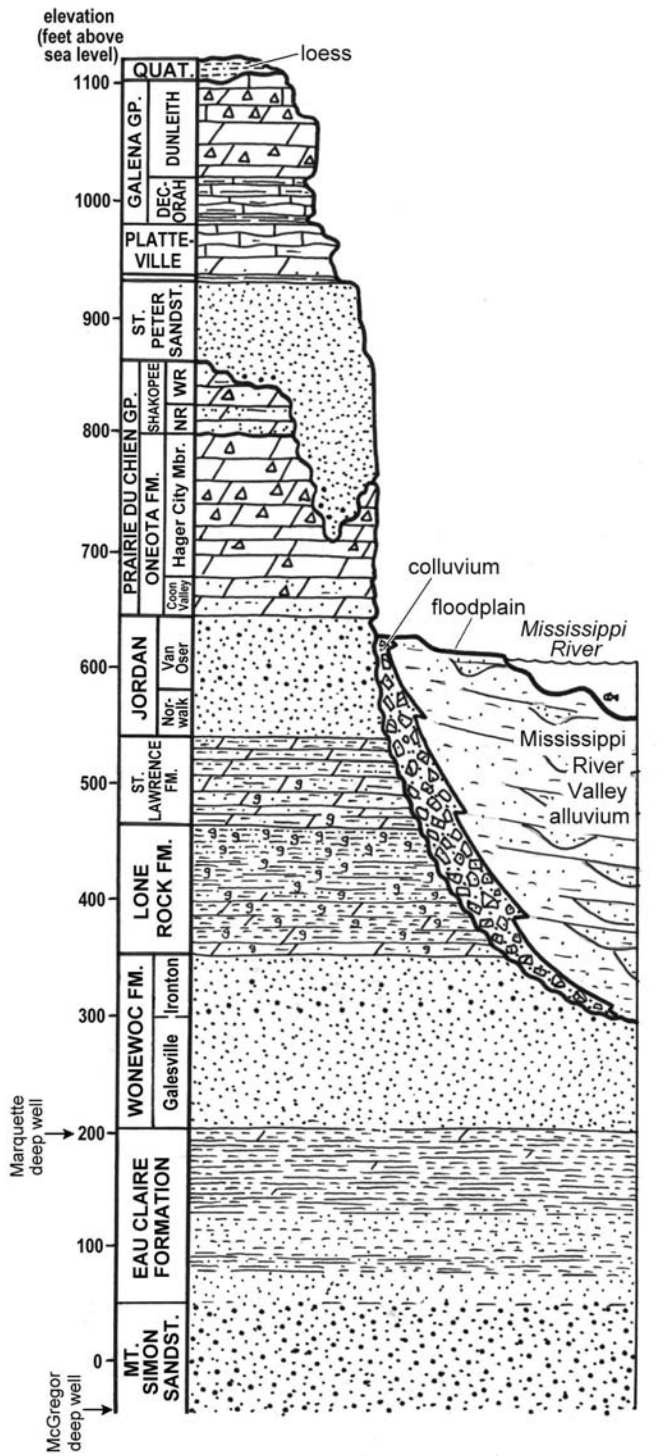

Figure 1. The Geologic section in the area of Pikes Peak State Park.

An instructive and picturesque succession of geologic strata is wonderfully displayed within Pikes Peak State Park. The down-cutting of the Mississippi River Valley has exposed rock strata in bold cliffs and steep ravines, and a number of geologic formations are represented (Fig. 1). The dramatic bluffs in the park tower 300 to 500 feet above the river, and the bluff-tops provide panoramic views up and down the Mississippi River Valley and the Wisconsin River to the east. The highest elevations in the park occur near the park's south entrance and campground (approximately 1130 feet above sea level), and the lowest elevations are along the banks of the Mississippi River (normal river level 611 feet above sea level).

LOWER SANDSTONE CAMBRIAN STRATA

The succession of exposed bedrock strata in the park begins below Point Ann, the bluff adjoining the city of McGregor in the northern area of the state park. The Jordan Sandstone of Cambrian age can be seen in this area (and northward along the highway to Marquette). These sandstones were deposited in shallow and nearshore environments of a vast inland sea that covered the region during Late Cambrian. The Jordan Sandstone is the youngest Cambrian formation in the Upper Mississippi Valley area, deposited about 505 million years ago. The Jordan Sandstone seen in Pikes Peak State Park represents the farthest south that Cambrian strata are exposed in the entire Mississippi Valley. Progressively older Cambrian strata can be seen proceeding northward up the Mississippi Valley from McGregor. The same succession of older Cambrian formations occurs beneath the level of the Mississippi River in the park, but these occur in the subsurface buried beneath the Jordan Sandstone. These strata have been encountered in the deep water well in Pikes Peak State Park as well as municipal water wells at McGregor and Marquette (see Fig. 1). The bedrock channel of the Mississippi River adjacent to Pikes Peak, which is now largely filled with alluvial sediments, is incised 300 feet or more into these Cambrian units, cutting across and into strata of the Jordan, St. Lawrence, Lone Rock, and Wonewoc formations (see Fig.1).

LOWER DOLOMITE LEDGES
THE ORDOVICIAN PRAIRIE DU CHIEN GROUP

Lower Ordovician dolomite strata of the Prairie du Chien Group overlie the Jordan Sandstone in the park. Although the Jordan-Prairie du Chien contact does not display significant erosional relief, an episode of missing time is marked at that position in the stratigraphic succession (a disconformity). The Prairie du Chien Group is characterized by ledges of dolomite strata, some containing nodules of chert. Minor sandstone and shale is also observed. The Prairie du Chien dolomites were formed by chemical replacement of original lime sediments which accumulated in shallow tropical seas that covered much of the interior of North America between about 490 and 505 million years ago. This chemical replacement of original lime sediments composed of calcium carbonate by calcium-magnesium carbonate (the mineral called dolomite) was a later-stage process. Because dolomites differ chemically from limestones, they have sometimes been termed “magnesian limestone” in the older geologic literature.

The Prairie du Chien Group derives its name from the nearby city of Prairie du Chien, Wisconsin, only a few miles north of Pikes Peak. The bluffs behind Prairie du Chien display these strata in bold cliffs and rocky slopes. Prairie du Chien strata are prominently exposed in bluff slopes and cliff faces throughout much of the Upper Mississippi Valley (from Prairie du Chien to the Twin Cities), commonly reaching thicknesses to about 250 feet. The interval contains rocks that are more erosionally resistant than the underlying succession of less resistant Cambrian sandstones. The Prairie du Chien Group has been divided into two formations, the Oneota below and the Shakopee above. Strata of the Oneota Formation are exposed in the lower bluff faces and lower ravine drainages of Pikes Peak State Park, and old quarries can be seen adjoining the railroad tracks south of McGregor. The Oneota Formation is subdivided into two members. The lower interval, the Coon Valley Member, has historically been considered under several different names, and it was variously included within the Jordan Sandstone or Prairie du Chien Group. Because it is an interval dominated by dolomite and contains fossils of Ordovician age, it seems reasonable to include it within the Prairie du Chien Group (as now classified by the Minnesota Geological Survey), as opposed to the underlying Jordan sandstones of Cambrian age. The Coon Valley interval, however, does contain some quartz sand, primarily as isolated sand grains in a dolomite matrix. By contrast, overlying strata of the middle and upper Oneota Formation (termed the Hager City Member) are generally devoid of quartz sand, and it is characterized by remarkably pure dolomite beds, in part cherty to very cherty.

Upper Prairie du Chien strata are included in the Shakopee Formation, which differs from subjacent Oneota strata in containing some sandstone, shale, and sandy dolomite. The lower Shakopee interval contains sandstone and sandy dolomite (the New Richmond Member), and the upper interval is less sandy and variably cherty (Willow River Member). The Shakopee Formation is not well represented within Pikes Peak State Park, primarily because it has been erosionally removed from much of the immediate area during a prolonged period of erosion that followed the withdrawal of the Prairie du Chien seas from the area and preceded the deposition of the St. Peter Sandstone. However, Shakopee strata are represented in the deep water well drilled in the uplands near the Pikes Peak State Park entrance, so the Shakopee Formation was not completely eroded across the entire park area. Shakopee strata are well exposed elsewhere in northeastern Iowa (portions of Clayton and Allamakee counties) and the Upper Mississippi Valley.

THICK MASSIVE SANDSTONE
THE MIDDLE ORDOVICIAN ST. PETER SANDSTONE

The shallow tropical seas in which Prairie du Chien lime sediments were deposited eventually withdrew from the interior of North America during later stages of the Early Ordovician, and a long period of erosion began in the area. This ensuing erosional episode spanned a remarkably long period of time, including portions of the Early Ordovician and much of the Middle Ordovician (approximately 25 million years duration). This period of erosion was characterized by deep weathering across the exposed surface of Prairie du Chien dolomite strata., resulting in the development of an irregular and incised topography. The region that now includes eastern Iowa occupied a geographic position in tropical latitudes (within about 10º of the equator) at that time. Tropical weathering produced a network of caves and sinkholes created by karstic solution of the Prairie du Chien carbonate rocks, and these solutional openings are known to penetrate up to 350 feet though the succession of Prairie du Chien strata in areas of eastern Iowa. Deep valleys were also eroded into this landscape, which in places in the Upper Mississippi Valley area cut through the entire Prairie du Chien succession and into underlying Cambrian strata. In the Pikes Peak area a deep valley was incised through the entire Shakopee Formation and into strata of the Oneota Formation.

The erosional landscape of valleys and sinkholes developed on Prairie du Chien strata was subsequently infilled by sediments of the St. Peter Sandstone during the latter part of the Middle Ordovician. This infilling was apparently initiated as shallow seas encroached once again into the continental interior of North America. Initially, rivers within the valley systems began to aggrade their sediment load as stream gradients changed in response to rising sea level. As the sea continued to expand into the region, the valleys likely became estuaries along the encroaching coastline. Ultimately the valleys, like the one developed across Prairie du Chien strata in Pikes Peak State Park, entirely filled up with sediment, primarily quartz sand. Once the valleys and karstic openings became filled, the seaway continued to expand over the region depositing a widespread body of sand across the shallow shelf. This valley-filling and shallow-marine sandstone body is known today as the St. Peter Sandstone. The St. Peter Sandstone comprises the thickest formation exposed today in Pikes Peak State Park.

The St. Peter Sandstone derives its name from exposures below Fort Snelling at the mouth of Minnesota River in St. Paul, Minnesota – the Minnesota River was formerly known as the St. Peter River. The St. Peter Sandstone is a remarkably widespread sandstone formation that has been recognized as far east as Michigan and Ohio, as far south as Arkansas, and as far west as Kansas and Nebraska. Of all the known exposures of St. Peter Sandstone across this vast area, the thickest known succession is seen within Pikes Peak State Park, where the full thickness of the formation is known to vary between 90 and 223 feet. By contrast, in nearby areas of Clayton and Allamakee counties, the St. Peter Sandstone is more typically 40 to 55 feet in thickness.

The St. Peter Sandstone is a remarkably monotonous and homogeneous succession of quartz sand (the rock is termed a “quartzarenite”). It appears within Pikes Peak State in thick massive beds best seen in bluff slopes and steep-walled ravines (as along the Sand Cave trail). The St. Peter is overwhelmingly dominated by very fine to medium grains of quartz sand, with little other material present. The quartz grains are commonly well rounded, and the sedimentologically-mature aspect of the St. Peter quartzarenites suggests that much of the sand was derived by the reworking of older sandstones (like those seen in Prairie du Chien and Cambrian strata). Because of its homogeneity it is difficult to distinguish sedimentary features within the succession, although some low-angle crossbeds and the burrow traces of marine animals can be seen in places. Argillaceous (clay) material is incorporated with the sand in the upper part of the sandstone succession, and clay-rich intervals with coarser reworked fragments of Prairie du Chien chert are locally present at the base of the St. Peter. At Pikes Peak, the lower portion of the St. Peter Sandstone where it is thickest (as in the Sand Cave area) displays dramtic swirls and bands of red-colored iron-oxide cements (which geologists sometimes term "Leisegang bands").

The St. Peter Sandstone in the region is capped by a relatively thin green-gray shale unit known as the Glenwood Shale. This shale is only about 4 to 5 feet in thickness in the park, and because of its soft and easily erodable character, it is typically not well exposed in the wooded ravines. The Glenwood Shale has been grouped together with the St. Peter Sandstone into a stratigraphic interval geologists have named the Ancell Group. The Glenwood Shale is phosphatic in part, incorporating vast numbers of tiny tooth-like phosphatic microfossils known as conodonts. Chitinous jaws of annelid worms (scolecodonts) are also abundant. The clay sediments of the Glenwood Shale in this area were deposited very slowly within the shallow seaway (geologists refer to such a slowly-deposited unit as a "condensed section"), likely in far offshore areas. The slow rates of sediment accumulation are reflected by the thinness of the Glenwood Shale across the Iowa area (generally less than 5 feet), but elsewhere in southeastern Iowa and Illinois equivalent Glenwood strata reach thicknesses of 75 to 150 feet. The Glenwood Shale is interpreted to have been deposited as the seaway continued to deepen (transgress) across the region.

DOLOMITE AND LIMESTONE
THE ORDOVICIAN PLATTEVILLE FORMATION

The Platteville Formation is exposed in the upper bluff slopes within Pikes Peak State Park, where it comprises a succession of carbonate rock strata (limestone and dolomite) about 45 feet thick. These strata form the lip of Bridal Veil Falls in the park. The Platteville Formation derives its name from characteristic exposures at Platteville, Wisconsin, about 40 miles southeast of the park. The lower part of the formation is characterized by ledges of fossiliferous dolomite (the Pecatonica Member), and upper Platteville strata (the McGregor Member) which form an interval of mostly wavy-bedded limestones, many containing a beautiful assemblage of well-preserved fossils. The member names derive from the Pecatonica River of southwest Wisconsin, and, of course, the nearby city of McGregor, Iowa. Platteville strata have previously been assigned a Middle Ordovician age based on the standard usage of geologic series in North America, but the recent definitions promoted by the International Subcommission on Ordovician Stratigraphy would now place the Platteville Formation and all overlying strata of the Galena Group within the Upper Ordovician Series.

The Platteville Formation represents the lithified sediments that were deposited within a broad tropical sea which supported a diversity of shelled bottom-dwelling animals. The influx of quartz sand, which marked earlier St. Peter deposition, waned and ceased altogether as depositon of the Pecatonica Member proceeded and as shorelines advanced deep into the continental interior. The deposition of carbonate mud along with the calcite shells and skeletons of invertebrate animals now prevailed in the region, and only a minor input of land-derived detrital siliciclastic sediment (largely clays) originated from distant riverine input to the sea. These carbonate sediments were largely precititated directly from seawater, a chemical precipitation typically mediated by biological processes. As sea levels fluctuated within the seaway, sediment accumulation varied in response to deepening and shallowing trends. The close of Pecatonica deposition was marked by widespread development of a so-called "hardground" surface, a surface formed across the seafloor at a time when sediment accumulation ceased altogether.

The overlying succession of wavy-bedded to nodular limestone strata comprise the McGregor Member. Fossiliferous stringers provide evidence of episodic transport and concentration of shell material during deposition, likely produced by storm-generated currents associated with hurricanes and other tropical storms. Episodes of sediment starvation are marked by hardground surfaces. The fossils are wonderfully preserved in these limestone strata. A number of creatures inhabited the sea bottom, including brachiopods, crinoids, trilobites, ostracodes, bryozoans, solitary corals, snails, and others. Large nautiloid cephalopods plied the waters in search of prey or scavenge, and very large molds of their chambered shells are found in the Platteville Formation of the area. The McGregor Member is a stratigraphic term used across parts of Iowa and Minnesota, but these strata have also been included within the Mifflin and "Grand Detour" formations (of the "Platteville Group") using a classification scheme proposed by the Illinois Geological Survey (Templeton and Willman, 1963). Mifflin strata comprise the typical wavy-bedded fossiliferous limestone succession, and the horizontally-bedded dolomitic limestone interval at the top of the Platteville Formation has been labeled the "Grand Detour"; this classification is discussed further for the McGregor Quarry field trip stop.

The flat surface that separates the Platteville Formation from the overlying Decorah Formation is in many respects geologically remarkable, and it is characterized by extreme sediment starvation or condensation across a vast area of the central and eastern United States (Kolata et al., 1998; Ludvigson et al., 1996). The amount of missing geologic time along this surface (a submarine disconformity) generally increases in an offshore direction (southeastward). A thin interval of limestone and shale in the Pikes Peak area (8 inches thick), which contains a prominent volcanic ash (Deicke bentonite), is all that remains of a unit termed the Carimona Member of the upper Platteville Formation in Minnesota (where it reaches thicknesses to 6 feet). The Carimona Member, which is included within the basal Decorah Formation (in Iowa and Wisconsin), completely disappears a short distance southward in Clayton County.

ORDOVICIAN SHALE AND LIMESTONE
THE LOWER GALENA GROUP, DECORAH FORMATION

The Decorah Formation is a succession of shale and limestone occurring high in bluff slope drainages of Pikes Peak State Park (for example, above Bridal Veil Falls). The Decorah Formation, which derives its name from Decorah, Iowa (38 miles to the northwest of Pikes Peak), comprises the lower shaley interval of the Galena Group. The Decorah differs from overlying strata of the Galena Group in containing an appreciable content of clay shale. These shales are typically greenish-gray in color and contain fossiliferous lenses and thin beds (commonly brachiopod shell hashes or coquinas) of limestone. The shale content of the Decorah Formation increases to the northwest, and these clays were sourced by erosion across an exposed low landscape that stretched across Minnesota. Because shales are soft and easily weathered, the shaley portions of the Decorah Formation are typically not well exposed in Pikes Peak State Park.

The Decorah Formation in the park includes a lower shale member (the Spechts Ferry Shale), a middle limestone unit (the Guttenberg Member), and an upper shaley interval (the Ion Member). The Spechts Ferry Shale, named after a location in northern Dubuque County, contains two widespread volcanic ashes (known as bentonites) visible as soft pale-colored (whitish to yellow-orange) layers 1 to 2 inches thick within the darker green-gray shale interval. These volcanic ashes have been chemically altered, and geologists label them as "K-bentonites" ("K" for potassium alteration, sometimes lithified by potassium feldspar). These bentonites represent volcanic ash falls blown over the interior seaway from distant volcanoes (the volcanic arc lay eastward from present-day Virginia), and the ash settled to the sea bottom where it remained largely undisturbed by bottom currents or burrowing organisms. Some of these ash falls were among the largest known in earth history (giant Plinian volcanic eruptions), with individual bentonite beds recognized across vast areas of eastern and central North America and northern Europe. The lowest bentonite at Pikes Peak immediately overlies the Platteville surface, and this bentonite bed is known as the Deicke K-bentonite in North America (dated at 454 million years old). A second bentonite is present about 1 ½ feet higher, this one termed the Millbrig K-bentonite (dated at 453.7 million years old).

Limestones of the Guttenberg Member overlie the Spechts Ferry Shale. This limestone interval, whose name derives from the town of Guttenberg about 15 miles south of Pikes Peak, resembles the McGregor Member of the Platteville Formation in possessing wavy to nodular bedded fossiliferous limestone strata. Although not clearly visible in exposure (due to oxidation), the Guttenberg Member contains thin organic-rich brown shales between the wavy limestone beds. Occasional whole articulated crinoid and trilobite fossils are found in the lower beds, which are interpreted to have been deposited in the deepest of the Guttenberg environments. Thin stringers of brachiopod shells were probably concentrated by storm activity, and the general upward increase of abraded and broken skeletal grains likely relates to overall shallowing conditions during deposition. Although the Guttenberg Member is dominated by limestone, the member incorporates progressively more shale in a northward direction. At Decorah, Iowa, and northward in Minnesota, the Guttenberg Member is not clearly recognized and the entire Decorah Formation becomes shale dominated. An additional two bentonite horizons occur within the Guttenberg Member. The Elkport K-bentonite is locally as a thin streak near the base of the member in the Pikes Peak area. The Dickeyville K-bentonite locallyoccurs in the upper Guttenberg, and it is tentatively recognized at the McGregor Quarry (field trip stop).

Upper strata of the Decorah Formation at Pikes Peak are included within the Ion Member, a named derived from a bridge crossing on the Yellow River a short distance north of Pikes Peak. The Ion Member includes interbedded green-gray shales and fossiliferous limestones, and it is notably more shaley than the underlying Guttenberg Member. An interval containing large trepostome bryozoans is widespread in the upper part, including distinctive hemispherical forms (the "*Prasopora* zone"). The Ion shaley interval is replaced southward in the Dubuque area by non-shaley dolomite strata included within the Dunleith Formation (Buckhorn and St. James members), and northward into the Decorah area and southern Minnesota Ion equivalents are part of the thicker undifferentiated Decorah Shale. In the Pikes Peak area, the last major influx of clay sediments occurred during Ion deposition, but Decorah shales occur at higher stratigraphic positions northwestward. The Ion is interpreted to have been deposited in shallower environments than the underlying Guttenberg, as evidenced by the progradation of shale from shoreward areas and the higher proportion of abraded and broken shell material.

UPPERMOST DOLOMITE LEDGES
THE ORDOVICIAN DUNLEITH FORMATION, GALENA GROUP

The highest Paleozoic bedrock strata found in Pikes Peak State Park belong to the Dunleith Formation, which along with the underlying Decorah Formation comprises the lower half of the Galena Group. These strata form the highest cliffs and ledges above elevations of 1000 feet in the park, and these resistant dolomite and limestone beds are well displayed below the main overlook structure. In contrast with underlying Decorah strata, the Dunleith Formation contains almost no shale and the carbonate beds are dominated by recrystallized dolomite and dolomitic limestone (unlike the fossiliferous limestones of the Decorah). In addition, the Dunleith contains a considerable quantity of nodular chert ("flint"), whereas underlying Decorah and Platteville carbonates completely lack chert. The Dunleith Formation reaches thicknesses to 80 feet in the park (generally less than 50 feet is represented in the bluff faces). However, the upper part of the formation has been erosionally removed from the park, and the full thickness of the Dunleith in the area is actually about 110 feet. The Dunleith Formation is found in cliffs and bluff faces along the Mississippi River Valley extending southward from Pikes Peak to the Dubuque area.

The Dunleith Formation, whose name derives from Dunleith Township, East Dubuque, Illinois, has been subdivided into a series of members based on variations in chert and argillaceous content (Templeton and Willman, 1963; Levorson and Gerk, 1972), and these individual members have remarkable continuity over a vast area (across Iowa, southern Minnesota, northern Illinois, Wisconsin, northern Missouri, eastern Nebraska). This continuity indicates that widespread and uniform conditions were established on the sea bottom during Dunleith deposition. However, a general northwestward increase in clay content characterizes the lower portion of this interval, and lower Dunleith strata at Pikes Peak correlate with shales included in the upper Decorah Formation at St. Paul. Minnesota. At any given locality, the shift from Decorah to Dunleith deposition is marked by a significant decrease in clay content. This change in clay content reflects the increasing distance from the eroding source area for these clays as shorelines advanced deep into the continental interior (clay sources largely vanished when much of present-day Minnesota and the Canadian Shield were submerged beneath the advancing seaway).

The Dunleith Formation is characterized by recrystallized dolomite and dolomitic limestone strata at Pikes Peak, and argillaceous (clay) content is very low to largely absent through the succession. However, lower Dunleith strata (Beecher Member) are slightly argillaceous, with some clay streaks and shaley partings noted, but clay is nowhere near as abundant as in underlying Decorah strata. Like the older Prairie du Chien Group, Dunleith strata were originally deposited as calcium carbonate sediments which were later replaced, partially or wholly, by dolomite. Interestingly, the Dunleith Formation to the north (as seen at Decorah, Iowa, and in southeastern Minnesota) lacks dolomite (and the succession is entirely comprised of limestone and cherty limestone), whereas, southward into Dubuque County, the Dunleith is entirely dolomitized (completely lacks limestone). Pikes Peak lies at an intermediate position between these extremes, where the Dunleith succession is characterized by an interfingering of dolomite and dolomitic limestone rock types (dolomitic limestones are limestones that are only partially dolomitized).

The Dunleith carbonate strata at Pikes Peak have been recrystallized during dolomitization, and original sedimentary features and fossils are thereby more difficult to distinguish than in the beautiful fossiliferous limestones of the underlying Platteville and Decorah formations. The secondary development of vugs and pores (open spaces and holes) in the dolomite strata has further obscured the fossils and fabrics. Nevertheless, brachiopods, crinoid material, snails, and solitary corals are seen in the park, indicating that the bottom environments in the seaway provided suitable habitat for a diversity of organisms. Relatively large but enigmatic fossils known as receptaculitids (belonging to the genus *Fisherites*) occur within these strata in the park, and the stratigraphic units which contain these fossils are correlatable across a broad region (three receptaculitid "zones" are recognized in the Galena Group). Receptacultids are sometimes called "sunflower corals" because the radiating geometric pattern formed by its skeleton resembles the seed-heads of sunflowers. However, the biologic relationships of receptaculitids are not known with certainty. Various proposals have allied them with corals, sponges, or algae. Receptaculitids share many features in comon with calcareous-plated green algae, but certain differences indicate that receptaculitids are a unique extinct group of organisms (possibly allied with green algae).

The Dunleith Formation in the Mississippi Valley area is known for its profusion of widespread "hardground" surfaces (see previous discussion for Platteville), and the accumulation of carbonate sediment on the seafloor during Dunleith deposition was probably very slow (and entirely absent at times when hardgrounds formed). Some hardgrounds are seen in lower Dunleith strata at Pikes Peak, but dolomitization and weathering have made the recognition of other widespread hardgrounds difficult to recognize. As seen in better-preserved limestone successions of Dunleith strata to the north, episodic tropical storm activity fragmented and transported fossils grains on the seafloor. Grains of calcareous green algae occur in some but not all of the beds, indicating that Dunleith deposition occurred, at least in part, within the zone of light penetration (photic zone). Burrowing organisms left complex burrow networks within these strata, sometimes accentuated by preferential dolomitization.

Although higher Upper Ordovician strata of the Galena Group (Wise Lake and Dubuque formations) and Maquoketa Shale can be seen in nearby areas of Clayton County, these stratigraphic units have been removed from Pikes Peak State Park by later erosion. Northeastern Iowa was subjected to many long-lived episodes of deep erosion marked by the erosional incision and truncation of various bedrock units. Recurring erosional episodes separated periods of shallow marine deposition in the region during much of the Paleozoic Era, but a dominantly erosional landscape was developed across the region later in the Paleozoic (beginning about 300 million years ago). Except for some minor Cretaceous-aged sediments in the area (e.g. at Waukon, Allamakee County), there is no evidence of any deposition in northeast Iowa for a period of time spanning most of that 300 million year interval. Pikes Peak was certainly subjected to the erosional downcutting of bedrock strata seen across the region during that prolonged period of erosion. Nevertheless, the steep erosion of bluff slopes and ravine drainages which has produced the dramatic and picturesque landscape of Pikes Peak State Park is primarily a reflection of erosional processes relating to the more geologically-recent incision of the Mississippi River Valley and its tributaries during the Quaternary Period, which includes the Pleistocene ("Ice Age") and Holocene (Recent) epochs.

VALLEYS, ALLUVIUM, COLLUVIUM, AND LOESS QUATERNARY EROSION AND DEPOSITION AT PIKES PEAK

The modern landscape of Pikes Peak State Park is dominated by steep bluff faces that border the Mississippi River Valley. This landscape has been dramatically sculpted by erosion of the bedrock strata, and this erosion continues with each passing year as cycles of rain and snowmelt, freeze and thaw, slowly but surely degrade the slopes and transport material down the valley walls. The origin of the deep incision of the Mississippi River Valley and adjacent tributary valleys (including the Wisconsin River) is not well constrained geologically. As discussed earlier, the base of the Mississippi bedrock channel lies some 300 feet below the modern river level. This deeper level of incision was likely related to episodes of continental glaciation, when vast ice sheets spread across large areas of the northern hemisphere several times during the last 2 ½ million years. As the ice sheets grew, global sea levels progressively dropped, reaching levels some 400 feet lower than today at the height of the northern glaciations. This lowering of sea level changed the gradient of the Mississippi River, leading to deeper erosion of its valley. In addition, as the ice sheets began to melt, huge volumes of meltwater and sediment moved down the Mississippi Valley and other drainageways (like the Wisconsin River), initially scouring the valley. As sea levels progressively rose once again, the sediment-laden meltwaters began to deposit large volumes of sediment within the valley.

The deepest portion of the bedrock incision in the Mississippi Valley is now buried beneath about 300 feet of alluvial sediments. These sediments accumulated during waning floods along the river, aggrading the river channels and floodplains with deposits of sand, gravel, silt, and mud. A complex history of sediment accumulation and erosion was likely produced in the valley by the waxing and waning of glaciers in the region, producing major variations in the river's flow and the intensity of its floods. Only the most recent portion of that history is known with any certainty, which largely encompasses the past 12,000 to 14,000 years. Meltwater surges resulting from the degradation of the most recent glaciers in the region (late Wisconsinan glacial stage) are documented in the valley. Climatic variations during the Holocene (the past 12,000 years) also influenced deposition and erosion within the river valley, producing variations in the sediment load, flow, and flood intensity of the river. The most recent sedimentation in the valley occurs on the active floodplains, and additional siltation is occurring in the pools above the Lock and Dams.

Some sediment has locally accumulated along the slopes and tributary drainages within Pikes Peak State Park, and much of this material has been derived by the erosional breakdown of bedrock materials. As the Cambrian and Ordovician rocks weather into fragments of varying size, these fragments roll, slide, creep, or fall down the hillslopes, aided in places by running water. This material is termed "colluvium." Bedrock strata of the Prairie du Chien, Platteville, and Galena groups commonly produce coarse colluvium comprised of broken and weathered blocks of limestone and dolomite of varying size. Other bedrock intervals of sandstone and shale typically weather in smaller particles, which may become mixed with coarser materials along the slopes. Coarse blocky colluvium can be seen along many slopes within the park, and some of this material is being actively transported by modern geologic processes. In other places, the colluvium has been partially stabilized beneath a vegetated cover. Ultimately, however, all colluvium will proceed downslope to the Mississippi River as the inevitable forces of erosion continue to sculp the landscape.. In addition to the weathered bedrock units, the colluvium commonly incorporates weathered material derived from upland loess deposits as well as soil units that were developed on the loess and bedrock.

The upland bluff tops in Pikes Peak and elsewhere in the Upper Mississippi Valley have a cap of silty material known as "loess." The widespread blanket of loess, which covers vasts areas of east-central United States and Mississippi Valley, was deposited as wind-blown silts accumulated on the landscape during the later phases of the Wisconsinan glaciation. The Midwestern United States was a very different place at that time. Glaciers expanded southward to DesMoines, Iowa, at the maximum glacial advance, and much of eastern Iowa was a cold and stark landscape under periglacial conditions and permafrost. Fierce cold winds picked up silts from the landscape, especially the glacial outwash plains and river valleys, transporting and depositing silt across the region. These wind-blown loess deposits comprise the base materials for much of Iowa's rich agricultural soils.

Northeast Iowa was not glaciated during either of the last two major glaciations of the Late Pleistocene ("Ice Age"), the Wisconsinan and Illinoian, but there is clear evidence of older glaciations ("pre-Illinoian") in the region. Although Pikes Peak lies near the western margin of the so-called "Driftless Area" ("Drift" is an older term referring to glacial deposits), eroded remnants of glacial till are known in places within the Driftless Area of northeast Iowa. We have been unable to locate any evidence of glacial till deposits within Pikes Peak State Park, although some remnants may be locally present. Christiansen et al. (1980) noted the possible occurrence of glacial till remnants in the park.

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THE CAMBRIAN JORDAN SANDSTONE AT POINT ANN, PIKES PEAK STATE PARK, AND IN MCGREGOR

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A BIT OF STRATIGRAPHIC HISTORY

During the early phases of Upper Mississippi Valley geologic investigations the strata currently differentiated as the Jordan Sandstone were lumped within the Potsdam Sandstone, a unit defined in upper New York State, and traced into Wisconsin, Minnesota and Iowa by Owen (1852) and Hall (1858). As originally used the Potsdam encompassed all strata between the crystalline basement and the first substantial dolomites of the region, today's Oneota Formation. The Jordan remained undifferentiated in what N.H. Winchell (1873) called the Saint Croix sandstone; a name derived from extensive sandstone outcrops along the St. Croix River on the border between Minnesota and Wisconsin. The Saint Croix, as used by Winchell, was simply a Midwest term for the same strata as that previously referred to the Potsdam by earlier geologists. The following year Winchell (1874) recognized Saint Croix strata along the Minnesota River, and introduced the name Jordan Sandstone for a distinctive coarse-grained sandstone exposed near the village of Jordan, Minnesota. At about the same time, Irving (1875), working in the Cambrian of Wisconsin, applied the name Madison Sandstone to equivalent sandstone exposures in the city of Madison.

The term, Saint Croix sandstone was officially introduced into Iowa literature by Keyes (1893) in the newly established Geological Survey's first Annual Report. Norton (1895), in his investigation of deep wells in northeastern Iowa, continued use of the term Saint Croix, and established a dual division based on the presence of a upper sandstone member (his upper Saint Croix), and a lower dolomite and shale member (his lower Saint Croix). Norton's upper Saint Croix sandstone was equivalent to today's Jordan Sandstone, and his lower member referred to today's St. Lawrence and Franconia or Lone Rock formations.

Calvin (1895), in his report on the geology of Allamakee County, maintained use of term Saint Croix sandstone and recognized that the section at Lansing, Iowa contained strata equivalent to the Jordan of Winchell and the Madison of Irving, but did not employ those terms as formalized stratigraphic names. That distinction was left to Norton (1897) who specifically included both the Jordan and the St. Lawrence as formations on his deep well geological section of Iowa. In 1906, in his report on the geology of Clayton County, Leonard (1906) maintained Norton's use of the terms, as did other latter annual reports.

From 1906 to the late 1930's essentially no published geologic investigations of the Iowa Cambrian outcrop belt were conducted. The lack of work in Iowa, coupled with considerable new work in Minnesota and Wisconsin, inspired Walter Schuldt, a University of Iowa graduate student, to embark, in 1938, on a comprehensive study of the Iowa Cambrian outcrop with particular emphasis placed on the best exposed unit, the Jordan Sandstone. In a summary of his thesis work Schuldt (1943) adopted the Wisconsin classification of Twenhofel et al. (1935) whereby the Jordan was included within a four-member Trempealeau Formation (Table 1). Schuldt restricted the term Madison to a fine to medium-grained sandstone facies that was distinguished by the common presence of thin bedding, intraclast conglomerates, variable dolomite cement, and occasional green shaly horizons, and he opined that the Cambrian-Ordovician boundary lay at the Madison-Oneota boundary.

Studies of this interval continued after World War II, but little attention was devoted to the outcrops in Iowa; most new work was done in the larger outcrop belts of Wisconsin and Minnesota. Raasch (1951) recommended dropping the term Madison because of potential confusion with the Mississippian

Trempealeau Formation	**Madison Member** 3-22 feet
	Jordan Member 70-130 feet
	Lodi Member 17-35 feet
	St. Lawrence Member 10-20 feet

Table 1. Stratigraphy of the Jordan and adjacent units in Northeast Iowa according to (Schuldt, 1943)

limestone unit of the same name in the western U.S. In place of Madison he substituted the term Sunset Point, a bluff locality in the City of Madison, Wisconsin, and promoted the Sunset Point to formational rank. One year later Raasch (1952) extended use of the term Sunset Point to the Mississippi Valley of western Wisconsin where he recognized numerous Sunset Point Formation sections in the Stoddard area. Nelson (1956) retained the Sunset Point Formation of Raasch and promoted the Jordan back to formational rank as it had been in publications prior to Twenhofel et al. (1935).

Several geologists continued work on this interval in the sixties and seventies. Ostrom (1964, 1965, and 1967) retained Raasch's Sunset Point but reclassified it as the upper member of the Jordan. Davis (1970), in his study of the overlying Prairie du Chien Group, maintained that the Sunset Point was extremely difficult to identify and could not be consistently recognized in the field or subsurface. He rejected the terms Sunset Point and Madison and recommended that all dolomitic sandstone and sandy dolomite between the friable Jordan sandstone and the pure dolomites of the Oneota be included in a new Stockton Hill Member of the Oneota Formation, named after a locality west of Winona, Minnesota. His definition emphazised the heterogenous and transitional lithic nature of the Stockton Hill and he maintained that its lower contact with the Jordan was abrupt and readily recognizable; he applied this terminology to one section in northwest Allamakee County along state highway 76. Odom and Ostrom (1978) presented conclusions from several investigations of the Cambrian-Ordovician sequence in southwest Wisconsin. Their studies extended into northeast Iowa where they introduced two new member names into the Jordan, the Waukon, and the Coon Valley. After introduction, these names were adopted by the Geological Survey in Iowa, deferring to Odom and Ostrom's detailed studies done in the adjacent and much larger outcrop belt of Wisconsin. The Waukon Member was defined as a fine-grained lithofacies similar in lithic character to the lower Jordan (Norwalk Member), but recurring as a lenticular deposit within the coarse-grained Van Oser Member of the upper Jordan in northern Allamakee County. The Coon Valley name was proposed to replace Davis' Stockton Hill Member due to prior usage of the term Stockton Hill as an informal member name of the St. Lawrence Formation. They also reassigned the Coon Valley strata to the Jordan because they felt the intervals' high sand content implied greater lithic affinity to the Jordan than the Oneota.

In more recent publications Smith et al. (1993), Runkel (1994), and Byers and Dott (1995) not only simplified stratigraphic nomenclature, but specifically addressed the sedimentology and depositional setting of the Jordan and adjacent units. These investigations recognize three lithofacies in the Jordan: a lower fine-grained hummocky cross-stratified sandstone facies often called the Norwalk Member, a middle fine- to medium-grained trough cross-stratified sandstone facies called the Van Oser Member; and an upper coarse-grained large-scale cross-stratified facies also assigned to the Van Oser Member. Runkel (1994) recognized a fourth, uppermost facies at one locality in Minnesota that consisted of very fine to coarse-grained sandstone thinly interbedded with siltstone, and shale. Runkel recommended retaining the term Coon Valley but preferred to include the strata as the basal member of the Oneota, much as Davis had done with the Stockton Hill. Byers and Dott (1995), following the conclusions of Smith et al. (1993), favored retaining the name Stockton Hill as the basal member of the Oneota.

Discussion of the conformable versus unconformable nature of the Jordan-Oneota contact, the exact placement of that contact, and the placement of the Cambrian-Ordovician boundary has been considered by numerous authors during the 20th century. Ulrich (1924) and Twenhofel et al. (1935) considered the contact unconformable and coincident with the Cambrian-Ordovician boundary. Raasch (1952) and

Raasch and Unfer's (1964) work, in the Stoddard area, located the system boundary at an unconformable Sunset Point-Oneota contact, but also concluded that the Sunset Point lay unconformably on highly cross-stratified Van Oser facies of the Jordan. Other authors, including Schuldt (1943), Ostrom (1964) and Odom and Ostrom (1978) maintained that the Cambrian-Ordovician boundary exists within a conformable upper Jordan through lower Oneota transition zone. In more recent works, Smith et al. (1993), Runkel (1994) and Byers and Dott (1995) concluded that lithostratigraphic and sedimentologic evidence supported the long-contested notion of a Cambrian-Ordovician unconformity between the sandstone dominated Jordan and the carbonate dominated Oneota. It should be noted however that those authors do not universally agree on contact or unconformity placement. Biostratigraphic studies across these unit transitions have been limited due to their sparsely fossiliferous nature, but recent investigations of conodonts by Miller and Runkel (1998), Runkel and others (1999), and Runkel (2000) support the contention that a substantial hiatus exists between the Jordan and the Oneota formations. These ongoing studies suggest that four conodont zones are missing between the top of the Jordan and the base of the Oneota (Coon Valley Member) at several outcrops in the southwest Wisconsin and southeast Minnesota. Missing conodont zones have also been recorded at the Jordan-Oneota contact from core samples in the subsurface of southern Minnesota and central and western Iowa.

In the absence of definitive conodont-based biostratigraphic data, the precise position of the system unconformity at any individual outcrop is still subject to debate. Runkel (1994, 2000) favors locating the unconformity at a lithofacies change coincident with a poorly sorted, pebbly sandstone deposit. He interprets the pebbly sandstone as a sedimentary lag deposit, or pebble concentration, that formed at the top of the Jordan regressive sequence by widespread erosion across a subaerially exposed, prograding sandy shoreline. Modification of the pebble lag occurred by wave and tidal current reworking during the subsequent Early Ordovician transgression. Byers and Dott (1995), in agreement with the recommendations of Smith et al.'s (1993) study of the Prairie du Chien Group, prefer to locate the Jordan's upper boundary at the point where well-sorted siliciclastic sands are sharply overlain by carbonates with variable sand content. They maintain that this sharp upper contact is coincident with a sequence scale boundary unconformity that separates Late Cambrian from Early Ordovician age strata. At some outcrops in Minnesota where it appears that both conditions exist - the pebble lag and the sharp dolomite contact – placement of the boundary might be accomplished with little disagreement, but conodont data, although very difficult to obtain, probably remains the most definitive measure.

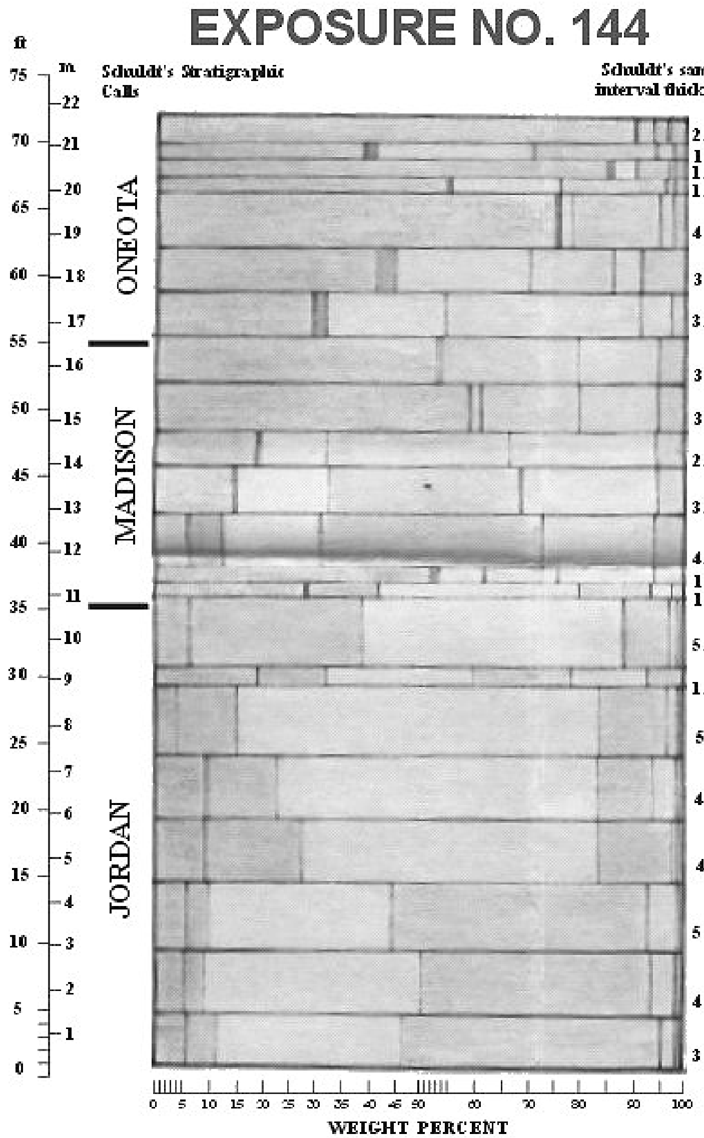
Figure 1. Photograph of the Point Ann North Jordan Sandstone exposure, McGregor

THE POINT ANN SECTIONS

The last stops of the day will focus on looking at the upper half of the Jordan Formation in the downtown area of McGregor. The outcrops in town are well exposed and are unique in that they are the southern most exposures of the Jordan in Iowa before the formation dips into the subsurface. For the time being the Geological Survey is including the carbonate dominated Coon Valley transitional strata in the Oneota Formation. In doing so the thickness of the

W34814 POINT ANN NORTH OUTCROP, McGregor, Iowa
SE SE SE Sec. 22, T95N R3W Clayton County

FROM: W. SCHULDT THESIS, 1940 (SUI); Plate IV



Schuldt's Sand Sieve Analysis in Percent

Schuldt's sample interval thickness	IR	VC	C	M	F	VF	SLT
2.1	89	---	1	3	3	1	3
1.3	38	1	1	31	24	3	2
1.4	85	---	1	5	6	1	2
1.1	54	---	1	21	20	2	2
41	76	---	1	2	17	2	2
3.4	42	---	3	26	16	5	8
3.4	28	1	2	23	38	6	2
3.5	53	---	---	1	26	16	4
3.8	60	---	1	2	18	15	4
2.7	17	---	1	12	36	29	5
3.6	14	---	1	16	37	27	5
4.0	6	1	5	18	44	21	5
1.3	53	---	2	8	14	18	5
11	28	1	13	39	13	4	2
51	6	1	32	51	7	2	1
1.5	19	1	11	29	18	15	7
51	4	---	11	69	13	2	1
4.8	9	1	12	62	10	5	1
4.8	8	1	18	57	15	1	1
51	5	1	4	35	49	5	1
4.8	5	1	3	40	46	4	1
3.9	5	1	5	36	49	3	1

Figure 2. Grain size analysis of Jordan Sandstone from the Point Ann North outcrop. From Schuldt (1943).

Jordan in the McGregor area becomes approximately 100 feet, the upper 40 feet of which is exposed in town. Several wells in town, in particular city well #6 (W5311) at the north end of Main Street, indicate that there is about 50 to 60 feet of friable sandstone The first stop will be at the north end of Point Ann, a promontory above the grain terminal. There are actually two sections along this bluff, Point Ann South and Point Ann North (Fig. 1). The north section is the same location as exposure number 144 from

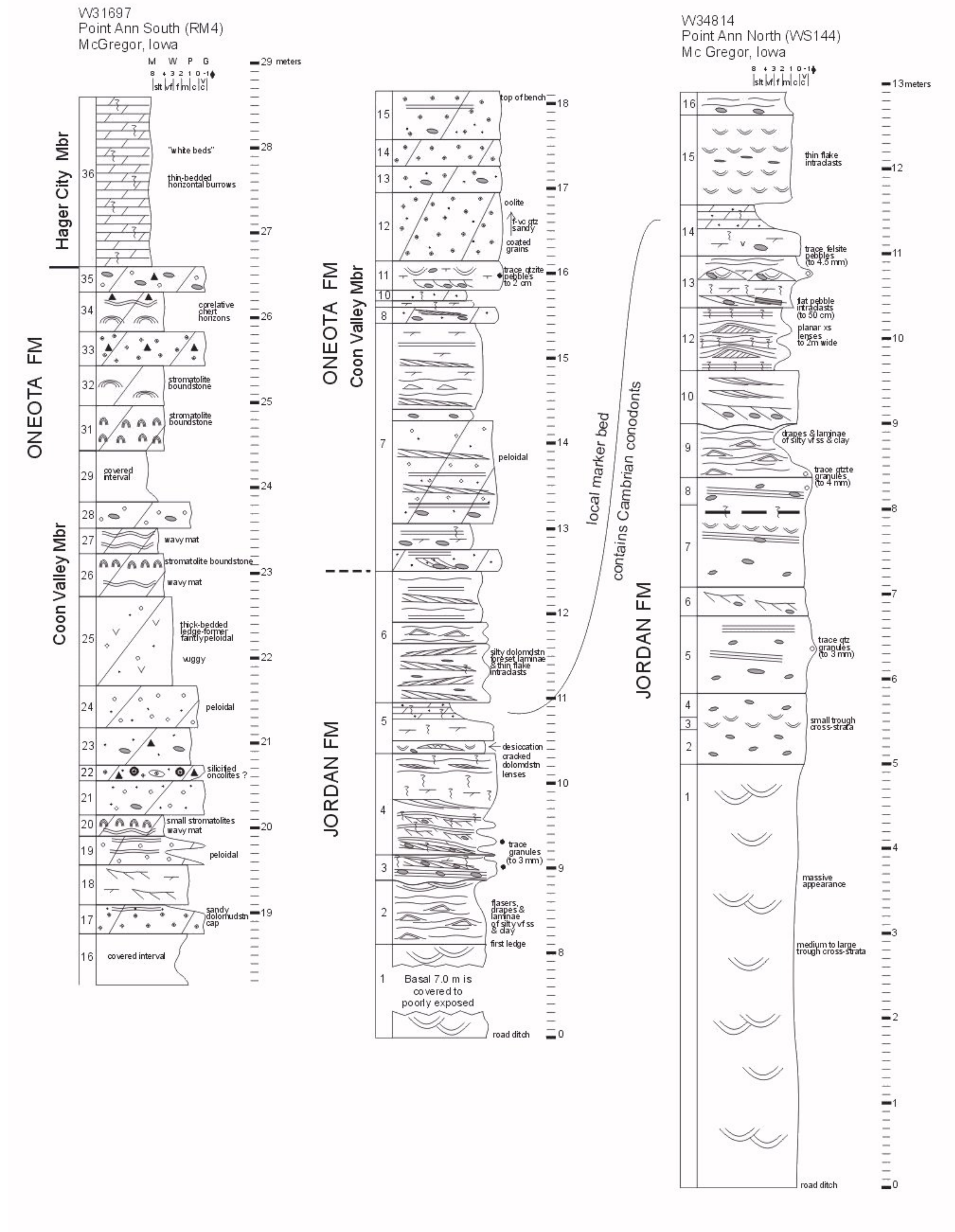


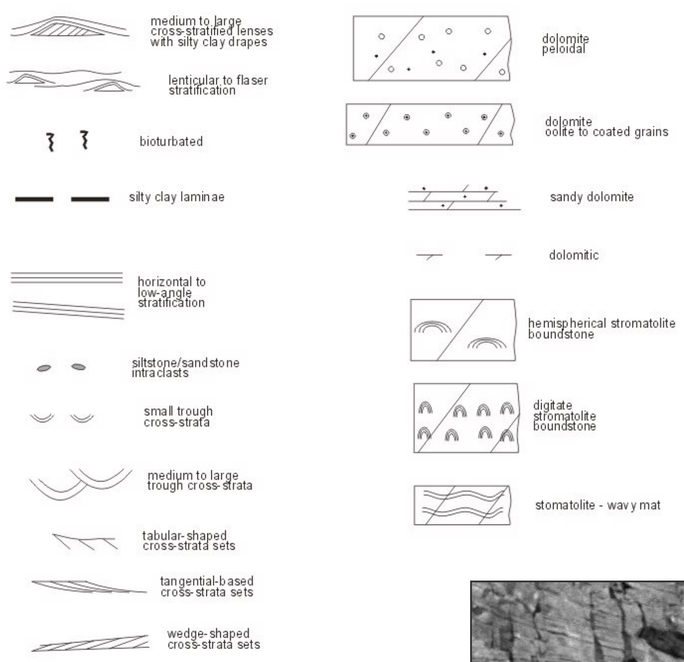
Figure 3. Composited graphic sections of Jordan Sandstone exposures from Point Ann North and South.

Walter Schuldt's thesis, and his graphical display of grain size analysis from this section is illustrated in figure 2. The more recent measured sections from these exposures are composited in figure 3. We will not visit the section at the south end of Point Ann but it is that section that provides the better accessibility to the uppermost Jordan and overlying Coon Valley. Schuldt's grain size and insoluble residue analysis was used to provide criteria for his separation of the Madison from the Jordan. At this locality he placed the contact where a medium and coarse-sand dominated unit is overlain by units having 28 and 53 percent insoluble residue (Fig. 2).

Figure 4. Cross-stratified lenses draped by partially *Skolithos* burrowed laminated finer sands and silts in Unit 12, Point Ann North exposure.

The first 5 meters of section at Point Ann North appears as a massive sandstone unit. Upon closer examination one can see that the sandstone is highly cross-stratified with medium to large-scale highly truncated trough cross-strata. This lithofacies is widespread in the Jordan of Minnesota and Wisconsin and typifies the middle portion of the Jordan throughout the area. Both Runkel (1994) and Byers and Dott (1995) interpret this facies as having developed during a relative shallowing of the Jordan seaway to a middle shoreface environment where storm-enhanced current energy regularly impinged the sandy ocean seafloor and molded the bottom into vast dune fields. The dunes dominant migration direction, as indicated by the azimuth of the trough axes, varied from southeast to southwest. The 5 to 8.5 meter portion of the exposure is characterized by coarser sand with abundant siltstone to very fine sandstone intraclasts. This coarser-grained lithofacies is in the same stratigraphic position as the large-scale cross-stratified facies of both Runkel (1994) and Byers and Dott (1995), but meter-scale medium to high-angle cross-beds are not apparent at this locality. Instead the strata are dominated by horizontal to large-scale low-angle stratification with common to abundant intraclasts intercalated with sets of smaller scale cross-strata. Although not readily apparent, this style of stratification may well be part of larger-scale composite bed forms that are only clearly discernable across larger, better-exposed outcrops. Alternatively, the strata are what they look like, horizontal to low-angle stratified sets of intraclast-rich coarse sandstone. In either case they almost totally lack slack-water bioturbation features and represent deposition under a frequent and energetic current regime. In other outcrops in town broad low-angle decameter wide truncation surfaces are present at this horizon. All these features are consistent with the interpretation that these strata were deposited in an energetic upper shoreface environment similar to that envisioned by Runkel (1994) and Byers and Dott (1995) for the upper part of the Jordan in the areas of their studies.

The remainder of this exposure (units 9 to 16) is accessible along the steep and sandy talus slope. It consists mainly of interbedded flasered to lenticular cross-stratified and biotubated sandstone sets that are suggestive of deposition under a tidal-current regime and perhaps represent deposits of a tidal flat. Runkel (1994) mentioned that at one outcrop in Minnesota there appeared a lithofacies with similar features suggestive of tidal flat deposition. Unit 12 is particularly interesting in that it consists of cross-stratified lenses, up to 2 meters wide, that are draped by partially *Skolithos* burrowed laminated finer



Legend for Figures 3 and 7

sands and silts (Fig. 4). These lenses could represent starved large ripples deposited on a tidal flat during spring tides with the finer-grained drapes having been deposited during the weaker neap tides.

Unit 14 represents a change in sedimentation style from the strata below. It corresponds to the high insoluble residue units in Schuldt's section at 11 meters, the base of what he called the Madison Formation. The lower part of the unit is dolomitic sandstone while the upper part consists of 3 to 5 thin beds of bioturbated, silty to fine-sandy dolomite. This unit forms a local marker bed in this portion of the county and can be traced as far north as Yellow River State Forest. Dr. James F. Miller, from Southwest Missouri State University, has processed samples of this unit from Point Ann South and from an outcrop adjacent to our next stop and has recovered the Cambrian conodonts *Eoconodontus notchpeakensis* and *Proconodontus muelleri* from both sets of samples. This is interesting in that although the unit is a dolomite it contains Cambrian, not Early Ordovican conodonts, and thus represents the only dolomite from the upper Jordan formation of the outcrop belt that is demonstrably Cambrian in age. The large Cambrian-Ordovician hiatus demonstrated by Runkel et al. (1999) must lie above this dolomite, and preliminary work suggests it may reside at the unit 6-unit 7 contact (Fig. 5) in the Point Ann South section, but further work remains before this conjecture is conclusive.

We will not visit the section at Point Ann South but as figure 3 illustrates the section continues upward through well-exposed Coon Valley strata into the pure dolomites of the Hager City Member. The

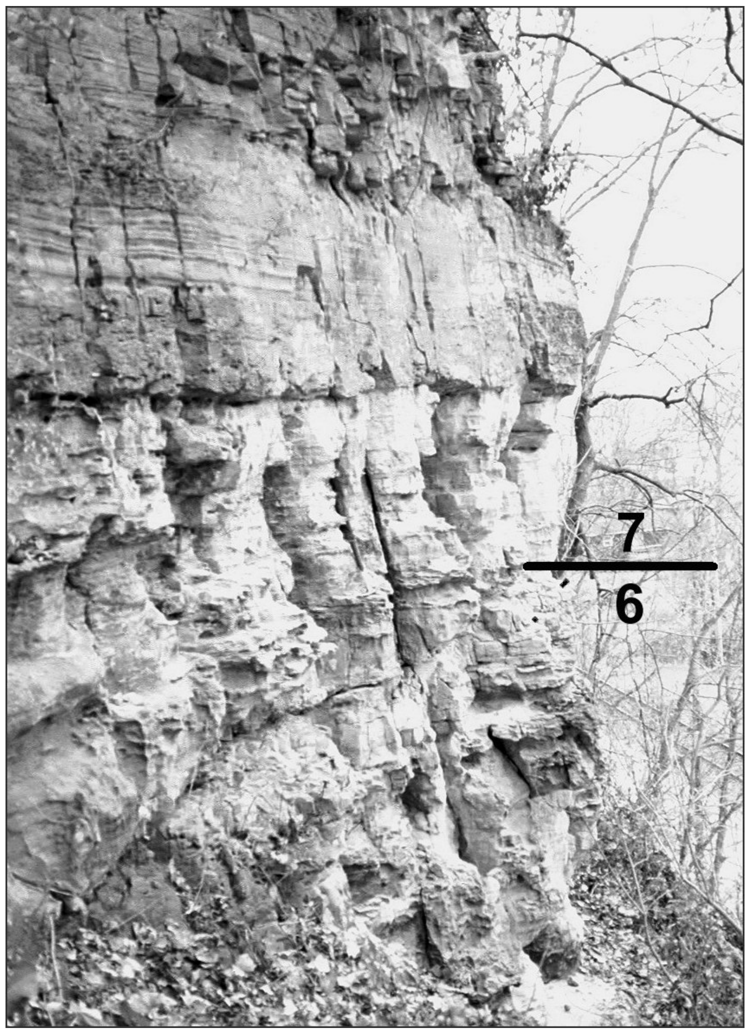


Figure 5. The contact between Unit 6 and Unit 7 in the Jordan Sandstone at Point Ann North, McGregor, may correspond to the Cambrian-Ordovician boundary.

Coon Valley here is similar to many other Coon Valley sections and is dominated by sandy peloidal and oolitic grainstones, several types of stromatolite boundstones, and dolomitic sandstone. Cherts occur in the upper half and two locally traceable chert horizons occur near the top of the member. The lower contact of the Coon Valley is placed at the base of unit 7 where highly intraclastic sandy dolomites sharply overlie variably stratified sandstone (Fig. 5). A quartz and metasediment pebble lag, similar to that described by Runkel (1994), has not been identified at this suggested contact, and only one indeterminate conodont element with Ordovician affinities has to date been recovered from unit 15 by Jim Miller, so the contact may yet be adjusted.

THE "A" STREET SECTION

From the grain terminal we'll walk over to "A" Street and view an almost identical Jordan section to that at Point Ann North but one that is more readily accessible (Figs. 6 and 7). This section is now maintained as a small city park but is actually owned by the state. The lower portion of the section is composed of medium to large scale trough cross strata with minor to abundant intraclasts. The sandstone is friable but stands well vertically because it is very weakly cemented by minute amounts of silt size dolomite rhombs. These two characteristics made the unit ideal for excavation with simple hand tools by the early settlers of McGregor, and numerous "caverns" and storage rooms were excavated during the 19'th century (McKay, 1997). Towards the western end of the exposure is the remains of an old brick lined cistern that was dug into the friable sandstone.

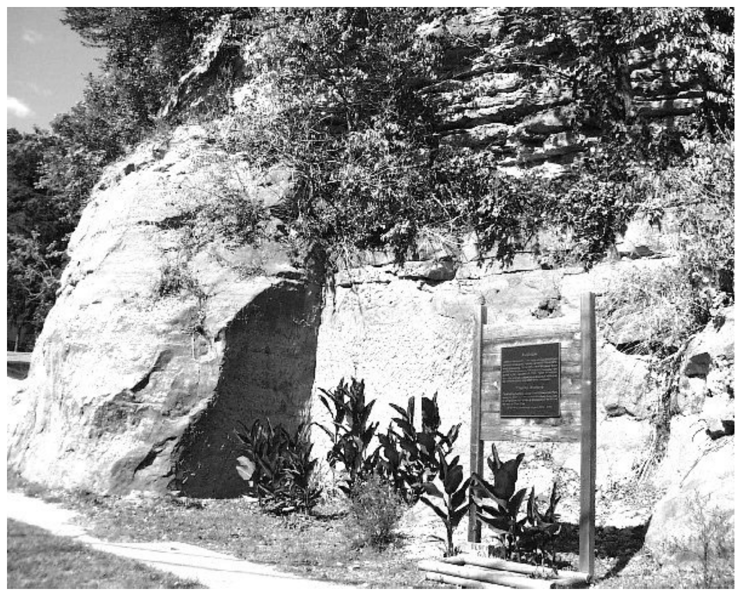


Figure 6. The A-Street Exposure of the Jordan Sandstone, McGregor

The excavations don't trend higher in the section than units 4 and 5, the distinctive recessive thin beds at the base of the main ledge. Those units display some rather rare clay draped form symmetrical ripples and overturned to contorted small cross strata, and contain a rather high concentration of small quartz pebbles near the base. The concentration of small pebbles at the base of unit 4 coupled with its' sharp lower contact initially led to the hypothesis that this contact might represent the Cambrian-Ordovician boundary; that proved not to be the case. Both unit 4 and 5 have been unsuccessfully processed for conodonts, however samples of the local dolomite marker bed of unit 8 have yielded the Cambrian conodonts *Eoconodontus notchpeakensis* and *Proconodontus muelleri* (Dr. Jim Miller email correspondance).

The occurrence of both symmetrical ripple lenses, clay flasers, and unidirectional cross sets in units 4 and 5 (Fig. 8) attest to deposition under waxing and waning orbital and asymmetrical current regimes, and the cross laminae and clay laminae deformation suggests rapid deposition followed by some type of loading. Units 6 and 7 contain stratification very similar to units 10 through 13 at Point Ann North; multiple sets of small to medium scale cross strata or cross stratified lenses separated by variably *Skolithos* burrowed laminated finer sands. Again, these structures are very suggestive of deposition under the ebb and flood of a tidal current regime, and may represent the spring and neap tide current deposits of a tidal flat. So one interpretation of the depositional setting of this section would be that it represents the deposits of an energetic upper shoreface environment overlain by a tidal flat that prograded across the shoreface. The overlying conodont bearing dolomite marker bed of unit 8 is silty to fine sandy and moderately bioturbated and must have been formed under distinctly different conditions. These features suggest deposition under a substantially less energetic setting experiencing a significantly slower rate of sedimentation that allowed for disturbance of the substrate by burrowing infauna. These conditions could have been created within a lagoon behind the tidal flat or more likely may represent deposits of quieter water conditions following a transgression of the seaway and deepening of the water column.

Figure 8. Symmetrical ripple lenses, clay flasers, and unidirectional cross sets in units 4 and 5 of the Jordan Sandstone at the A-Street Exposure, McGregor.

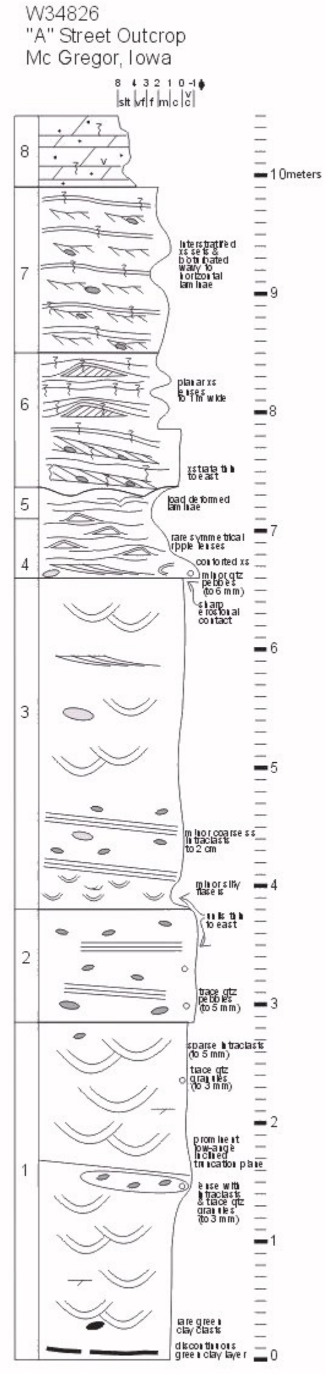


Figure 7, Graphic section of Jordan Sandstone at the A-Street Section, McGregor. (see Fig. 3 for explanation of symbols)

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A PROFILE OF THE MID-CARADOC (ORDOVICIAN) CARBON ISOTOPE EXCURSION AT THE McGREGOR QUARRY, CLAYTON COUNTY, IOWA

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N.R. Emerson, S.J. Carpenter, and L.A. González

Abstract

Carbonate $\delta^{13}C$ profiles of a mid-Caradoc carbon isotope excursion are compared between three exposed stratigraphic sections: the McGregor Quarry in Clayton County, Iowa, the Dickeyville North Roadcut section in Grant County, Wisconsin, and the Eureka Roadcut section in St. Louis County, Missouri.

Introduction

The Earth Sciences remain in a period of discovery of carbon isotope excursions, geologically brief episodes of changes in the $^{13}C/^{12}C$ ratios of inorganic and organic carbon in stratigraphic successions of sedimentary rocks, recording global perturbations in the carbon cycle (Kump and Arthur, 1999). A positive carbon isotope excursion first recognized in the Middle Ordovician Decorah Formation of eastern Iowa (Hatch et al., 1987; Ludvigson et al., 1996) has since been recognized in correlative carbonate strata in Pennsylvania (Patzkowsky et al., 1997) and Estonia (Ainsaar et al., 1999). Widespread appearance of this chemostratigraphic event, along with a coincident decrease in $\delta^{13}C_{carbonate}$-$\delta^{13}C_{organic\ matter}$ values ($\Delta^{13}C$) during the excursion (Patzkowsky et al., 1997; Kump and Arthur, 1999) suggest that the event was global in extent, recording a brief drawdown of atmospheric pCO_2 resulting from increased marine organic carbon burial. Recent analysis of the carbon isotopic chemistry of chlorophyll-based photosynthetic biomarkers in the discovery site in eastern Iowa, the Cominco Millbrook Farms SS-9 drillcore (IGSB site W-27581) by Pancost et al., (1998, 1999,), shows the same $\Delta^{13}C$

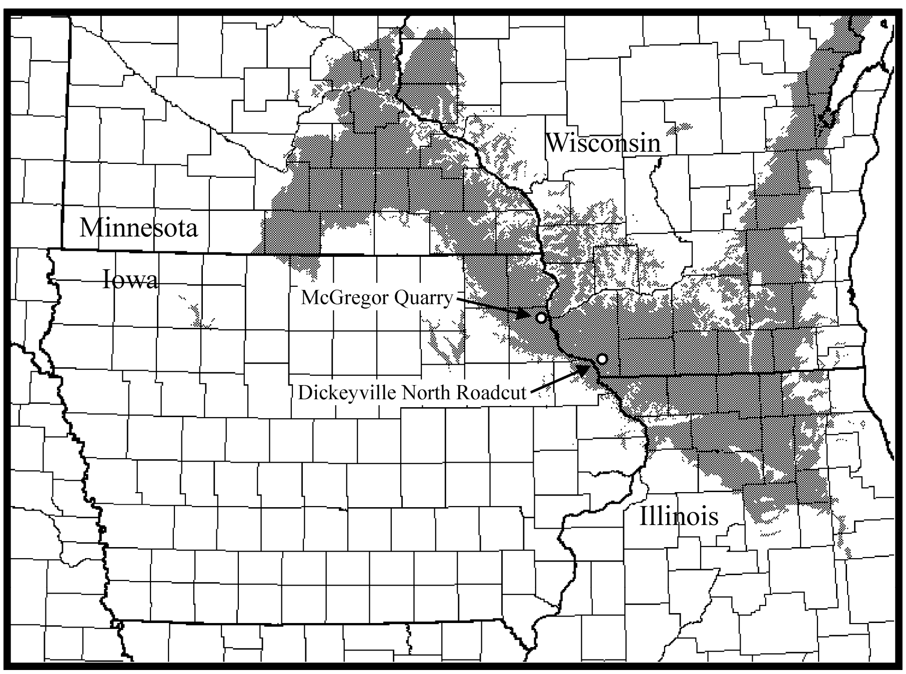

Figure 1. Location map showing the McGregor Quarry and the Dickeyville North Roadcut sections. The Eureka, Missouri, roadcut section is located to the southwest of St. Louis in east-central Missouri. Shaded area shows Ordovician outcrop belt.

values detected by Patzkowsky et al. (1997) in Pennsylvania, further supporting the idea that the event recorded a global drawdown in atmopheric pCO_2.

We recently embarked on an effort to characterize changes in the local expression of this carbon isotope excursion along a transect perpendicular to the ancient shoreline (Ludvigson et al., 2000; Smith et al., 2000). This transect extends from stratigraphic sections in southeastern Minnesota through eastern Iowa into western Illinois, ending in southeastern Illinois. The rock strata containing the excursion interval have been proposed to starve out in offshore settings along this cross section line by Ludvigson et al. (1996) and Kolata et al. (1998). While most of this work has involved studies of curated drillcores, we have also collected from exposed sections that contain widely-correlated volcanic ash beds of the Hagan K-bentonite complex, including the 454±0.5 Ma Deicke and 453.7±1.3 Ma Millbrig K-bentonites (Kolata et al., 1998). Studies of these sections permit refined chronostratigraphic correlations that have enabled us to assess local changes in the expression of the carbon isotope excursion (Smith et al., 2000). Among the surface sections that we have collected are the McGregor Quarry section adjacent to Pikes Peak State Park, the Dickeyville North Roadcut section in southwest Wisconsin, and the Eureka Roadcut section in southern Missouri. Comparisons between the lithostratigraphy and carbon isotope profiles of these sections are the subject of this paper.

All isotope analyses reported in this paper were performed at the Paul H. Nelson Stable Isotope Laboratory in the Department of Geoscience at The University of Iowa. Ludvigson et al. (1996) showed that the $\delta^{13}C$ excursion signal in this interval resides in micritic components, and for this study, powdered carbonate samples were milled by dental drill bit from micritic domains in hand samples. Powdered carbonate samples were reacted with anhydrous phosphoric acid at 74 ºC in a Kiel III automated carbonate reaction device coupled to the inlet of a Finnigan MAT 252 stable isotope ratio mass spectrometer. The analytical precision of reported $\delta^{13}C$ values relative to the PDB standard is better than 0.05 ‰.

The McGregor Quarry Section

The McGregor Quarry section exposes all of the Decorah Formation and its bounding units (Fig. 2). High wall exposures of the Platteville Formation were sampled along a talus cone in the southern part of the quarry, and the Decorah Formation and overlying strata of the Dunleith Formation were sampled above a bench at the top of the Platteville. The best exposures of the Spechts Ferry Member of the Decorah Formation are only accessible on life-threatening slopes, and thus the sampling frequency in this interval was lower than in other units in the section.

Uppermost Platteville strata below the Deicke K-bentonite in the McGregor Quarry show baseline $\delta^{13}C$ values between –2 to –1.5 ‰ (Fig. 2). Carbonate beds immediately above the Deicke show an abrupt negative shift to a value less than –3 ‰, followed by a positive shift in the interval below and immediately above the Millbrig K-bentonite. As noted in other sections in the area (Ludvigson et al., 1996), the interval of the Spechts Ferry Member often includes a negative carbon isotope excursion, and this is also evident in the section at the McGregor Quarry. Above this negative excursion is an interval showing an abrupt positive excursion reaching to $\delta^{13}C$ values above +1 ‰ in the uppermost beds of the Spechts Ferry Member and at the base of the Guttenberg Member, just above the position of the Elkport K-bentonite (Fig. 2).

Multiple positive $\delta^{13}C$ peaks have previously been noted in the Guttenberg Member (Ludvigson et al., 1996), and the high stratigraphic sampling frequency in this interval at the McGregor Quarry shows a systematic organization into two well-defined positive peaks with values greater than +1 ‰, separated by a negative shift reaching to a value less than 0 ‰ PDB (Fig. 2). The two positive peaks occur below the position of a possible bentonite occurrence in the upper Guttenberg Member (?Dickeyville? K-bentonite). Upward from this position, $\delta^{13}C$ values undergo a steady decline in baseline values from about 0 to –1 ‰ (Fig. 2). The uppermost beds of the Ion Member appear to show an abrupt positive shift of about 1 per mil that interrupts this mostly steady decline in $\delta^{13}C$ values.

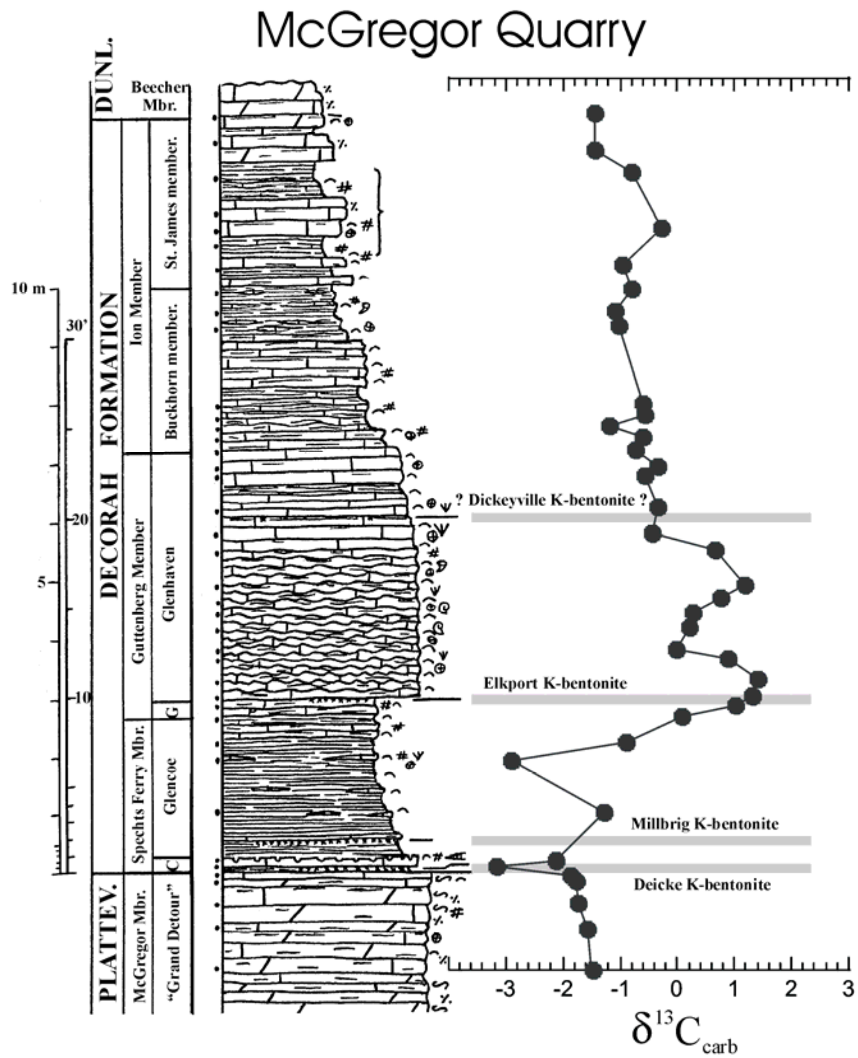

Figure 2. Graphic log of the McGregor Quarry section, showing a matching carbon isotope profile of sampled carbonate beds.

The Dickeyville North Section, Southwest Wisconsin

The Dickeyville North Roadcut Section (locality 40 of Kolata et al., 1986) exposes uppermost strata of the Platteville Formation and much of the Decorah Formation (Fig. 3). In this section, uppermost Platteville strata have baseline $\delta^{13}C$ values of a little less than –1 ‰, about the same as in the McGregor Quarry section. Unlike the profile in the McGregor Quarry, the profile from the Dickeyville section shows no negative shift in $\delta^{13}C$ values at the position of the Deicke K-bentonite. Instead, an abrupt positive shift in $\delta^{13}C$ values begins just below the Deicke, and continues to a position just above the Millbrig K-bentonite (Fig. 3). This lower positive carbon isotope exursion interval is a common feature observed in many profiles (Smith et al., 2000) that we have sampled.

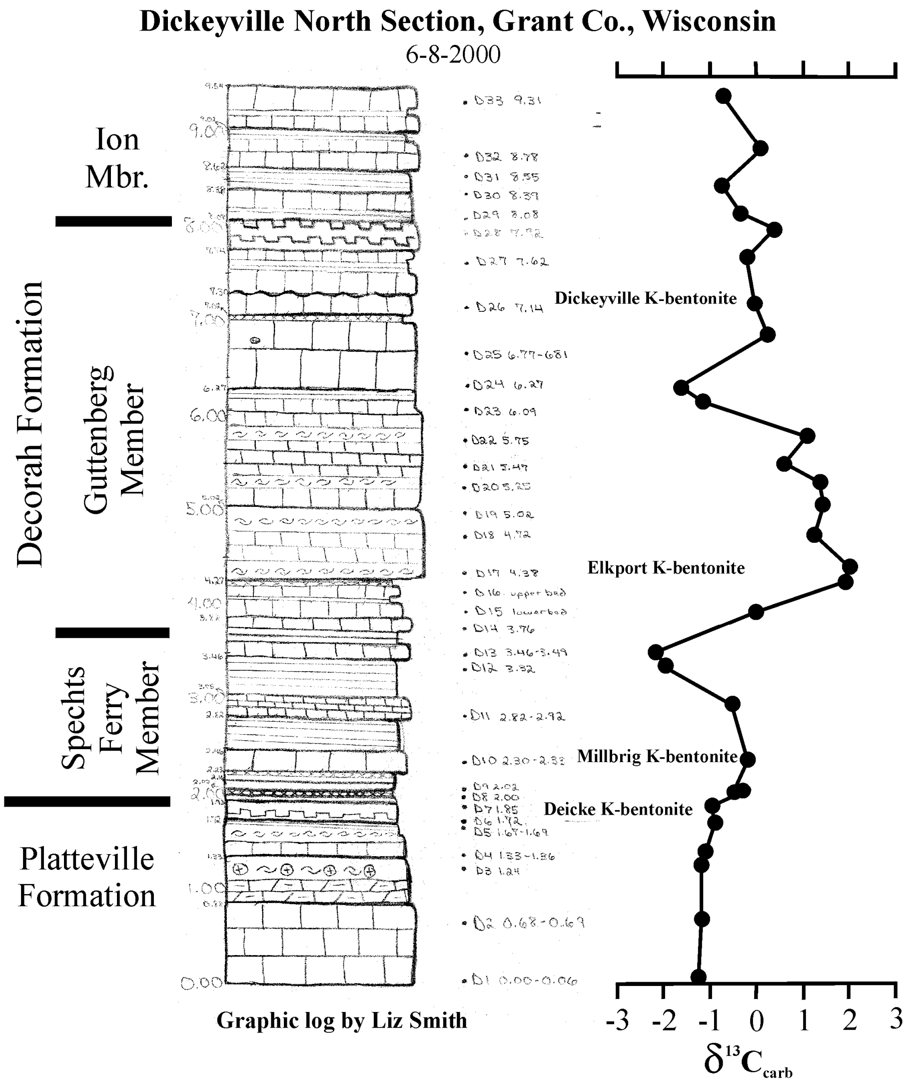

Figure 3. Graphic log of the Dickeyville North Roadcut section, showing the carbon isotope profile of sampled carbonate beds.

As was the case in the McGregor Quarry section, a negative shift to $\delta^{13}C$ values less than –2 ‰ occurs in the Spechts Ferry Member at the Dickeyville section, followed by a positive excursion to peak values of about +2 ‰ (Fig. 3). The dual positive peaks seen at the McGregor Quarry section are not evident at the Dickeyville section. Instead, a broad-shouldered positive excursion is succeeded by a negative shift to $\delta^{13}C$ values less than –1 ‰ below the Dickeyville K-bentonite. Above the Dickeyville K-bentonite, the profile returns to baseline values mostly between –1 to 0 ‰ PDB (Fig 3).

The Eureka, Missouri, Roadcut Section

Longer-range correlation of the carbon isotope excursion within the North American midcontinent region is shown by comparison to the $\delta^{13}C$ profile at Eureka, Missouri. The Eureka, Missouri roadcut section (locality 217 of Kolata et al., 1996; archived collection stored as IGSB site W-31225) exposes the Spechts Ferry Formation, and the Kings Lake/Guttenberg limestones and their bounding units (Fig. 4;

stratigraphic terminology after Thompson, 1991). In this section, uppermost strata of the Plattin Group have variable $\delta^{13}C$ values that range between less than –1 to a little less than 0 ‰ PDB (Fig. 4). A positive excursion in $\delta^{13}C$ values begins below the position of the Deicke K-bentonite and extends upward to the position of the Millbrig K-bentonite, with peak values of about +0.5 ‰ (Fig. 4). As in the other sections discussed above, a negative shift, in this case to $\delta^{13}C$ values of about –0.5 ‰, occurs in the upper part of the Glencoe Shale Member of the Spechts Ferry Formation, and is immediately succeeded by the major positive shift in $\delta^{13}C$ values, with peak values ranging up to +2 ‰ in the lower part of the Kings Lake/Guttenberg interval (Fig. 4). Multiple positive peaks are present in this interval at Eureka, although from the present stratigraphic sampling density, it is unclear whether these shifts are organized into systematic, well-organized trends (Fig. 4). In the upper part of the Kings Lake/Guttenberg interval, $\delta^{13}C$ values decrease back to baseline values less than –0.5 ‰ in the basal Kimmswick Limestone.

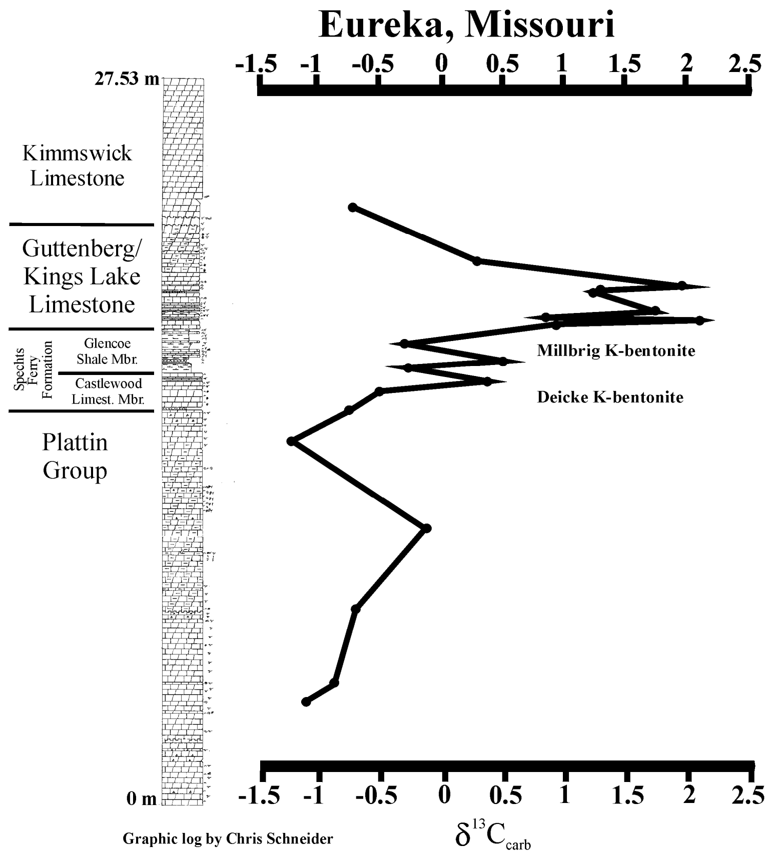

Figure 4. Graphic log of the Eureka, Missouri roadcut section, showing the carbon isotope profile of sampled carbonate beds.

Discussion

The similarity of the carbon isotope profile at Eureka, Missouri to those we have described from the Upper Mississippi Valley (McGregor and Dickeyville sections) raises questions about the validity of the Kings Lake Limestone of Missouri as a genetically distinct unit, and proposed unconformable relationships with overlying strata of the Guttenberg Limestone (as originally proposed by Herbert, 1949, and outlined in Kolata et al., 1986, and Thompson, 1991, p. 172-182). The most distinctive feature shared between all three sections is the major positive shift in $\delta^{13}C$ values at the contact between the Spechts Ferry interval and the immediately overlying carbonates. This chemostratigraphic correlation suggests that the "Kings Lake Limestone" at Eureka is a direct time-stratigraphic correlate to the lower part of the Guttenberg Member at the McGregor and Dickeyville sections.

Carbon isotope profiles from all three sections show that a lower positive carbon isotope excursion of lesser magnitude is present in the strata between the Deicke and Millbrig K-bentonites, and immediately overlying strata (figs. 2, 3, and 4). This lower positive $\delta^{13}C$ excursion is always separated from the major positive $\delta^{13}C$ excursion to maximum values (which begins at about the position of the Elkport K-bentonite) by a negative shift in values in the Spechts Ferry interval. Our continuing studies in cored sections show that this lower positive excursion reaches maximum values of up to +1.5 ‰ in sections where the overlying positive excursion reaches maximum values of up to +2.5 ‰. In many sections, the onset of the lower excursion begins well below the position of the Deicke K-bentonite (Smith et al., 2000). The sequence stratigraphic significance of the Carimona-Castlewood carbonates below the shales of the Spechts Ferry is a continuing focus of this research. This interval may be bounded by an underlying sequence boundary, as suggested by Ludvigson et al. (1996).

Acknowledgments

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ANDREW CLEMENS SAND ART

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Along the drainage below Bridal Veil Falls, in a wooded glen known as 'Pictured Rocks', the Saint Peter Sandstone that is exposed here displays numerous tints of red, yellow, and gray that shade into white (see Plate 3, on the following pages). The colors are produced by small amounts of minerals, mostly iron oxide, that have percolated down from overlying rocks and were deposited in the sandstone. These colored sands were the source of material for Andrew Clemens' sand paintings.

Figure 1. Photograph of Andrew Clemens. Photo from *The Sandbottles of Andrew Clemens.*

Andrew Clemens (Fig. 1) was born on January 29, 1852. He became deaf at age 5, the result of a serious illness known then as "brain fever." When he turned 13, he attended the State School for the Deaf and Dumb in Council Bluffs.

During summer vacations, he created his technique for sand paintings. Clemens collected the sand from 'Pictured Rocks' and allowed the sand to dry. He separated the dry sand into piles of uniform grains of each color. These naturally colored grains formed the basis for Clemens' sand paintings. To create his sand paintings, Clemens used only a few tools: brushes made from hickory sticks, a curved fish hook stick, and a tiny tin scoop to hold sand. His sand paintings ranged from original designs to reproductions of images from photographs.

Because the majority of the bottles that Clemens used were round-top drug jars, he painted his designs upside down. Clemens inserted the sand using the fish hook stick. The brushes were used to keep the picture straight. No glue was used in the process; the sand was only held in place by pressure from other sand grains. Once a design was completed and the bottle was full, the bottle was sealed with a stopper.

Clemens originally sold his sand paintings in the McGregor grocery store. A small bottle sold for $1; a larger personalized bottle sold for $6-$8. The popularity of his sand paintings increased as travelers and steamboat agents purchased the bottles as souvenirs. Eventually, orders for his bottles became world-wide. Although he created mostly original designs, he also did reproductions.

Some of Clemens' work is on display in the McGregor Historical Musuem and in the State Historical Building. Photos of three of Clemens' bottles are reproduced on Plate 2 on the following pages, and more can be seen on *The Sandbottles of Andrew Clemens* website (see references below).

Reference

The Sandbottles of Andrew Clemens: http://www.geocities.com/kaos1010/gallery/home.html

Plate 1. Photograph of the color diorama in Iowa Hall of the University of Iowa Museum of Natural History depicting two Native Americans at the Pikes Peak overlook site observing the arrival of Marquette and Joliet at the confluence of the Wisconsin and Mississippi rivers.

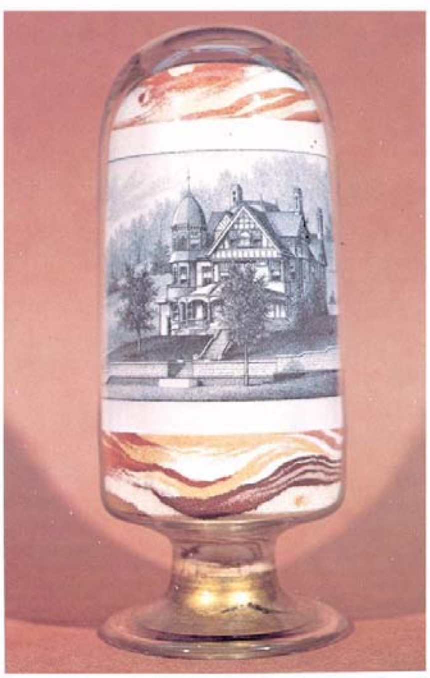


Plate 2. Photograph of sand art created by Andrew Clemens using sand from the sand cave area of Pikes Peak. **a**. depicts the William Huntting home in McGregor

b. shows George Washington on horseback, and **c.** shows the Seal of Iowa and several scenes from Iowa history (Photos **b** and **c** from the State of Historical Society.

a.

b.

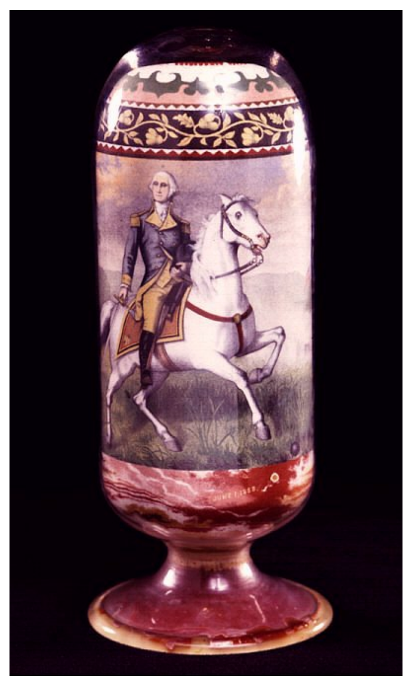
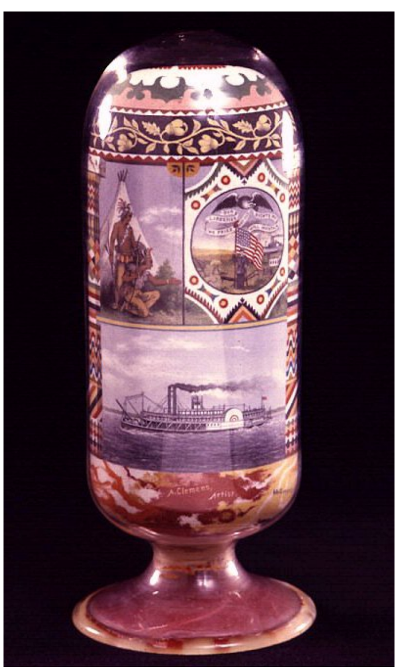


Plate 3. Iron oxide banding (liesegang) in St. Peter Sandstone near Sand Cave in Pikes Peak State Park. Image depicts an area about 20 inches wide



C.

QUATERNARY GEOLOGY OF THE PALEOZOIC PLATEAU REGION OF NORTHEASTERN IOWA

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INTRODUCTION

Pikes Peak State Park is situated along the Mississippi River in Clayton County. The physiographic region surrounding Pikes Peak State Park is markedly different from other landform regions of Iowa. Most notably are the steep-sided cliffs, bluffs, deeply entrenched stream valleys, and karst features. In contrast to other parts of the state where glacial cover dominates, the surficial character of this area is bedrock controlled. The scarcity of glacial deposits led to the original term "Driftless Area", indicating that the area had never been glaciated. However, later studies disproved this idea and the term "Paleozoic Plateau" was applied (Prior, 1976). Many researchers still use the term Driftless Area in their descriptions due to the limited exposures of glacial materials in this region.

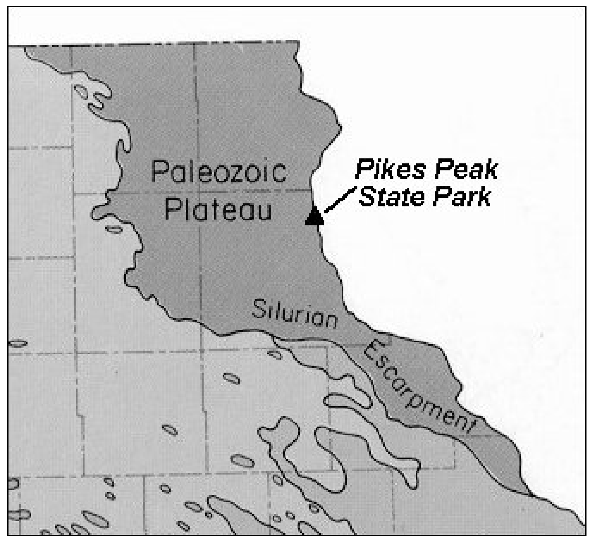

Figure 1. The area now known as the Paleozoic Plateau was formerly called the "driftless area".

EARLY STUDIES OF NORTHEASTERN IOWA - THE "DRIFTLESS AREA"

The landscape region of northeast Iowa was originally termed the "Driftless Area" due to the belief that this area had never been glaciated. Later studies indicated this was not the case, and it was termed the Paleozoic Plateau (Prior, 1976). The first geological investigations of the area were completed during the 1840's under the direction of David Dale Owen (in Calvin, 1894). In 1862, Whitney was the first to document a Driftless Area in Iowa, Wisconsin, Minnesota, and Illinois and produced a map depicting this region. Chamberlain (1883) and Chamberlain and Salisbury (1886) later used the western line of Whitney's map in their mapping of the Driftless Area boundary in Iowa. They also noted a "pebbly border of earlier drift" in all except a few townships. Although the researchers recognized this drift as foreign material, they did not believe these materials had been deposited directly by the ice, and thought they were possibly ice-rafted debris or the result of floodwaters.

Numerous studies and maps were published for this region by the Iowa Geological Survey from 1892 through the early 1900's. McGee (1891) and Calvin (1894, 1906) recognized upland glacial materials and granite boulders, but did not consider them to be "proper" drift. Other studies described glacial outwash materials and boulders of non-native origin, but they were not determined to be directly deposited by glaciers. Due to the lack of glacially deposited materials, the high relief, and the extensive bedrock exposures, all these investigations led to the same conclusion- that the northeastern region of Iowa had not been glaciated.

While working on a Master's thesis, A. J. Williams documented 80 patches of glacial drift in what had previously been called the Driftless Area. Due to the upland position of the drift and the differences between these materials and the Kansan drift to the west, he believed these deposits were Nebraskan in age. Prior to the completion of his PhD in 1923, a field conference was held, and at its completion researchers generally agreed that the drift east of the Kansan border was in fact deposited by a glacier and that the Kansan occurs both in the valleys and on the uplands. Kay and Apfel (1928) later published Williams' map showing the locations of upland drift in northeastern Iowa. From then on the area was mapped as Nebraskan and no truly driftless area was recognized in Iowa.

In 1966, Trowbridge published a summary of previous works and included additional data from his studies of the region. In all, Trowbridge documented more than 100 occurrences of glacial drift and determined that these materials are till and not outwash. Trowbridge's research further supported the idea that areas in northeast Iowa previously considered "driftless" by researchers had been glaciated.

The term Driftless Area came into being and was commonly used as a term to describe the region of high relief, heavily dissected, bedrock-controlled landscape of northeastern Iowa. The original area designated as the Driftless Area was much smaller than the region of rugged topography and associated flora and fauna commonly referred to by natural scientists. Therefore it was incorporated into a much larger area than initially defined and termed the Paleozoic Plateau. Within this larger area, many remnants of glacial drift are identified (Williams, 1923; Trowbridge, 1966), making the terminology "Driftless Area" incorrect. The term Paleozoic Plateau (Prior, 1976) is a better description for this physiographic region and incorporates the much larger topographically and ecologically similar area referred to by natural scientists and biologists.

GENERAL DESCRIPTION OF THE PALEOZOIC PLATEAU

The Paleozoic Plateau region has distinct physiographic features that separate it from any of the other landform regions in Iowa. The boundaries of this landform region are defined along the southern and western margins with the change from a rugged, dissected, rock-controlled landscape to that of the gently rolling, lower relief landscapes of the Iowan Erosion Surface to the west and the Southern Iowa Drift Plain to the south.

The Quaternary deposits of the Paleozoic Plateau are characterized by loess covered patches of isolated glacial till. Generally this area is a bedrock controlled terrain with deeply entrenched valleys, karst topography, and an integrated drainage network. The Paleozoic Plateau is unique as the only region of Iowa where bedrock dominates the landscape. In all other regions of Iowa the landscape features are dominated by unconsolidated materials and landforms (or dissections of them) including glacial materials, loess, and alluvium.

The characteristic features of the Paleozoic Plateau are representative of deep dissection by streams through gently inclined Paleozoic rock units with varying resistance to erosion. These rocks range in age from 350 to 600 million years old and include formations from the Devonian, Silurian, Ordovician, and Cambrian. The rocks dip gently to the southwest, exposing progressively older Paleozoic rock units in the northeast corner of the state. The more resistant rock types (sandstones, carbonates) form cliffs and escarpments high on the landscape whereas the more easily weatherable shales have gentler slopes. This differential weathering creates a landscape reflecting the local bedrock. Topography is also controlled by extensive karst development in this area forming caves, sinkholes, springs, and subsurface caverns.

In addition to the karst and other erosional features, the regional landform characteristics are also controlled by river development. The Mississippi River and its tributary valleys contain well preserved terraces, older floodplain deposit remnants, and entrenched and hanging meanders. All of these features indicate the complexity of the alluvial history and river development associated with glacial melting and drainage diversions.

The Paleozoic Plateau region is characterized by an abundance of bedrock exposures, deep and narrow valleys, and limited glacial deposits. The steep slopes, bluffs, abundant rock outcrops, waterfalls and rapids, sinkholes, springs, and entrenched stream valleys form a unique physiographic setting. These characteristics combine to form an area of many diverse microclimates that support varied flora and fauna communities not represented elsewhere in the state.

QUATERNARY MATERIALS IN THE PALEOZOIC PLATEAU

Glacial Till and Loess Deposits

The Paleozoic Plateau region was glaciated multiple times during the Pre-Illinoian. Willman and Frye (1969) identified two tills in Iowa as well as glacial outwash on upland surfaces in the Driftless Area of Illinois. Knox (1982) also showed that Pre-Illinoian till is present in the Wisconsin portion of the area east of the Mississippi River and holds that although there are driftless areas in parts of Wisconsin, that Iowa does not have driftless areas. Additionally, large parts of the Driftless Area in Minnesota show evidence of glaciation as well. Based on work by Hallberg (1980a) it has been determined that two Pre-Illinoian till units, the Wolf Creek and the Alburnett Formations, occur in the Paleozoic Plateau of Iowa.

The younger Wolf Creek Formation cannot be directly dated in northeast Iowa, but based on other studies it is younger than 600 ka, and it is estimated to be about 500 ka indicating the last time glacial ice advanced into this area (Hallberg and Boellstorff, 1978; Lineback, 1979; Hallberg, 1980b). Stream erosion and hillslope development since the last glaciation has resulted in the removal of most of the glacial materials, except those high on the divides, and has produced the dissected landscape we see today (Hallberg et al., 1984).

Upland surfaces are mantled with 3 to 6 meters of Wisconsin age loess which have been radiocarbon dated at 25.3 ± 0.65 ka (Hallberg et al., 1978). The end of loess deposition in Iowa is considered to be about 14 ka (Ruhe, 1969) and this coverage may obscure other glacial deposits. On the primary stream divides, 4 to 6 meters of loess overlies well-drained paleosols developed on Pre-Illinoian tills. The paleosols are generally 1 to 2 meters thick, but locally may be up to 2 to 5 meters thick. These thicknesses and other features are typical of Late-Sangamon paleosols. Yarmouth-Sangamon paleosols are only locally preserved on the divides. The Late-Sangamon paleosol and surface may truncate the Pre-Illinoian till and descend onto the Paleozoic bedrock. (Hallberg et al., 1984)

Mississippi River

Although many early studies suggested that the landform features of the Paleozoic Plateau are very old, more recent research indicates that the modern drainage system and dissected landscape of this region occurred during the Pleistocene. The oldest valley remnants are buried by Pre-Illinoian tills and may be middle to early Pleistocene in age, although the time of incision is not well constrained. Evidence is derived from studies of the upland stratigraphy and erosion, karst systems, fluvial and terrace deposits of the stream valleys, and the dating of speleothems.

Knox and Attig (1988) studied the Bridgeport terrace in the lower Wisconsin River valley, Wisconsin. Paleomagnetic dating of the Bridgeport terrace sediments indicate that they are older than 730 ka. The valley would have had to already be entrenched by this time, indicating a minimum age for these deposits. Therefore, they believe that the Mississippi River between northeast Iowa and southwestern Wisconsin was deeply entrenched by Pre-Illinoian time.

Research summarized in Hallberg et al. (1984) suggests that the Mississippi River and its tributaries are of middle Pleistocene age (500 ka). The major drainage lines were established by Late Sangamon time, however major stream incision probably began prior to the Illinoian. The Upper Mississippi River valley likely originated as an ice-marginal stream during what had been referred to as the "Nebraskan" glaciation. Current terminology would place this as Pre-Illinoian.

Figure 2. View up the Mississippi River from the Pikes Peak overlook. McGregor and the bridge at Marquette can be seen on the left; Prairie du Chien is visible on the right.

The relationship between karst deposits and Pre-Illinoian tills can also yield information regarding the landscape evolution of the Paleozoic Plateau area. Karst ages have been determined by radiometrically dating speleothems. Fifty speleothems in Minnesota and Iowa have been dated (Lively, 1983). A few dates range from 250 ka to greater than 350 ka, but the majority of the dates fall into three general groupings: 163-100 ka, 60-35 ka, and from 15 ka to present. Speleothem dates provide minimum ages on major valley downcutting, which lowered the piezometric surface and allowed speleothem growth in the vadose caves. Speleothem growth is episodic and partially controlled by climate.

Wisconsin time represented one of the main periods of valley entrenchment when bedrock-cored, cutoff meanders formed. During the formation of these deep valleys, periglacial activity formed colluvial slopes and karst features collapsed, creating a mantle of bedrock-derived rubble on the steep slopes of related valleys. Between 9 and 25 ka the stream valleys underwent a complex history of erosion and aggradation in response to changes in glacial drainage in the Mississippi River basin. The role of isostatic rebound on the process of stream incision in the area is not clearly understood.

During the past 25 ka in the upper Mississippi River valley, there have been four major episodes of alluvial activity (Knox, 1996). The period between 25 ka and 14 ka was characterized by large quantities of bedload sediment being transported by a braided stream system. This aggradation has been related to outburst floods from glacial lakes and normal meltwater discharge from the Wisconsin glacier. An island braided channel system developed between 14 ka and 9 ka as large discharges from outlet failures of proglacial lakes and sustained low sediment flows caused major downcutting. Modern Holocene climate and vegetation systems developed from 9 ka to approximately 150 to 200 years B.P. The upper Mississippi

River returned to aggradation as Late Wisconsin age sediment in tributaries remobilized. Dominant processes during this period involved minor downcutting, channel migration, and the development of fluvial fans and deltas at the junction of tributaries. The fourth episode encompasses the time since European settlement when agricultural land use, channelization, and dam building have greatly impacted the upper Mississippi River.

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VEGETATION OF PIKE'S PEAK STATE PARK

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Pike's Peak State Park is located along the bluffs of the Mississippi River in northeastern Clayton County, Iowa. Physiographically, it is contained in the eastern portion of the Paleozoic Plateau Landform Region, commonly known as the "Driftless Area" (Prior 1992). The varied topography of the park, including steep bluffs, deep ravines, and flat to rolling uplands, is typical of this landform region and provides diverse habitats for plant species and plant communities. As will be seen, a diversity of rock formations and land uses also contributes to floristic diversity of the park.

Forests

Historically, as revealed by compilation of General Land Office (GLO) plat maps originally drawn between 1837 and 1849, the vegetation in and around the park was predominantly forest (Fig. 1). In fact, based on the GLO maps, Clayton County was the most extensively forested county in Iowa, with 70% of its land surface mapped as "timber" (Anderson 1996). Additional woody vegetation types-"grove", "thicket" and "barren"- occupied small areas of upland in the county, less than 0.1% each. Islands in the Mississippi River also provided additional forest cover (about 0.8%). Today, forest cover in Clayton County is still the highest among all counties in Iowa, with 21% of its surface covered with forest (Brand and Walkowiak 1991). The difference between 71% forest cover in the "presettlement" era and 21% forest cover today largely reflects extensive clearing and deforestation by agriculture and urbanization since 1850 (Fig. 2). However, differing precision between the coarsely drawn GLO maps and finely delineated photo-interpretations by modern forestry surveys may also account for a portion of the disparity.

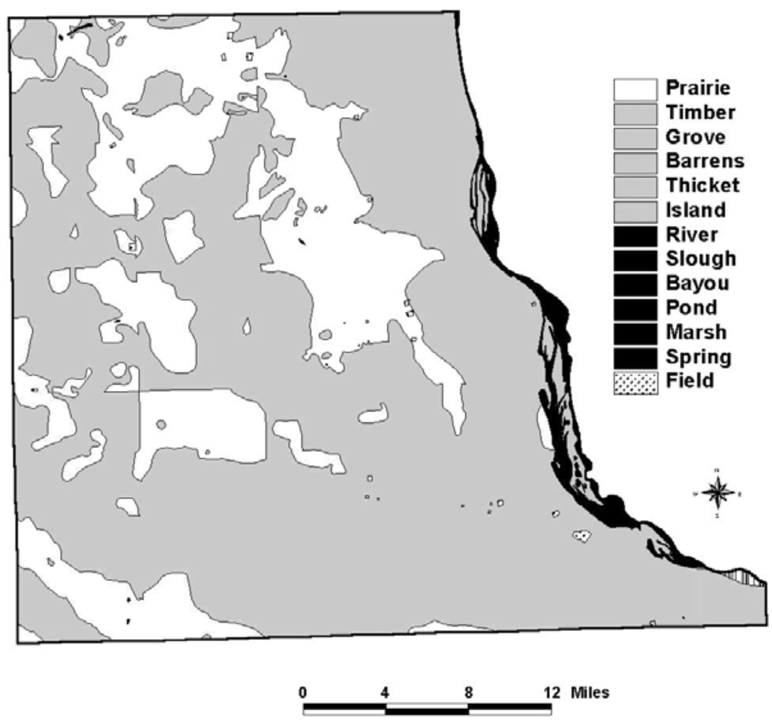

Figure 1. Historic vegetation of Clayton County based on 1837 – 1849 GLO maps.

The forest vegetation of northeast Iowa has been classified differently by various researchers. On a national atlas of potential natural vegetation, Kuchler (1966) depicted all of the Paleozoic Plateau plus the easternmost section of the Southern Iowa Drift Plain as "Maple-Basswood Forest (*Acer-Tilia*)", a classification first assigned to the area by E. Lucy Braun (1950) in her classic book *The Deciduous Forests of Eastern North America*. This classification emphasized the potential of the forest vegetation to become dominated by shade-tolerant sugar maple (*Acer saccharum*) and basswood (*Tilia americana*) trees if natural succession were uninterrupted by disturbance. Alternatively, Shantz and Zon (1924) classified northeast Iowa as part of a larger "Oak-Hickory (*Quercus*-*Carya*)" forest. This classification was based on the existing prevalence of shade-intolerant oaks and hickories, especially white oak (*Quercus alba*), red oak (*Quercus rubra*), and shagbark hickory (*Carya ovata)*, despite their seemingly successional status. The presence of numerous small stands of conifers in the region, especially eastern white pine (*Pinus strobus*), led Tolstead (1938) and Shimek (1948) to classify northeast Iowa as a western unit of the mixed coniferous-deciduous forest of the Great Lakes region.

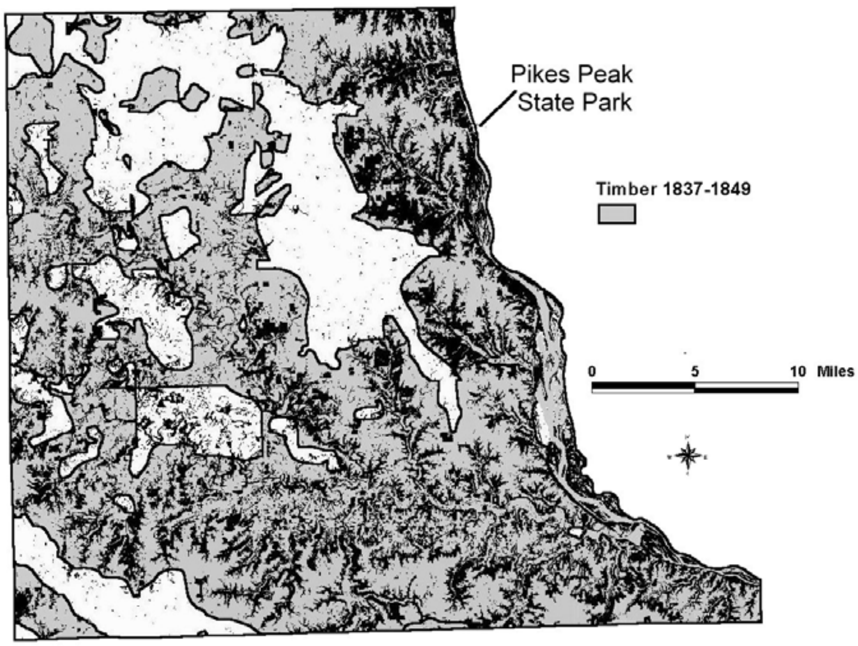

Figure 2. Relationship of modern and historic forest cover.

In contrast to sweeping classifications of broad geographic areas, Cahayla-Wynne and Glenn-Lewin (1978) studied the upland forest vegetation of the northeast Iowa by inventorying 35 study plots distributed among eight public forest reserves. Eight of the 35 plots were established in Pike's Peak State Park. (The other seven areas were Merritt Forest State Preserve, Retz Woods State Preserve, Effigy Mounds National Monument, Yellow River State Forest, Brush Creek Canyon State Preserve, Backbone State Park, and White Pine Hollow State Preserve.) Overall, they quantitatively described five major "dominance-types" among the forests of the region:

Acer- communities dominated by sugar maple (*Acer saccharum*) with basswood and white oak of secondary importance, usually found in the most mesic (moist and shaded) and oldest sites.

Tilia- communities dominated by basswood (*Tilia americana*) with bitternut hickory (*Carya cordiformis*), sugar maple, and red oak of minor importance, usually found in mesic sites.

Quercus rubra- communities strongly dominated by red oak with sugar maple of minor importance, usually found in mesic sites.

Quercus alba- communities dominated by white oak (*Quercus alba*) with red oak as a secondary species and sugar maple and basswood as minor components, usually found on drier sites.

Pinus- communities dominated by white pine (*Pinus strobus*) with white oak an important secondary species and red oak and sugar maple as minor components, usually found on xeric (very dry) sites.

Additionally, they qualitatively described one more community-type on exposed, xeric sites such as crags and bluffs dominated by eastern red cedar (*Juniperus virginiana*) and chinquapin oak (*Quercus muhlenbergii*). Communities of this type were always too small in area to be sampled with their standard plot size of 0.1 hectare (20m X 50m). (This interesting community type is discussed below as a "glade".)

The woody understory of the major forest types was generally dominated by ironwood (*Ostrya virginiana*) and blue beech (*Carpinus caroliniana*) trees. The herbaceous layer was typically populated with

Virginia creeper (*Parthenocissus quinquefolia*), sweet cicely (*Osmorhiza claytoni* and *O. longistylis*), wild geranium (*Geranium maculatum*), and enchanter's nightshade (*Circaea lutetiana*), among others. Seedlings and saplings of sugar maple were the most common species encountered in the lower strata of the forest throughout their plots.

Of the five major dominance types identified by Cahayla-Wynne and Glenn-Lewin (1978) for north-east Iowa, two (white oak and red oak) were well-represented in their sample of Pike's Peak State Park (Cahayla-Wynne 1976), reflecting the placement of their plots on ridgetops and gentle slopes in the park. Other community-types were present, but remained unsampled until Christiansen (1980) conducted a comprehensive inventory and mapped the vegetation of the entire park. Using a combination of small plots, linear transects, and qualitative reconnaissance, he documented the occurrence of communities dominated by white oak, by red oak, and by sugar maple. Basswood occurred as a secondary species in many samples, but was never observed as solely dominant. Although scattered individuals of white pine were found in the park, communities dominated by this tree species were determined to be absent.

Because of the comprehensive nature of his study, Christiansen (1980) documented the occurrence of a variety of forested and non-forested vegetation in Pike's Peak State Park (Fig. 3). Approximately half of the park contains natural vegetation, primarily on the steep bluffs and deep ravines along the Mississippi River. The natural vegetation is mostly forest, but small prairie and glade communities are also present. The other half of the park, primarily on flat to rolling uplands away from the river bluffs, contains a complex of non-natural vegetation, including old fields, mowed lawns, and a pine plantation.

Christiansen (1980) identified six natural forest community-types in the park. Three of them form an intergrading complex on steep, rocky slopes dominated by a variable mixture of sugar maple, red oak, basswood, and white oak. They were mapped as occurring extensively on bluffs along the Mississippi River and in three large ravines (named, from north to south,

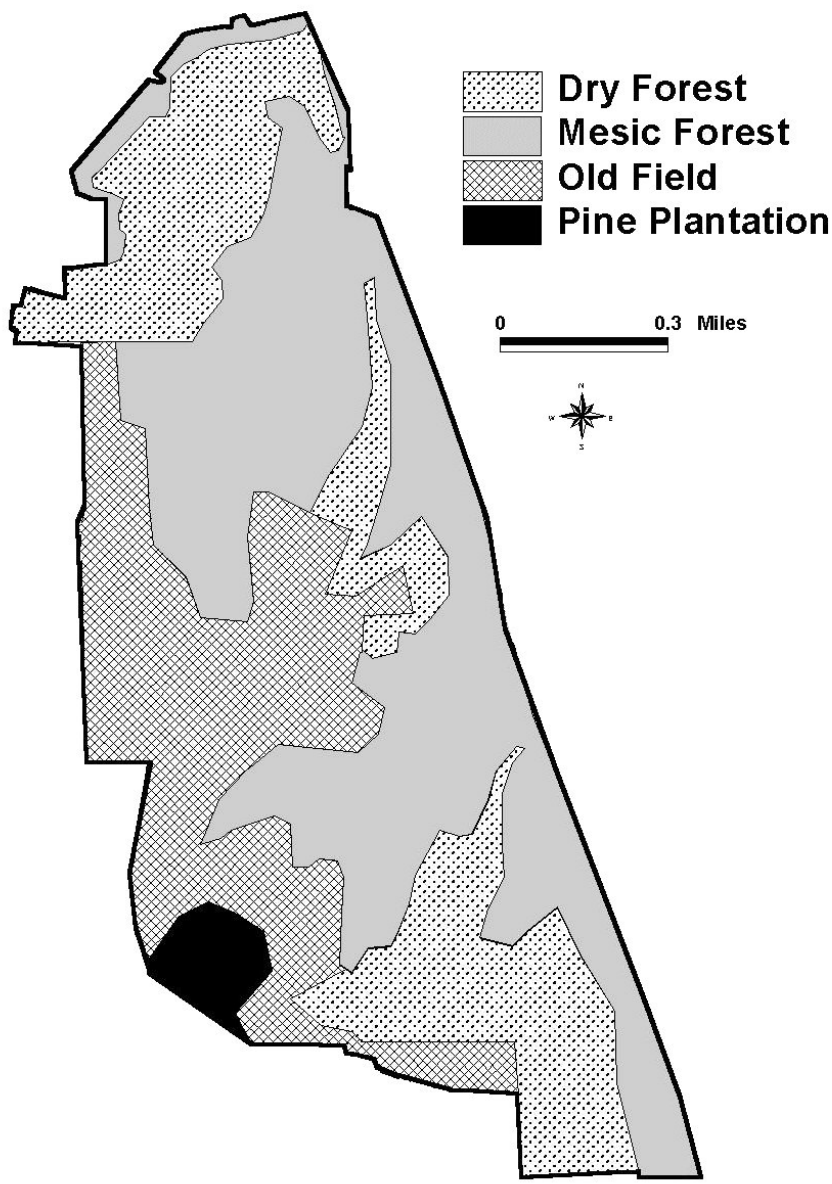

Figure 3. Vegetation map of Pikes Peak State Park (simplified from Christiansen, 1980).

"Schade Glen", "Weir's Glen", and "Pictured Rock Glen"). The "sugar maple-basswood" community was restricted to the steepest bluffs facing the Mississippi. The "red oak-sugar maple" community was the single most extensive forest type in the park, mapped mainly in large ravines. The "red oak-sugar maple-white oak" community occurred at the head of a single large ravine (Weir's Glen). Except for the central portion of Schade Glen (once cleared for use as a vineyard, now in an advanced stage of woody succession), this community occupies most of the mesic habitat suitable for its development. The sugar maple-dominated communities correspond to the "southern mesic forest" recognized by Curtis (1959) for Wisconsin while the red oak-dominated communities correspond to his "southern dry-mesic forest".

A fourth forest type, termed "Oak-Hickory" by Christiansen (1980), was dominated by white oak and shagbark hickory and occurred only on the gently sloping, loess-covered summits of ridgetops between major ravines. This type corresponds to the "dry southern forest" of Curtis (1959). The largest expanse of this community is located on the broad ridge in the northernmost part of the park (the "Point Ann" area). Small areas of this community can also be found on long, narrow divides between Pictured Rock Glen and Weir's Glen in the southern part of the park and between Weir's Glen and Schade Glen in the east-central part. The existing stands within the park are remnants of a formerly more widespread community that was largely converted for use as agricultural fields in the past. (Following establishment of the park, these areas were retired from production and are now old fields). Christiansen (1980) also recognized a disturbed variant of the Oak-Hickory community that he called "open woodland", sites where the area under the trees was maintained as a lawn for visitor use (such as the picnic area, campground, and the Indian mound area on the ridge between Pictured Rock Glen and Weir's Glen).

Two other forest types described by Christiansen (1980) occupied very small areas of land in the park. The "streamside" community, corresponding to the "wet-mesic forest" of Curtis (1959), occurred on the banks of the lower reaches of Schade Glen and Weir's Glen; its dominant trees were basswood, red elm (*Ulmus rubra*), and walnut (*Juglans nigra*). The "floodplain" community, corresponding to the "southern wet forest" of Curtis (1959) and located on small deltas along the banks of the Mississippi River at the mouths of Weir's Glen and Pictured Rock Glen, is dominated by silver maple (*Acer saccharinum*) and willows (*Salix*).

Prairie openings and glades

Christiansen (1980) identified a non-forested natural community-type in Pike's Peak State Park, the "prairie opening". He mapped two small occurrences on the east side of Schade Glen, but only one of them (on the spine of a rocky ridge) is probably a natural occurrence. The other (on an eroded lower slope once cultivated as a vineyard) is most likely an old field that was partially colonized with prairie plant species spreading from the nearby natural community. Big bluestem (*Andropogon gerardii*) and little bluestem (*Schizachyrium scoparium*) are dominant grasses in this community, with several other typical prairie species such as purple coneflower (*Echinacea pallida*), spiderwort (*Tradescantia*), azure aster (*Aster azureus*), and flowering spurge (*Euphorbia corallata*) also present. This community corresponds to the "dry prairie" community of Curtis (1959).

Although not specifically recognized or mapped by Christiansen (1980), another prairie-like opening is found on a narrow bedrock ridge on the east side of Pictured Rock Glen (the "Crow's Nest" area). The vegetation here is a mixture of scattered stunted trees of eastern red cedar and chinquapin oak, an herbaceous understory with several prairie species, and exposures of bare rock and ledges. Sometimes termed a "cedar glade" (Curtis 1959) or simply "glade", this is an example of the "crags and bluffs [dominated by] *Juniperus virginiana* and *Quercus muhlenbergii*" as described by Cahayla-Wynne and Glenn-Lewin (1978). In addition to prairie species, this site also contains cliff goldenroad (*Solidago sciaphila*) and blueberries (*Vaccinium angustifolium* and *V. myrtilloides*). The goldenrod occurs on bare rock of the Galena Limestone while the blueberries occur in sandy soil weathered from the St. Peter Sandstone.

Old fields

Christiansen (1980) mapped a complex of old fields on flat topography in the west-central and southwestern parts of the park. These fields were retired from cultivation following acquisition of land parcels by the park in 1968. Christiansen (1980) recognized several variants that reflected the degree of invasion of woody plants into these formerly cultivated areas:

> **“Grassy”** fields dominated by Kentucky bluegrass (*Poa pratensis*), smooth brome (*Bromus inermis*), quackgrass (*Agropyron repens*), redtop (*Agrostis gigantea*), Canada goldenroad (*Solidago canadensis*), and late goldenrod (*S. gigantea*).
>
> **“Early Woody”** fields similar to the grassy old fields except that the tree saplings, including Siberian elm (*Ulmus pumila*), boxelder (*Acer negundo*), and white mulberry (*Morus alba*), were taller and well established, although scattered.
>
> **“Advanced Woody”** fields dominated by young trees forming a complete canopy. Principal trees were boxelder, Siberian elm, American elm (*Ulmus americana*), white ash (*Fraxinus americana*), walnut, bitternut hickory, and black cherry (*Prunus serotina*).

He also pointed out that one old field in the southwest corner of the park had been densely planted with conifers, mainly white pine, Scotch pine (*Pinus sylvestris*), and Austrian pine (*Pinus nigra*). The latter two species are not native to North America.

Comparison with Wyalusing State Park, Wisconsin

In *The Vegetation of Wisconsin* (1959, pp. 88-89), ecologist John Curtis provided a map and brief descriptions of natural forest communities in Wyalusing State Park, which is located in Wisconsin at the mouth of the Wisconsin River, directly across the Mississippi River from Pike’s Peak State Park. Of the nine communities mapped in Wyalusing, six were directly comparable to vegetation types in Pike’s Peak:

> cedar glade, on a southwest-facing slope at the tip of a narrow ridge above escarpment of Prairie du Chien dolomite
>
> dry-mesic forest of white oak and red oak, on high upland
>
> dry-mesic forest of nearly pure red oak, on steep slope
>
> dry-mesic forest of red oak and basswood, on north-facing slope and in ravine
>
> southern mesic forest of maple and basswood, largely confined to the steepest portion of the north face of the hill [overlooking the Wisconsin River]
>
> lowland hardwood forest of silver maple, American elm, and green ash, in floodplain of Wisconsin River

In fact, four communities in Wyalusing State Park were used as “typical examples” of their types in Curtis’ classic book *The Vegetation of Wisconsin*: cedar glade, mesic forest, wet-mesic forest, and wet forest. Thus the examples of these communities in Pike’s Peak State Park are probably very similar to what is widely used as a standard reference (or “type-locality”) throughout the Midwest.

Flora and rare species

Over 250 species of vascular plants were observed by Christiansen (1980) for Pike’s Peak State Park during his community-level inventory of the vegetation. Although an impressive number, this is probably an underestimate of the total number of plant species that could be detected with an intensive floristic inventory. For example, a detailed, multi-year inventory of Backbone State Park focusing specifically on the flora yielded over 600 species of vascular plants (Bill Norris, personal communication).

Several rare plants (Eilers and Roosa 1994) have been documented at Pike's Peak:

Jeweled shooting star (*Dodecatheon amethystinum*), shaded limestone cliffs, first documented by Mark Leoschke circa 1986

Shining clubmoss (*Lycopodium lucidulum*), found only on sandstone outcrops in forested areas; listed by Christiansen (1980)

Rice grass (*Oryzopsis pungens*), originally reported by Hartley (1962) from dry sandy woods

Sullivantia (*Sullivantia sullivantia*), found on moist, shaded cliffs; listed by Christiansen (1980)

Low sweet blueberry (*Vaccinium angustifolium*) and **velvet-leaf blueberry (*V. myrtilloides*)**, in sandy upland woods and on sandstone ledges; collected by Robert Thorne, cited by Hartley (1962), listed by Christiansen (1980)

Summer grape (*Vitis aestivalis*), originally collected by Hartley (1962)

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WILDLIFE OF PIKES PEAK STATE PARK

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Pikes Peak State Park is located on the highest bluff along the Mississippi River, Clayton County, Iowa. The confluence of the Wisconsin River with the Mississippi River can be seen from atop the 500-foot bluff. The rocky bluffs, steep ravines, wooded valleys, and spring-fed streams are home to a variety of wildlife. Because the Mississippi River is an important migratory pathway for many bird species, Pikes Peak State Park provides excellent viewing of songbirds, hawks, and waterfowl during the spring and fall migrations. The composition and diversity of trees and shrubs in the forest, the time of year, and the amount of disturbance from park visitors are some of the factors affecting the presence and distribution of wildlife in the Pikes Peak State Park.

Wildlife Species

Large populations of white-tailed deer reside within Pikes Peak State Park and the surrounding areas. Furbearers found within the park and the adjacent Mississippi River area include mink, river otters, muskrats, beavers, red and gray fox, cottontail rabbits, and raccoons. Many small mammals inhabit the area including weasels, fox and gray squirrels, many species of shrews, mice, voles, and ground squirrels, and several species of bats. The park is a good place to view bats during the summer, especially near the shelter. Common species observed are the big brown bat and little brown myotis; however, northern myotis, silver-haired bats, eastern pipistrelles, red bats (Fig. 1), and hoary bats also occur in this part of the state during the summer months.

Figure 1. The red bat is a resident of Pikes Peak State Park.

Pikes Peak State Park and the surrounding area have high bird species diversity. The Paleozoic Plateau contains Iowa's largest populations of species that prefer large woodlands, such as the bald eagle, red-shouldered hawk, ruffed grouse, and Cerulean warbler. The forested landscape of the park and its location along the Mississippi River make it a haven for many breeding birds. A few of the numerous confirmed nesting birds are wood ducks, Cooper's hawks, red-shouldered hawks (state endangered – see Fig. 2), yellow-bellied sapsuckers, ruby-throated hummingbirds, blue-gray gnatcatchers, yellow warblers, and Louisiana waterthrush. A variety of other neotropical migrants are considered probable breeders in the park (e.g., yellow-billed cuckoo, pileated woodpecker, Acadian flycatcher, wood thrush, blue-winged warbler, Cerulean warbler, Kentucky warbler, scarlet tanager – Fig. 3). Great blue herons and great egrets from nearby rookeries raise their young along the river in spring and summer. Large populations of wild turkey reside within the park and in the surrounding forest areas. Ruffed grouse also inhabit woodlands in this part of the state. Bald eagles are commonly seen during fall migration along with other raptors like broad-winged hawks and sharp-shinned hawks. Bald eagles also winter along the Mississippi River.

Large numbers of turtles live in the area surrounding Pikes Peak State Park. Some species (i.e., map turtle, false map turtle, smooth softshell) are limited to the Mississippi River or adjacent pools and ponds. Others may be seen near water within the park: painted turtle, Blanding's turtle, snapping turtle, spiny

Figure 2. The red-shouldered hawk, a state endangered species, is also observed at Pikes Peak.

softshell turtle. Five-lined skinks (Fig. 4) can be observed along the forest edges near rock outcrops during the warmer months.

Frogs and toads surveyed in Clayton County are northern leopard frog, green frog, chorus frog, bullfrog, Blanchard's cricket frog, American toad, Cope's gray treefrog, northern spring peeper, and eastern gray treefrog. Pikes Peak State Park is in the historical range for the pickerel frog, a species typically found in cold-water streams feeding into the Mississippi River; however, none have been recorded in the county in recent years. Mudpuppies (state endangered) and tiger salamanders (Fig. 5) are two other amphibians that could be encountered within the park.

Fourteen different snake species can be found in Clayton County. The particular habitat that one visits in Pikes Peak State Park determines the snakes that may be observed. The northern water snake is the only water snake found in this part of the state. Common woodland or forest edge species include brown snakes, northern redbelly snakes, milk snakes, fox snakes, and bullsnakes. Eastern, redside, and plains garter snakes are commonly found along the edges of water bodies with good amphibian populations. Eastern hognose snakes and occasionally blue racers may be found in forest clearings. Timber rattlesnakes inhabit wooded areas, primarily around rock outcrops or bluff prairies. Because of their required habitat, they occur only in scattered populations along the Mississippi River bluffs where relatively undisturbed habitat remains. Timber rattlesnakes are protected as a nongame species in Iowa.

Figure 3. The scarlet tananger is one of many neotropical songbird migrants that may breed in the park

Wildlife Management

The goals of wildlife management activities at Pikes Peak State Park and surrounding wildlife areas are to develop self-sustaining and diverse wildlife populations and provide public viewing of a variety of species. Forest management within the park will largely determine wildlife composition, distribution, and population levels. Natural succession will create old growth stands of red and white oak, maple, basswood, and hickory. The habitat and mast provided by successional woodlands supports populations of wild turkeys, white-tailed deer, ruffed grouse, neotropical migrants such as Acadian, flycatcher, Cerulean warbler, and scarlet tanager, and a variety of small mammals. White-tailed deer can have negative impacts on vegetation within state parks if their populations become too large. Hunting is prohibited in Pikes Peak State Park and all other state parks unless special hunts are implemented. In the absence of natural predators, hunting remains the most effective tool for controlling deer numbers.

Populations of many neotropical migratory bird species have declined in the past 25 years. One theory for this decline is increased habitat fragmentation. Large forests have been broken-up, resulting in smaller forest tracts that attract edge predators such as skunks, raccoons, fox, crows, and blue jays. Brown-headed cowbirds are also attracted to habitat fragments. These nest parasites lay eggs in the nests of neotropical migrants that in turn incubate cowbird eggs and raise cowbird young at the expense of their own young. The large forest tracts at Pikes Peak State Park offer some protection from habitat

Figure 4. The skink is one of the reptiles at Pikes Peak State Park.

fragmentation and are safe nesting areas for many breeding neotropical migrants. Woodland management needs to be accomplished in such a manner as to minimize impacts to breeding bird species.

Management activities should also be accomplished with regard for the various species of bats that inhabit the park area. All of Iowa's bats live in forest areas during the summer. Several species of bats use live and dead trees with loose bark for nursery roosts, whereas others use cavities and foliage for roost sites. In general, woodland management for bats includes protection and retention of trees with loose bark and trees with cavities.

Planting shrubs and trees near public use areas provides food and cover for a variety of wildlife species and enhances viewing opportunities. Appropriate tree and shrub species include oak, ash, gray dogwood, chokecherry, wild plum, serviceberry, nanny berry, elderberry, hawthorn, and other native or non-invasive woody species. The DNR has several guidebooks to assist viewers in identifying species: The Snakes of Iowa, The Salamanders and Frogs of Iowa, The Lizards and Turtles of Iowa, A Guide to the Bats of Iowa.

Figure 5. The tiger salamander is an amphibian that makes Pikes Peak its home.

Pikes Peak State Park supports a variety of wildlife species, thus making it a valuable resource that requires careful management. Recreation, wildlife management, and forestry goals for the park and surrounding areas should be coordinated to ensure that all Iowans can enjoy the park while critical wildlife habitat is maintained.

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ARCHAEOLOGY OF PIKES PEAK STATE PARK

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Introduction

People have lived in northeast Iowa for at least 13,000 years. Pikes Peak State Park contains a wealth of archaeological resources relating mostly to one segment of this time span, the Late Woodland period, ca. A.D. 600-1100. Sixty-five Woodland mounds have been documented in 11 separate groups within the main portion of the park. Several probable habitation sites also have been found. The large number of archaeological sites in the park indicates that Pikes Peak, like the adjacent Mississippi and Wisconsin River valleys, was heavily utilized in prehistoric times, particularly during the Woodland period.

The Pikes Peak mound groups, situated on bluff tops and narrow upland ridges, contain four bear effigies, eight linears, and 53 conical mounds. Most of the mounds at Pikes Peak and nearby locations probably were built by people of the Effigy Mound "culture" of the Late Woodland period. Mound construction appears to have been a ritual and ceremonial practice. The mounds covered and honored the dead and also symbolized the connections between humans, spirits, and the landscape. The effigies may represent animate spirits, while the linear and conical mound shapes have uncertain meanings.

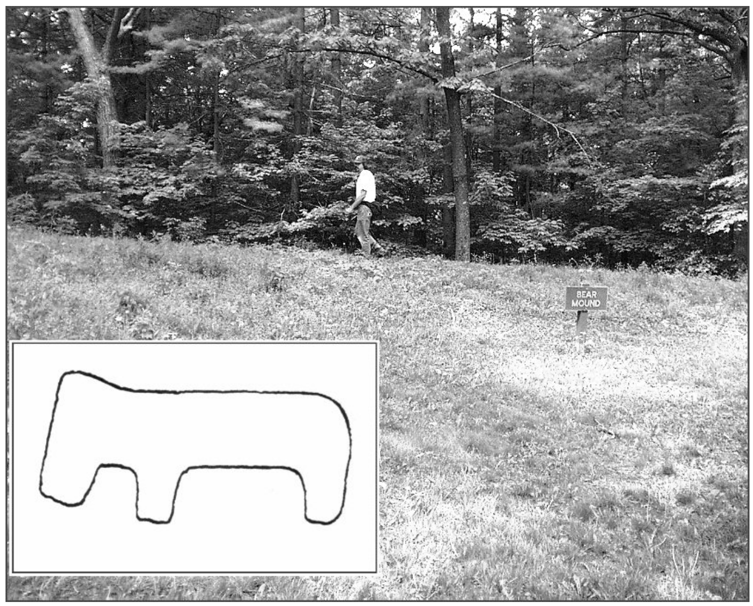

Figure 1. Photograph of the Bear Mound near the concession stand at Pikes Peak State Park. The insert is a sketch of the mound made by Ellison Orr in 1939.

Late Woodland people located their campsites, villages, and other habitation and special-purpose sites throughout the landscape. They made repeated use of rock shelters and nearby terraces and floodplain surfaces. Mississippi River islands served as warm-season camp locations for exploitation of fish, shellfish, and other resources, while rock shelters served as cool-season habitations.

Pikes Peak and its surroundings have been subjected to periodic archaeological study over a period of 125 years or longer. The most extensive surveys were those of self-taught local archaeologist Ellison Orr in 1912 and Luther College archaeologist R. Clark Mallam in 1973 and 1978. Not every part of the park has been intensively inspected, so it is likely that additional sites will be found if more of the park is carefully surveyed. Enough has been discovered to permit a useful review of ancient cultures and their uses of the local landscape. The following discussions, from the report of the 1978 Luther College archaeological survey of the park (Mallam et al. 1979), review the history of archaeological work at Pikes Peak and the significance of the finds that have been made. Additional information is available in Sellars and Ambrosino (1989).

The Mississippi bluffs in northeast Iowa contain one of the highest concentrations of mounds in North America. Effigy Mounds National Monument, Pikes Peak State Park, and other public lands preserve and interpret this unique heritage. Despite damage from looting and plowing that occurred before Pikes Peak was dedicated as a state park, the archaeological studies at the park have shown that many of the sites are still well preserved and worthy of continued protection. Pikes Peak thus plays an important role in preserving ancient mounds and making them available for public view.

Note: Burial mounds in Iowa are protected by state law. Please report any damage to the DNR and the State Archaeologist.

Previous Archaeological Research

from Mallam et al., 1979:14-17

During the latter half of the nineteenth century northeastern Iowa was the scene of numerous archaeological and geological surveys. These early surveys, especially in regards to archaeology, were undertaken by a variety of individuals, social organizations and institutions. Although considerably disparate in terms of objectives, all shared a common denominator irrespective of either archaeological expertise or quality — that being the acquisition of data that would either refute or support the Mound Builder thesis. The central tenet of this thesis was that the mounds and earthworks of prehistoric America, especially those in the eastern Woodlands, were constructed by a vanished race, antecedent, unrelated and superior to the Native Americans.

It is important to note that none of these surveys focused directly on northeastern Iowa. Instead, this portion of the state was only one of many areas visited by researchers during the course of their broad-based regional investigations. Since the major objective of the surveys was to acquire generalized data relating to mounds and earthworks, no systematic studies were conducted. Consequently, the antiquities of northeastern Iowa were only sampled in the most general sense rather than being subjected to thorough investigations. The results of these surveys provided much data but no one area was intensely inspected; hence, considerable gaps exist in the archaeological record.

The first of these nineteenth century surveys, that included northeastern Iowa, was undertaken privately in the 1840's by William Pidgeon, an amateur archaeologist and ardent advocate of the Mound Builder thesis. Pidgeon, seeking prehistoric data to confirm the existence of a vanished race of mound builders, carried out limited and intermittent surveys along the Iowa side of the Mississippi River (Mallam 1976b:159–60). While he recorded several Allamakee County mound groups (Pidgeon 1858) and undoubtedly fabricated others, there is no evidence indicating that he worked in Clayton County.

By the last quarter of the nineteenth century, the controversy over the Mound Builder thesis had become an issue of national importance. In order to resolve the controversy the American Congress in 1881 appropriated funds for the creation of a Division of Mound Exploration within the Bureau of Ethnology. Directed by Cyrus Thomas, this extensive survey ranged widely throughout the eastern United States between 1881 and 1890 with particular emphasis placed upon the antiquities of the Mississippi River Valley.

Thomas' main goal was to determine whether or not the various mounds and earthworks had been constructed by Native Americans. Therefore, he sought to cover as broad an area as possible in order to obtain a representative sample of the diverse prehistoric mound data. As a result, his surveys only briefly focused on northeastern Iowa. Both Clayton and Allamakee counties were visited by one of the Division research teams and a number of mound groups were recorded. Unfortunately, exact mound group proveniences were not always recorded and many of the plats were later ruined in a rainstorm. From Thomas' massive report it appears that the research team recorded the "Marching Bear" mound group in the South Unit of Effigy Mounds National Monument and may have ascended the bluffs near McGregor (Thomas 1894:108):

> *There are many other interesting works along Turkey River and upon high bluffs above McGregor, notably effigies of antlered elks, uniformly in lines or groups heading southeastward.*

There is no evidence, though, which would categorically demonstrate that the research team visited the Pikes Peak State Park area. At best, the researchers may have walked through the park hurriedly noting the existence of "many interesting works upon high bluffs above McGregor."

While the Division of Mound Exploration was in existence, a similar survey effort was launched by two Minnesota residents. In 1880, Alfred J. Hill, a civil engineer living in Minneapolis, hired Theodore H. Lewis, a surveyor, to undertake an extensive survey of the mounds and earthworks in the north central states. Together, these two men formed the Northwestern Archaeological Survey, which remained in existence until 1895 (Lewis 1898).

During the 15 year existence of this organization, Lewis periodically visited northeastern Iowa and spent considerable time in Clayton County. His efforts resulted in the recording of numerous mound groups along the Mississippi River and its principal tributaries. On May 21 and 23, 1892, Lewis surveyed several mound groups in the McGregor Heights area. Portions of this area are now part of Pikes Peak State Park.

Strangely, Lewis does not appear to have surveyed the bluffs immediately south of McGregor where the main portion of the park is now located. A thorough search of the Northwestern Archaeological Survey notes and plats in the Archives of the Minnesota State Historical Society reveals a complete absence of research by Lewis in this area. It is a well known fact that his surveys were not systematic. His work pattern seems to have been highly sporadic and his peripatetic investigations may reflect information he received from local residents pertaining to known mound groups. Regardless, there is no evidence indicating that he knew of the existence of the mounds in the main park.

The first archaeological survey of the main park area occurred in 1912. It was conducted by Ellison Orr, an enthusiastic amateur archaeologist living in Waukon, Iowa. Orr had long maintained an interest in the mound building cultures of Iowa and kept meticulous records and plats of his research. In the spring of 1912, aided by the McGregor Boy Scout Troop, he initiated a survey of the Mississippi River bluff regions in and around McGregor.

Orr began the first phase of his survey in the McGregor Heights area noting and platting six separate mound groups (Orr 1940:110). These mound groups contained a total of 37 mounds - 9 linears and 28 conicals. At that time, 1912, housing development was already occurring in this area and Orr observed that several mounds showed evidence of vandalism. Writing again in 1940 he stated (Orr 1940.110):

> *Since our survey was made the number of cottages has doubled and all the mounds of this last group (Mound Group #6) have been more or less mutilated by the building operations or the making of a tennis court.*

Following the McGregor Heights survey Orr directed his research toward the main portion of the park then known as the McGregor-Pikes Peak area. He described the area in this manner (Orr 1940:114):

> *... we have, including Point Ann and Pikes Peak, five spurs running from the crest of this bluff, a high divide between a dry ravine paralleling it on the west and that of the Mississippi on the east, and terminating in high rocky cliffs and promontories.*

Altogether, Orr platted seven distinct mound groups in this area. These mound groups, according to his calculations, contained 7 effigies, 38 conicals, 9 linears and 1 compound. The most distinctive group of mounds, Mound Group #5, was listed as containing three "buffalo" effigies (Orr 1940:115):

> *The most westerly of these 3 effigies lies in a cultivated field and has been nearly obliterated. The remaining two to the east lay in pasture at the time the survey was made and were in a fine state of preservation. They were certainly intended to represent the buffalo. The hump was very prominent and the outline in general unmistakably of that animal.*

Virtually, all of the mounds were intact and, with the exception of the one buffalo effigy, damage through agriculture and logging was minimal. Orr's field notes do not indicate that he conducted any excavations of the mounds or carried out surface surveys for habitation sites in the adjacent fields. In fact, it does not appear that he even visited this area again following the 1912 survey (Orr 1940:116).

A total of 63 years passed before any additional archaeological research was undertaken in the park. In 1973, members of the Iowa Effigy Mound Survey visited the park for a period of two days. This survey focused exclusively on the Effigy Mound culture and the time spent in the park was used mainly to corroborate Orr's mound group plats, particularly those containing effigies. The survey party noted that since 1912 one bear effigy in Mound Group #1 had been destroyed and all of the buffalo effigies in Mound Group #5 were rendered indistinct through farming (see Mallam 1973:28). Until the present survey in 1978, the Iowa Effigy Mound Survey marked the most recent archaeological research efforts undertaken in the park.

Analysis of the last 125 years of archaeological research in northeastern Iowa reveals that the Pikes Peak State Park area received only limited attention. All of the studies carried out during these years, as they relate to the park, focused entirely on the mounds. Since none of the studies were concerned with locating habitation sites, the archaeological record for this area can be considered incomplete. Due to the incomplete record, one of the major objectives of the 1978 Pikes Peak Cultural Resource Survey was to provide the Iowa Conservation Commission with a complete archaeological inventory of mound groups and habitation sites within the park boundaries.

Interpretive Summary

from Mallam et al. 1979:43-47

The reconnaissance level survey of Pikes Peak State Park resulted in the acquisition of numerous data pertaining to prehistoric cultures. These data, however, are inadequate to construct an interpretive summary oriented to the general public. Such a summary must necessarily rely on other research conducted throughout northeastern Iowa where more intensive investigations have yielded greater information. The following summary, therefore represents a correlation of these previous studies with the data obtained from the present survey.

One June 17, 1673, Marquette and Joliet, two French explorers, became the first Euro-Americans to enter the Mississippi River. Their entry occurred at the mouth of the Wisconsin River directly across the Mississippi River from the present location of Pikes Peak State Park. The Native Americans whom they encountered in this region were village-dwelling horticulturists, quite distinct culturally from the preceding Woodland societies who had earlier left their cultural stamp in the form of mounds and earthworks along the high bluffs.

The rapid expansion of Euro-Americans into the interior of eastern North America following the Marquette and Joliet expedition revealed the existence of numerous Native American tribes and, also, the material remains of their predecessors. Few attempts were made to investigate these remains, though, because the Euro-Americans were too preoccupied with exploration and defending their land claims against each other and the resident native populations to do more than offer vague speculations.

However, as settlement intensified in this region more information was gathered regarding the prehistoric cultures. Of particular interest and wonderment to these settlers were the incredible numbers and varities of mounds and earthworks that literally abounded along the major rivers and their tributaries. Some of these earthworks, especially those in Ohio, were massive enclosures featuring high, rounded earthen walls. Others were in the shape of animals, such as bears, birds, panthers and, in some instances, humans. Perhaps the most spectacular earthen mounds were those of southeastern North America. There, Native Americans had constructed huge, flat-topped earthen pyramids. And, throughout all of eastern North America were found conical mounds, round earthen structures of varying size.

Various theories were presented in an effort to identify the builders of these monumental works. By the early 19th century the most popular theory was that of the "Vanished Race of Mound Builders." The central tenet of this theory was that the mounds and earthworks of America were constructed by a vanished civilization, antecedent, unrelated and superior to the Native Americans. As an explanation, this theory was widely accepted by the majority of the American public and a significant number of academicians for almost the duration of the 19th century. There can be little question that its impact on American society was profound. In fact, there is some evidence to suggest that it even influenced the burial practices of some segments of the American population for there are recordings of whites interred in mounds.

The "Vanished Race" theory was not discredited until 1894 with the publication of Cyrus Thomas' "Report on the Mound Exploration of the Bureau of Ethnology." Since that time, archaeological research has not only established that mounds and earthworks were erected by numerous prehistoric cultures but that the antiquity of the New World has considerable time depth as well. The product of this research has resulted in the construction of many culture-historical sequences throughout North America.

In northeastern Iowa research has demonstrated the existence of four distinct prehistoric periods. The earliest of these periods, the Paleo-Indian, is poorly known. Beginning at the close of the last major glaciation and extending from approximately 9000 B.C. to 6000 B.C., this period is characterized by small bands of hunters who subsisted primarily on large game animals. Their lifeway, essentially nomadic, may be viewed as an adaptation to a post-glacial environment which favored the existence of herd animals.

By 6000 B.C. this lifeway was slowly being modified. Warming environmental conditions created extensive floral and faunal changes and necessitated new cultural adaptations. The adaptation formed in response to these conditions has been labeled the Archaic. Lasting in northeastern Iowa from approximately 6000 B.C. to 500 B.C. the Archaic virtually formed the foundation for all subsequent adaptations. It may be best described as a multifocus lifeway, one tailored to broad and systematic utilization of a wide variety of plants and animals on a seasonal and cyclical basis. The key feature in this lifeway was equilibrium — the maintenance of a delicate balance between humans and environmental resources.

The third prehistoric cultural period, the Woodland, approximately 500 B.C. to A.D. 1000, must be viewed as a continuation and elaboration of the Archaic lifeway. The systematic pattern of hunting and gathering was maintained but it appears that some horticultural practices were emerging. All evidence suggests a gradual increase in societal complexity. There was, simultaneously, an intensification of food production, population increase, the development of social ranking and the construction of mounds and earthworks. In regards to mounds, the first forms seem to have been conical structures. Later, around A.D. 1. the construction patterns of these mounds become more complex with the addition of various internal features such as raised platforms, log crypts, and exotic grave goods. It was at this time that some enclosures or earthworks were constructed. In Iowa, this phase of mound building is referred to as the McGregor Phase. It terminates about A.D. 300.

Thereafter, a major change in social organization occurs. For the next 300 to 350 years there is a period of transition or social reorganization. The formerly ranked social system with its attendant elaborate mound construction and exotic grave goods disappears. In its place is substituted a more egalitarian lifestyle represented by small bands of hunter-gatherer/horticulturists. Known as the Allamakee Phase, this period is most distinctive for the construction of conical mounds that exhibit wide variability in regards to internal features.

The final phase of the Woodland period, the Keyes Phase, lasted from about A.D. 600 to A.D. 1000. This was the time when effigy mounds were constructed along with linears, compounds and conicals. In some instances, these mounds were interspersed or built around previous earthen structures. Many theories have been proposed to explain the function of these animal shaped mounds. This writer favors the view that the mounds symbolized the elements critical to the hunting-gathering lifestyle. In this interpretation, the birds would represent the sky forces (sun, wind, rain, etc.), bears and panthers the creatures of the earth while lizards and turtles represent water, the sustainer of life itself. And, a few mounds appear to represent humans. If so, it seems reasonable to suggest that they symbolize the integration of humans with the resources of the universe. In other words, these mounds may have been the means by which humans sought to express their philosophical convictions about the universe, the life force and the intricate web of relationships that bonded them together.

Somewhere around A.D. 1000 the Woodland period began to disappear. It was gradually replaced by a vigorous new adaptation known as Oneota, A.D. 1000 to the historic period. This adaptation was characterized by a dual-subsistence economy in which foodstuffs were equally derived from hunting and gathering and horticulture. In contrast to the small and frequently dispersed Woodland habitation sites, there occurred the development of large, semi-permanent villages erected along high terraces and benches overlooking rivers. Archaeological evidence indicates that these peoples probably lived in the villages from spring through fall and then segmented into small family units for the winter. The origin of this lifeway has not been satisfactorily determined. Some interpret Oneota as an outgrowth of Woodland while others view it as unrelated and probably an extension north of peoples from the large chiefdom complexes in the Middle Mississippi region. Most would agree that the Oneota are the ancestors of such historic tribes as the Otoe and Ioway.

The archaeological resources of Pikes Peak State Park fall predominantly within the Woodland period of the northeastern Iowa culture-historical sequence. There is certainly the possibility that material remains representative of the other culture period may also be present in this area. If these remains are to be located, it will be necessary to carry out large-scale excavations since they lack the prominence and visibility of the Woodland mounds and earthworks.

The archaeological materials in the park are extremely important. The mounds may be representative of the entire Woodland period, approximately 500 B.C. to A.D. 1000. It is our view, however, that virtually all of these mounds are representative of the Effigy Mounds culture or Late Woodland period. This assessment is based on analysis of mound construction patterns derived from soil hand probes. Their actual cultural affiliation can be determined only through excavation which is not warranted at the present time as they are not in danger of destruction.

Assuming that the majority of these mounds fall within the Keyes phase (Effigy Mounds culture), A.D. 600 to A.D. 1000, it may be stated that they constitute a significant data source for advancing our understanding of prehistoric cultural dynamics. The most recent Effigy Mounds research (Mallam 1976a; Benn 1979) suggests that these mounds were manufactured by hunter-gatherer/horticulturalists who seasonally and cyclically exploited the natural resources of the Driftless Area. During the spring through fall seasons these small family units congregated into larger social groupings at the band level for the purpose of intensifying production.

These congregations usually occurred along terraces adjacent to the confluence of streams and rivers with the Mississippi River. It was at these particularly favorable areas that annually renewable and high-yielding natural resources could be consistently found. Since the majority of effigy mounds occur near these confluences, usually on prominent terraces or spur ridges, it can be postulated that they served as territorial markers in addition to their mortuarial function.

In observing the mounds within Pikes Peak State Park it will be noted that, with one exception, all are located either along the Mississippi River bluffline or spur ridges. There can be little doubt that this portion of the Mississippi Valley and its immediate tributaries was an extremely lucrative natural resource area. This was an aquatic habitat supported by the life-sustaining waters and nutrients of the Wisconsin River and a host of freshwater streams erupting from the contact of the Pecatonica dolomite and underlying Glenwood shale. Consequently, this area could be consistently relied upon to produce the necessary foodstuffs requisite for maintaining a lifeway heavily oriented toward hunting and gathering.

[These] dispersed hunting and gathering families met at this area [seasonally]. Besides carrying out economic tasks they also constructed mounds in the form of effigies, linears, conicals and compounds. The construction of these mounds supported and justified their lifeway and symbolized their dependence on the life force responsible for perpetuation of the natural resources. In addition, mass cooperation in the mound construction phases strengthened and solidified the social arrangements by which they organized in pursuit of economic goals.

This lifeway persisted for approximately 400 years. Unfortunately, the material remains necessary to continue testing our assumptions of this lifeway are rapidly disappearing. For example, the 1973 Iowa Effigy Mound Survey produced data demonstrating that over 80 percent of the effigy mounds in the state had been destroyed. Moreover, it is highly likely that this depletion rate would also be applicable to the other mound building cultures.

In summary, the archaeological resources of Pikes Peak State Park represent a nonrenewable scientific resource. It is imperative that they be accorded proper management and preservation. Each mound and campsite contains a data source that may significantly contribute to our understanding of how prehistoric peoples in northeastern Iowa lived and interacted among and between themselves and the environment. It is this information, once scientifically examined and presented to the public that can provide the basis for assessing our current adaptation and its sociopolitical-environmental relationships.

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HISTORY OF PIKES PEAK STATE PARK

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Introduction

Welcome to northeast Iowa, welcome home, that's what greets me at Strawberry Point as I turn north from State Highway 3 onto 13. There is no sign; it's just the feeling I get as I head north and east on 13. The highway bends and rises and falls, like a big ribbon that has fallen from the sky and left to lie as it landed. No more roads following the north-south surveyors section lines, straight and flat to the point of boredom. The people who routed roads in northeast Iowa had to be a little more artistic. Look at an Iowa road map; compare the lines that depict the major highways in the rest of the state with northeast Iowa. In the northeast corner the highways look like abstract art.

Home for me is Pikes Peak State Park on the eastern edge of a unique part of the state called the Paleozoic Plateau (Fig. 1) by naturalists. "The Peak" as it is locally known is located just south of McGregor on a bluff about 500 feet above "The River" (as the Mississippi is known locally). It offers modern camping, picnicking and a place from which you can view and explore an area rich in history and prehistory.

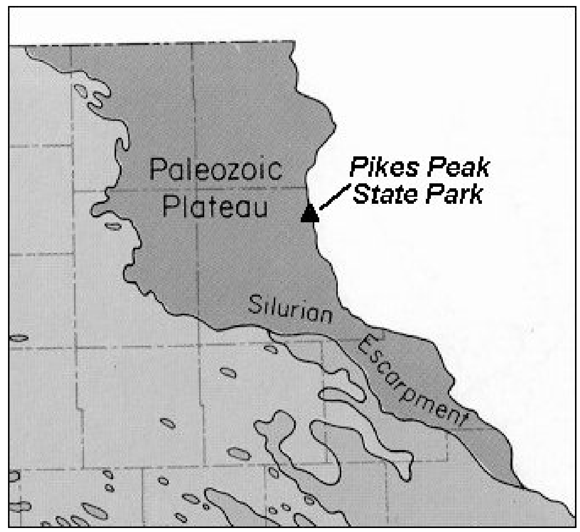

Figure 1. Map of the Paleozoic Plateau landform region in Iowa.

The term Paleozoic refers to the old bedrock units that influence the landscape in northeast Iowa. Iowa's bedrock units are tilted from northeast getting deeper towards the southwest. They have been exposed to erosion and weathering longer than just about any other part of the state. It's scenic hills and valleys escaped the flattening influence of all but the earliest glaciations during the ice age. But even though most bypassed the area, the glaciers had a profound influence on the Paleozoic Plateau. Great torrents of melt water ran through the area during warm periods and as the ice age came to an end. At these times streams and rivers carrying large volumes of water, gravel and stones from the retreating ice cap, ripping through landscape, cutting through the hills and feeding a raging torrent we now call the Mississippi. The Mississippi valley was at one time as much as 150 feet deeper than its present level. Cold times would find the scoured river valley dry and exposed to the westerly winds that would carry the lighter sands away depositing them on the east bluffs of the valley. The result of this sand deposition can be seen on the Wisconsin bluffs. The sandy soils are drier giving rise to more hillside prairies and fewer trees especially on south and west oriented slopes, which are more exposed to the drying effects of sun and wind. The eroding melt water fed rivers and streams exposing the geologic history of the state as recorded in the underlying rocks. The rocks show, as interpreted by geologists, that in the past Iowa's landscape was at times a seascape.

Rocks Exposed in the Park

The oldest exposed rock formation at the Peak is the Jordan Sandstone, which is believed to be over 500 million years old. The sandstone was deposited as advancing and retreating beaches. The Jordan sandstone is an important aquifer and the park water supply is draw from it from a well that is 560 feet deep. We will see this unit in McGregor during this field trip.

On top of the Jordan Sandstone are beds of the Prairie du Chien Group, some of which are reef-like in structure. At the end of Prairie du Chien deposition these beds were exposed as evidenced by the eroded surface upon which the St. Peter Sandstone was deposited.

Figure 2. Exposures of St. Peter Sandstone at Sand Cave in Pikes Peak State Park.

The St. Peter Sandstone (Fig 2) is of local interest. The sandstone is richly colored with reds, oranges, browns and purples coursing through a mostly buff to pure white colored matrix of quartz sand. The sands were stained by deposited minerals mostly iron. The colored sands of the St. Peter are a source of material for area artists' sand paintings done in bottles. Examples can be seen at the McGregor Historical Museum. (Read more about this art in the article on Andrew Clemens Sand Art in this guidebook).

The Platteville and fossil-rich Decorah formations lie on top of the St. Peter. The Decorah Formation was deposited in a near-shore environment with periodic supplies of mud and high biologic activity. The mud gave rise to impervious shale units of the Decorah Formation and provide the year-round water source for picturesque Bridal Veil Falls. Groundwater percolating vertically starts to travel horizontally when it comes to the impenetrable Spechts Ferry Shale and seeps out of the valley walls above the falls. The Platteville Formation's McGregor Member (which is below the Spechts Ferry Shale) is very resistant to erosion and thus forms the ledge of Bridal Veil Falls.

The Galena Limestone is of local importance. This formation is just below or at the surface and is around one million years old. Water carrying acids from decaying vegetation percolating through this formation dissolved the stone, giving rise to the caves and sinkholes of the area. Known as karst topography, this is more evident west of the park where groves of trees in the middle of fields indicate sinkholes where a cave roof has collapsed, and at the privately operated Spook Cave. The cave is west of McGregor on US highway 18 and offers a unique tour by boat.

Pre-History of Pikes Peak

The unique nature of this part of the world was recognized by humans when they first set eyes upon it in the dimness of prehistory. Life was good here for the first inhabitants. Food and fiber were abundant, the rivers created travel and trade opportunities. The area that is now Pikes Peak State Park was the land of several tribes of Native Americans. Many groups used the river as a travel and trade route (with tribes from other areas). In the late 1600s, explorers found an Indian village in the nine-mile prairie where the present-day city of Prairie du Chien is found. The Fox and Sac lived and farmed the land near the river and hunted in nearby hills. The Dakota lived west and north in what is now northeastern Iowa and southeastern Minnesota. The Winnebago tribe lived in river valleys across the river in present-day Wisconsin. For the most part, Native Americans lived in campsites and small villages near waterways. The Winnebago, Iowa and Otoe have spiritual ties to the mounds and mound building culture. Many groups came to the area for trading and gatherings. These included the Potawatomi, Menominee, Chippewa, and Ottowa. From around 800 to 1200 AD these peoples celebrated their good fortune and their belief in the oneness with mother earth by constructing earthen mounds on the landscape. Many are simple conical or linear shaped structures but others are more elaborate effigies of area animals. A bear effigy resides in the picnic area at the Peak, just a short easy walk from the parking area. For an in-depth interpretation of the mound builders culture it is suggested that you visit Effigy Mounds National Monument, just 4 miles north of Marquette on Iowa 76. An audio-visual presentation, a museum and ranger-guided hikes help to bring this part of the area's history to life.

The first Europeans to visit the area were Father Marquette and Louis Joliet. They arrived one June day in 1673 via the Wisconsin River, which empties into the Mississippi just opposite the lower main overlook at Pikes Peak. Leaving the great lake Michigan they paddled their canoes up the Fox River to the Grande Portage, now Portage, Wisconsin, where they accessed the Wisconsin. Native peoples, early explorers, and trappers used the Mississippi much as it is used today, trading, trapping, fishing and transporting their goods. In 1685, Nicholas Perrot established Fort St. Nicholas near present-day Prairie du Chien to protect the French interests in the fur trade. Pierre Paul Marin built a trading fort near the mouth of Sny Magill Creek in 1738, 4 miles south of Pikes Peak State Park, for trade with Sac, Fox and Winnebago Indians. An Indian trail that extended west across present Iowa was also located in this area.

In 1781, Michael Brisbois, the first independent fur trader to live in Prairie du Chien, established a good working relationship with the Indians and the area soon developed into a profitable fur trading post. A man by the name of Cardinal built a grist mill across the Mississippi River from the present day Effigy Mounds Monument in Mill Coulee. He traded with the Native Americans exchanging grain from his mill for furs. The primary furbearer that trappers caught in this area was the beaver. The fur was used for fur felt hats in France. Other furs gathered included mink, muskrat, otter, wolf, raccoon, and fisher from the far north.

Figure 3. Villa Louis State Historic Site built by Louis Dousman on St. Feriole Island in Prairie du Chien.

John Jacob Astor set up a post of the American Fur Company at Prairie du Chien in 1808 on St. Feriole Island. This corporation was important during conflict between the French, British, Americans, and Indians. Joseph Rollette managed the American Fur Company. In 1826, Hercules Dousman became John Jacob Astor's agent and in 1843 built the "House on the Mound." Dousman and his descendants acquired considerable wealth, which was used to purchase land and bring the railroad to the area in 1857. The Villa Louis State Historic Site (Fig. 4) includes the country home of Hercules' son, Louis, built in 1870, a fur trade museum and this historic Brisbois House, all located on St. Feriole Island in Prairie du Chien.

Military Activity in the Pikes Peak Area

With the acquisition of the Louisiana territory in 1803, giving the fledgling United States claim to land on both sides of the Mississippi, exploration and finding the source of the river became important. In 1805 Lieutenant Zebulon Pike was dispatched from St. Louis to do just that. On January 31,1806 Pike and his men reached the frozen Leech Lake, MN and declared it the source of the great river. In 1805, on his way up the river, he selected the bluff that is now Pikes Peak State Park as a possible site for a fort. With its commanding view of the river valley below it was a good choice. Possibly considering the difficulty of supplying a fort perched on this bluff, Washington chose a site on the floodplain just to the north and east. Fort Crawford was built at a settlement known as Prairie du Chien. The inhabitants of

Fort Crawford were subjected to floods and malaria and over the years the fort was moved three times to its present location on S. Beaumont Road where tours are given. Maybe the rigors of hauling supplies up the bluff would have been preferred.

Later, in 1807, Zebulon Pike was commissioned to explore the west giving rise to the more famous Pikes Peak in Colorado. I used to joke that old Zeb must have been pretty full of himself, going around naming all these places after himself. I met a Pike historian from Colorado at the Peak this summer and mentioned this to her. She said quite the contrary, Pike was quite unassuming and quiet and that the Pikes Peak in Colorado, at least, was not named by Pike but by his men. And while he was not able to scale the Colorado mountain, history records that he did make it to the top here.

A log fort was completed on St. Feriole Island by Americans in June of 1814. Fort Shelby, as it was called, was captured by the British the following summer and was renamed Fort McKay, in honor of the British commander. When the British left, the fort was burned and replaced by Fort Crawford in 1816. Flood waters made this location a poor choice for a fort site and this fort was later allowed to rot away. The military reservation for Fort Crawford included Pikes Peak and extended south to Sny Magill Creek.

In 1825, the U.S. government called for a Great Council of Plains and Woodlands tribes in an attempt to put an end to unrest and establish tribal boundaries. As many as 10,000 Native Americans and U.S. Army personnel met on St. Feriole Island. By 1830, a "neutral zone" was established as a buffer area between the tribes. This neutral zone was located north of the present State Park.

Congress authorized the construction of a new fort in Prairie du Chien, this time to be built on a terrace above the flood plain. The timbers for the new Fort Crawford came from a sawmill site located three and one-half miles up the Yellow River, north of Pikes Peak. Colonel Zachary Taylor, commander of Fort Crawford at the time, sent Lieutenant Jefferson Davis to oversee the sawmill. Evidently this was an attempt by Colonel Taylor to break a budding romance between Jefferson Davis and Taylor's daughter

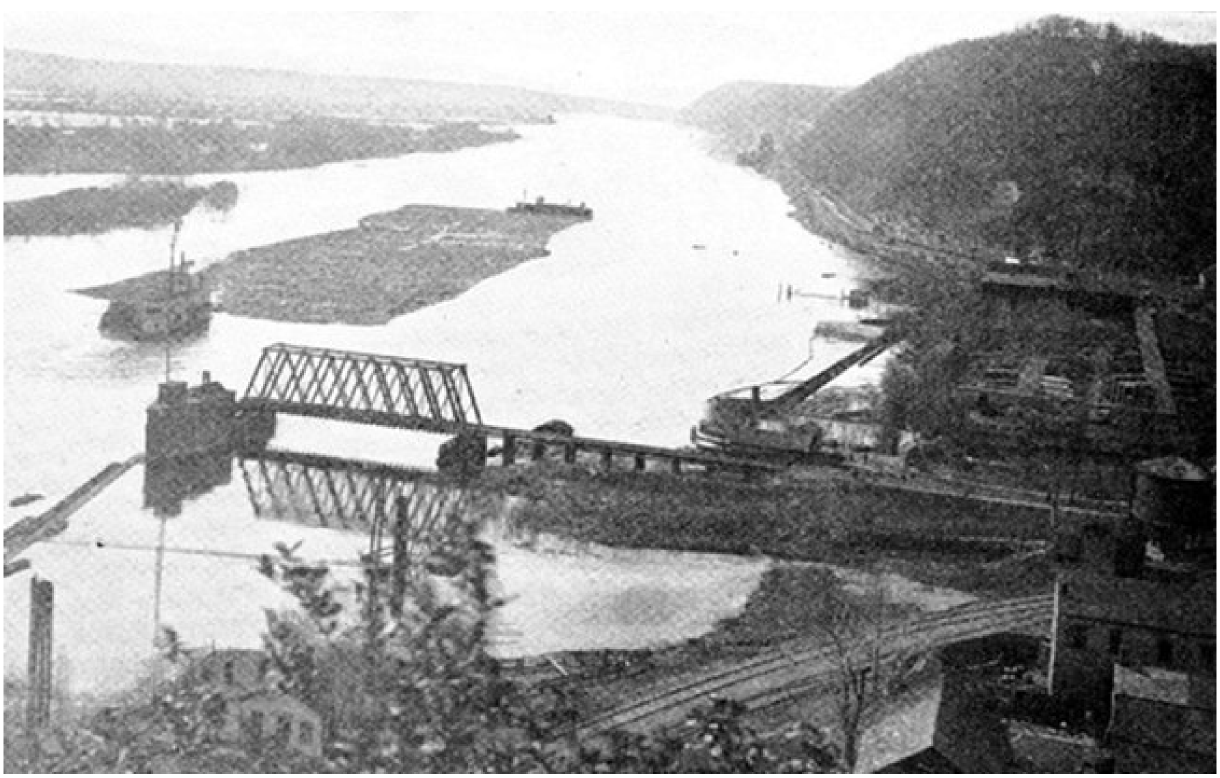

Figure 4. 1905 photograph of the Mississippi River at Marquette. The paddle wheeled tug on the river is guiding a raft of logs downstream. The lower ridge in the distance is Point Ann with Pikes Peak just beyond it. The dark form in the foreground is the old grain mill at McGregor, the foundation of which can still be seen. Photo from IGS Annual Report XVI.

Sarah. Wood from the sawmill was also used to build the Yellow River Mission School three miles west of the present Effigy Mounds National Monument.

Fort Crawford figures into an intriguing story of buried treasure at Wyalusing State Park, in Wisconsin across the river from Pikes Peak, dates back to the fur trading era. As the legend goes, bandits stole a quantity of gold from payments at Fort Crawford in Prairie du Chien. With soldiers pursuing them, the thieves were forced to bury the loot. Only one of the bandits survived and then just long enough to give a general description of the hiding place. If we can believe this tale, tens of thousands of dollars in gold lies, "*…on a high bluff near the mouth of the Wisconsin River.*"

In 1840, a military road was built to connect Fort Crawford with Fort Atkinson forty miles to the west. Supplies were taken up the military road in wagons pulled by teams of mules. Fort Atkinson was built to protect the Winnebago Indians from rival tribes. In 1837, the Winnebago tribe was moved from Wisconsin to Iowa. The military used the road until 1849 when Fort Crawford was abandoned. Pioneers continued to use the road until 1860. The old military road that passed Pikes Peak State Park along the Mississippi River is still visible where it passed through the South Unit of Effigy Mounds near the Yellow River.

Commerce and McGregor

In 1837, Alexander MacGregor and Thomas Burnett established a ferry boat landing along the Mississippi River at the mouth of Bloody Run Creek just north of Pikes Peak. This landing eventually became one of the most important shipping depots west of Chicago (Fig. 4). In 1847 MacGregor hired a surveyor to plot out a size-block area, which later became known as McGregor upon its incorporation in 1857. McGregor grew rapidly, becoming known as "Gateway to the West". Its colorful history included the near lynching of a railroad official by unpaid workers at the present American House; floods; and fires. The boys of the local Ringling family, who went on to found the Ringling Brothers Circus, spent their formative years in McGregor back yards. Jesse James once visited the Moody farm south of town; and the steamboat shipping office of the colorful Diamond Jo Reynolds still stands in McGregor and is listed in the National Historic Register. The 20-room mansion built by business tycoon William Huntting (Fig. 5), considered one of northeast Iowa's finest examples of 19^{th} century architecture, adds another page to McGregor's unique in historical lore.

Figure 5. The beautiful Victorian house built by William Huntting in McGregor.

Origins of Pikes Peak State Park

The core of Pikes Peak State Park is 960 acres that was part of a parcel of land once owned by Martha Buell Munn. She was the granddaughter of James MacGregor, brother of Alexander MacGregor was the founder of the nearby town of McGregor, two miles to the north. The Pikes Peak portion of these parcels was always a favorite family picnic spot and the MacGregors' and Munns' protected it from being logged for firewood to feed the hungry riverboat boilers. Several old oaks in the picnic area, estimated to be over 300 years old, bear testament to this protection. A relative of Martha Munn, James B. Munn of New York, first offered the land as a gift to the Upper Mississippi River Wildlife and Fish Refuge in 1928. The original gift consisted of Pikes Peak, Point Ann, McGregor Heights, and a few smaller parcels of land.

The recipient of the donated lands was the federal government, and the deed restrictions stated that the land must be used for a park. At the time there was sentiment that a National Park be created along the Mississippi river, but before anything was done about this proposal the Great Depression struck. When the social programs of the Thirties were instituted to get people back to work Iowa was ready. With visionaries such as McBride, Pammel and Shimek a state park system had already been designed. Several parks were already on line others were in advanced planning stages and more areas to be considered identified.

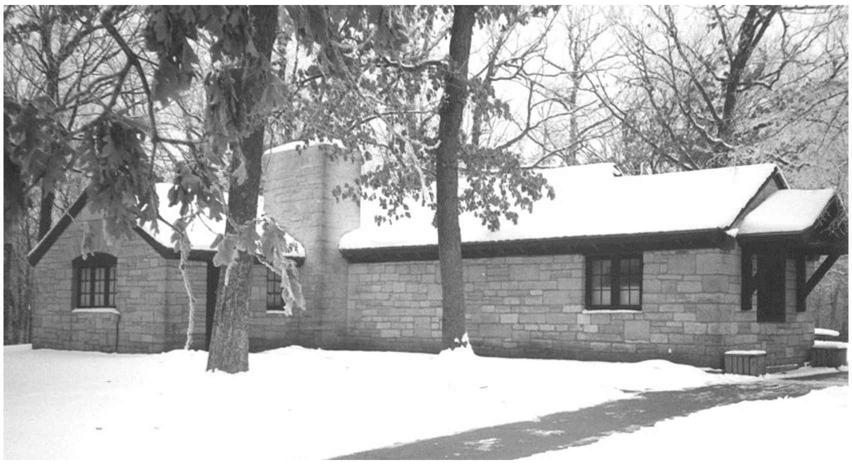

Figure 6. Pikes Peak's concession stand was constructed by the CCC in the 1930s.

Because the Iowa Conservation Commission was at the forefront in developing a state park system, the federal government gave, by act of Congress, the Munn property to the State of Iowa. Originally there were three separate parks considered for the Munn lands. Pikes Peak, Point Ann on the southern boundary of McGregor, and McGregor Heights on the bluff on the north edge of town. In the mid Thirties work at the Pikes Peak portion was commenced by a Civilian Conservation Corps company that was originally based in Des Moines. The company had spent some time just across the border in Hokah, Minnesota, before being moved to McGregor.

Point Ann, McGregor Heights, and the other parcels have not yet been developed. In the late 1960's and early 1970's the Iowa Conservation Commission started acquiring the private lands in between Pikes Peak and Point Ann. The park now consists of 960 acres with 13 miles of trails winding through it.

More recently Pikes Peak has undergone a major renovation. Two overlook structures (Figs. 7 & 8) were constructed, providing access to the magnificent views of the Mississippi and Wisconsin rivers to all. Concrete walks were constructed to connect many of the parks

Figure 7. A two-tiered overlook was recently constructed at Pikes Peak, providing a full access view of the scenic river valleys.

attractions to the parking area, and a series of boardwalks and improved trails give firm footing and easy access to many other areas, such as Bridal Veil Falls and the Bear Mound adjacent to the picnic area. The overlooks and boardwalks are kept clear of snow in the winter. The picnic area has a playground for the kids, modern toilets and a park store for snacks and souvenirs. The 77 unit camp area has modern shower and rest rooms facilities (open May through October), non-electric, 30 and 50 amp electric sites and 23 camping pads requiring very little leveling.

Come and explore. You'll known when you arrive, no sign needed.

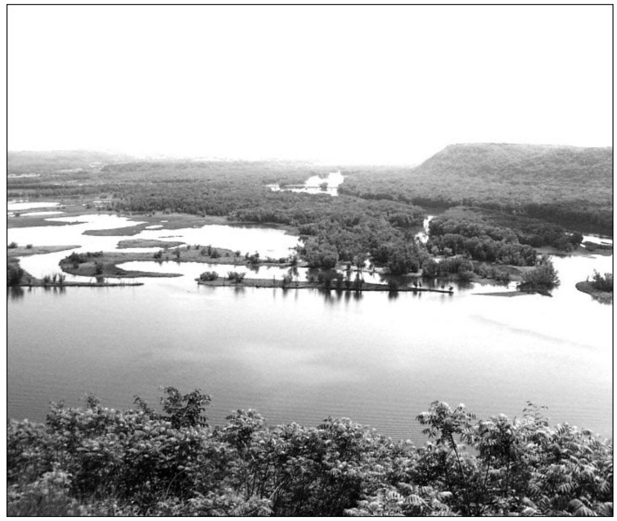

Figure 8. The view looking east across the Mississippi River and up the valley of the Wisconsin River. Wyalusing State Park is on the bluff to the right.

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prepared by
Raymond Anderson

HISTORY OF MCGREGOR – 162 YEARS ON THE MISSISSIPPI

modified from McGregor Chamber of Commerce Brochure

McGregor sprouted from a ferryboat landing that Alexander MacGregor and Thomas Burnett established in 1837. This landing eventually grew into one of the most important shipping depots west of Chicago. It was in 1847 when MacGregor hired a surveyor to plot out a block-size area which later became known as McGregor upon its incorporation in 1857. Apparently the "a" in the MacGregor family name was dropped from the town's name (McGregor) early in its history with the consent of the MacGregor family. They had apparently deleted the "a" when referring to the town in family letters and diaries.

McGregor's colorful history is full of tantalizing tidbits of Midwest culture. These include the rapid growth of McGregor as the "Gateway to the West", the near lynching of a railroad official by unpaid workers; tragic floods and fires; the story of how the famous Ringling Brothers Circus had its beginning in the back yards of McGregor (see story beginning on page 71); a visit from Jesse James on the Moody farm south of town (detailed below); the colorful Diamond Jo Reynolds whose steamboat shipping office still stands in McGregor and is listed in the National Historic Register; the story of business tycoon William Huntting's 20-room mansion which is credited today with being one of northeast Iowa's finest examples of 19th century architecture, and many other stories. These adventures make McGregor unique in historical lore.

Agri-Grain Marketing in McGregor

Barge traffic is a common sight in the McGregor area. At Agri-Grain Marketing, tourists and home folks alike enjoy watching the barges being loaded with grain and shipped out to the gulf for the purpose of exporting to other countries. An average season will send about 25 million bushels of corn and 10 million bushels of soybeans to market. For your education and interest, they have guided tours each Wednesday at 3 p.m. from mid-March to mid-November. Other times can be arranged through their office.

McGregor Historical Museum

At the McGregor Historical Museum you can find exhibits on river history and the founding of the community as a ferry boat landing in 1837. There is also information on how the Ringling Brothers, as in Ringling Brothers Barnum & Bailey Circus, got their start performing in the back yards of McGregor. It additionally has displays of Civil War relics, household antiques and more! Open Monday, Friday and Saturday, 2-5 P.M. at 254 Main St. in McGregor, IA 52157, phone 319-873-2186.

JESSE JAMES STOPS FOR BREAKFAST

from http://www.mcgregor-marquette.com/history/things/jesse.htm

It was a normal August day on the Maple Moody farm just three miles south of McGregor in 1876. Maple was away helping a neighbor with the harvest and a neighbor girl, Martha was helping Mary. There came a knock at the door. Mary upon opening the door was impressed with the appearance of the leader of the men at the door. He was very polite as he requested breakfast for the men he was traveling with. Mary and Martha enjoyed fixing the meal for the men and were especially surprised when each of them left a dollar on their way out for the wonderful hospitality. A few days later while Mary was reading the paper after having supper with Maple, she was amazed to see a picture of the man who came knocking at her door just days earlier. It was the notorious Jesse James. He was wanted in connection to a robbery in Northfield, MN. He had told Mary that the men where headed to Northfield to work in the wheat fields. Mary lived to be 104 and never forgot the day Jesse James stopped for breakfast.

McGregor Statistics & Facts

> The population of McGregor is approximately 797.

> The approximate number of families is 477.

> The amount of land area in McGregor is 3.596 sq. kilometers.

> The amount of surface water is 0 sq kilometers:.

> The distance from McGregor to Washington DC is 827 statute miles. The distance to the Iowa state capital is 163 statute miles. (Statute miles are "as the crow flies")

> McGregor is positioned 43.02 degrees north of the equator and 91.18 degrees west of the prime meridian.

A BRIEF HISTORY OF MARQUETTE

In the beginning, around 1857, Marquette was known as North MacGregor, it was born from the need of a supply point for the proposed railroad that would be passing through the valley of Bloody Run Creek. This supply point quickly developed into a thriving community. As the railroad grew, so did the community now known as Marquette. It was the first all rail route between Chicago and the Twin Cities.

Marquette was incorporated on May 12, 1860. Much of the town and the railroad were destroyed during disastrous floods in 1896 and 1916. The damages, however, were quickly corrected. Marquette received its name in honor of Father Marquette, who with Joliet, first explored through the upper Mississippi River in 1673.

The Isle of Capri Riverboat Casino

Nestled between the picturesque bluffs and Mississippi River, the Isle of Capri (formerly the Miss Marquette) Riverboat Casino is home to the widest variety of casino games and entertainment facilities in a 100 mile area. As the premiere riverboat casino on the upper Mississippi, Isle of Capri Riverboat Casino offers live table games and a variety of slot machines. There's blackjack, live poker, roulette, craps, Let It Ride, Caribbean Stud, and over 675 slot machines from a nickel up. Plus, there's a great buffet, comfy cliff-side hotel and showroom that offers some of the finest national and regional acts around, and it is open 7 days a week.

Figure 1. Isle of Capri Riverboat and Casino.

MCGREGOR'S OWN RINGLING BROTHERS

by Raymond R. Anderson

The Ringlings in the McGregor Area

modified from http://www.ringling.com/home

The town of McGregor was the home of harness maker Augustus Ringling and his family from 1859 to 1972. Four of his famous sons, the Ringling brothers of Ringling Brothers Circus fame (including the youngest and most successful John) were born at the family home at Walton Hollow near Pikes Peak. Jim Franklin, McGregor writer, is currently completing a book on the Ringlings, ***"The Ringling Brothers: From McGregor to Baraboo,"*** to be published soon by Popcorn Press of McGregor. Mr. Franklin's research indicates that the Ringling boys were first exposed to the circus life when **Dan Rice's Steamboat Circus** came to McGregor. The boys soon developed tumbling and juggling skills, one even learned to balance a plow on his chin. Their early performances were in the back yards of McGregor where they honed their skills. In 1872 the Ringling family moved to Prairie du Chien, then in 1874 to Baraboo where the brothers organized their first commercial circus in the late 1870s.

Alf Ringling

Al Ringling

As the 19th century was coming to a close, the Ringling brothers of Baraboo, Wisconsin, were building a reputation. Beginning their tented circus in 1884, Alf T. Ringling, Al Ringling, Charles Ringling, John Ringling, and Otto Ringling soon became known as Kings Of The Circus World. A sixth brother, Henry Ringling, joined the show in 1886.

By 1887, the Ringling brothers' show was growing. The official title was **Ringling Bros. United Monster Shows, Great Double Circus, Royal European Menagerie, Museum, Caravan, and Congress of Trained Animals**.

Charles Ringling

In 1889 the seventh Ringling brother, A.G. "Gus" Ringling, joined the show, which now had a seating capacity of about 4,000 as it played cities and towns in Wisconsin and Illinois. Admission was 50 cents for adults and 25 cents for children. The year also marked a first for the Ringlings, as they took to the rails, becoming the 12th such circus to do so.

As time went on, the Ringling's show grew bigger, and a series of business deals enabled them to absorb some of their competition. In 1905, James A. Bailey sold the Ringlings 50 percent interest in his Forepaugh-Sells Bros. Circus; Bailey died in the spring of 1906, and the Ringlings subsequently purchased the other 50 percent from his widow for $100,000.

Otto Ringling

In 1907, the Ringlings finally purchased their largest competitor -- Barnum & Bailey Circus -- after more than a year of discussion and negotiation. Interestingly, the Ringlings were split in their opinions as to whether the purchase ought to have happened: Otto and John wanted the deal to happen, while Al, Charles, and Alf T. needed to be convinced. On July 8, 1907, the deal went through and **THE GREATEST SHOW ON EARTH®** became the property of the Ringlings for a price of $400,000.

The Ringlings shared the public's respect for the Barnum & Bailey name, and toured the two shows separately until 1919. That year, due to wartime conditions that included labor shortages and rail travel problems, the Ringlings merged the two great entities. The result, consisting of 100 double-length railroad cars and 1,200 employees, was arguably the largest traveling amusement enterprise up to that time: **Ringling Bros. and Barnum & Bailey® Combined Shows, THE GREATEST SHOW ON EARTH®**.

John Ringling

THE GREATEST SHOW ON EARTH® was becoming truly legendary, but none of John Ringling's six brothers lived to see what was perhaps his greatest business triumph. In 1929, reacting to the fact that his competitor, the **American Circus Corporation**, had signed a contract to perform in New York's Madison Square Garden, Ringling purchased American Circus for $1.7-million. In one fell swoop, Ringling had absorbed five major shows: **Sells-Floto**, **Al G. Barnes**, **Sparks**, **Hagenbeck-Wallace**, and **John Robinson**.

By the time John Ringling died in 1936, **Ringling Bros. and Barnum & Bailey® Circus** had become deeply ingrained into the American tradition and consciousness. John Ringling North, an executor of his uncle's estate, became president of the show in 1937, a position he held until 1943 when his cousin, Robert, became president. John took the position once again in 1947.

Times, and the public's taste, were changing, and the circus had problems keeping pace. On July 16, 1956, in Pittsburgh, Pennsylvania, the financially troubled **Ringling Bros. and Barnum & Bailey®** gave its last performance under the big top. John Ringling North commented that "the tented circus as it exists today is, in my opinion, a thing of the past." *Life* magazine wrote that "a magical era had passed forever."

Before long, though, the magic would return.

Later that year, Irvin Feld would save **Ringling Bros. and Barnum & Bailey®** from oblivion by masterminding its transition from tents to arenas, his vision and creativity ushering in a new era of entertainment. Feld not only restored Ringling Bros. and Barnum & Bailey® to its former glory, but set the stage for **THE GREATEST SHOW ON EARTH** to reach new heights of excellence!

Ringling Brothers Mud Show Wagon

modified from http://www.circusparade.com/wagons/w_rbmud.htm

Small circuses that were not big enough to travel by railroad moved from town to town using horse-drawn wagons, making short jumps of perhaps 5 to 15 miles. When it was raining, the dirt roads became very muddy. Thus these small wagon shows were known in the circus business as "mud shows." One of the most esteemed wagons in the Circus World Museum's collection is this vehicle from the Ringling Brother's mud show days. The Ringling Brothers started their circus in Baraboo in 1884. For the first six years, this circus traveled from town to town by horse power. This venerable wagon spent many a season in this period hauling concession equipment for the Parsons, who operated this department. The Parson family of Darlington, Wisconsin had this wagon in storage along with a great collection of miscellaneous circus gear, all of which they presented to the Circus World Museum in Baraboo, Wisconsin, where it can be viewed today.

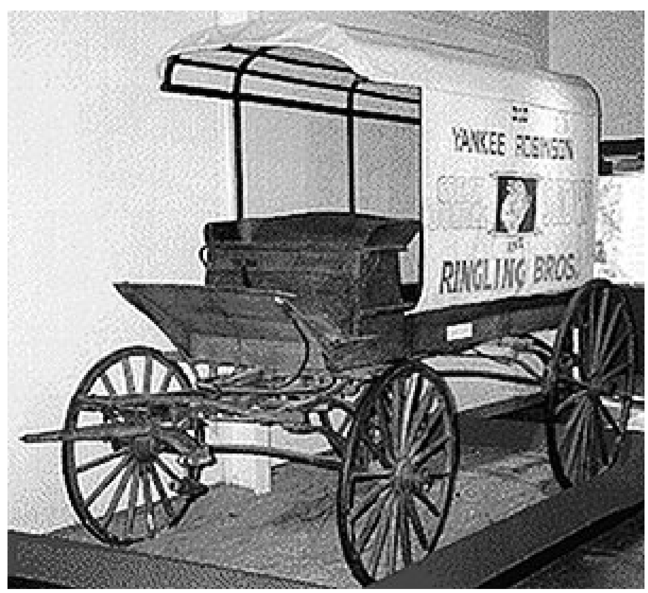


Figure 1. The Ringling's first circus wagon can be seen at the Circus World Museum in Baraboo

Ringling Brothers Bell Wagon

modified from http://www.circusparade.com/wagons/w_bell.htm

Having graduated from a horse-drawn wagon show to a full-blown railroad show in 1890, the Ringling Brothers felt they had to have some special parade wagons to prove they were a big show. So, for the 1892 season, they ordered the famous and magnificent Bell Wagon (Figure 2). The Moeller Bros. Wagon Works of Baraboo received the order. Centennial Bell Foundry in Milwaukee produced the nine bronze bells that weighed 4300 pounds and the Milwaukee Ornamental Woodcarving Co. produced the

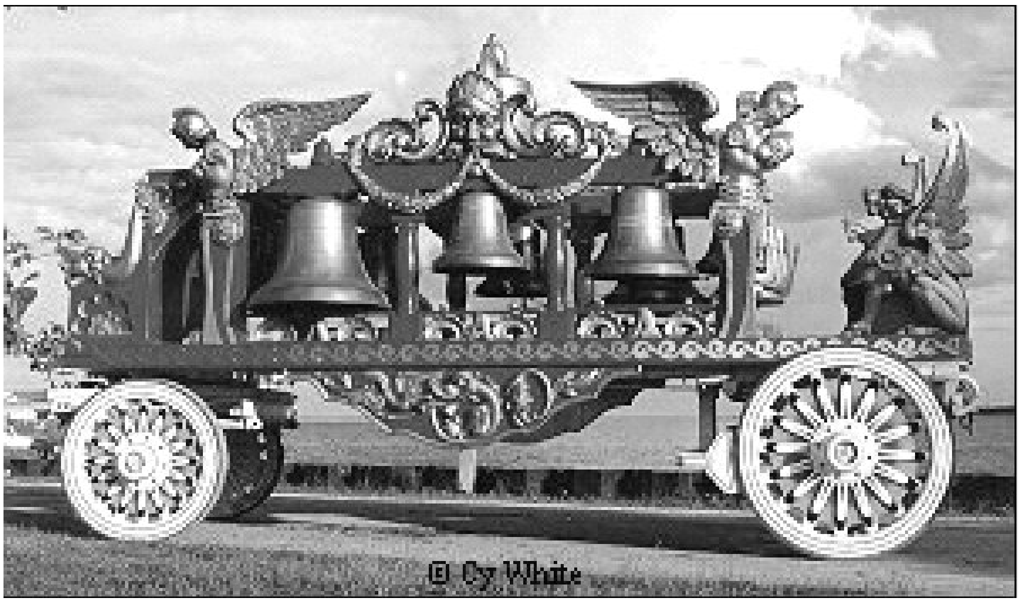


Figure 2. The Ringling Bell wagon, the star of many circus parades, is now on display at the Circus World Museum in Baraboo, Wisconsin

decorative woodcarvings. This street parade vehicle is considered one of the most beautiful of all time. Traditionally, music was an important part of any circus street parade. The operator of the bell wagon sits on the rear seat in front of nine spring-primed levers, each connected to one of the clappers. The glorious and melodious tones that emanated from the bells could be heard many blocks away, adding to the excitement of the parade

LOCK AND DAM CONTROL OF THE MISSISSIPPI RIVER

revised from U.S. Army Corp of Engineers-St Paul District
http://www.mvp.usace.army.mil/history/pamphlets/old_man_river/

Mississippi River Pool 10

The Mississippi River that borders Pikes Peak State Park on the east is a part of a sophisticated transportation and recreation system modified and controlled by the U.S. Army Corps of Engineers. In the 1930s they constructed a series of 27 locks and dams along the upper Mississippi River between Red Wing, Minnesota, and St. Louis, Missouri (see Fig. 1). The dams serve to impound water to insure that an adequate water depth is present in times of low flow and to contain floodwaters in times of high flow. Lock and Dam 10, located in Guttenburg (Fig. 2), controls the stretch of river that borders the park. The lock at this facility was completed on May 29, 1935; the dam was completed 15 December 15, 1936. The gates were closed and the lock and dam was officially placed in operation November 26, 1937; total project cost was $ 6,560,252. The facility is 600 feet long and 110 feet wide, and impounds a pool with and elevation of 611 feet above sea level, 8 feet higher than the river downstream. The dam includes 4 roller gates that are each 80 feet long and 20 feet high, and 8 Tainter gates, each 40 feet long and 20 feet high. The maximum discharge through the dam is 226,300 cubic feet per second. The Corps has title to 3,720.71 acres of land along Pool 10, including most islands and much of the land directly adjoining the river.

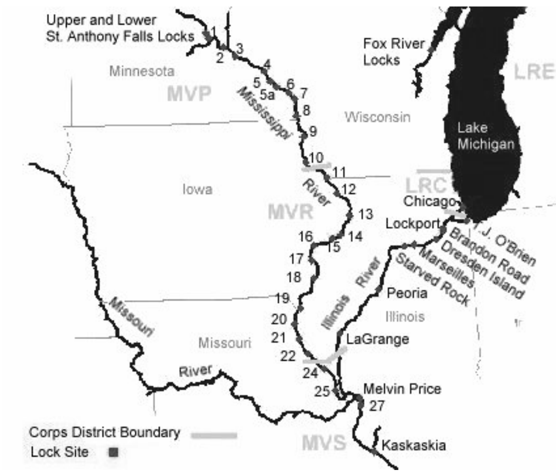


Figure 1. Location of locks and dams on the Upper Mississippi River.

Commercial History of the Mississippi River

Congress authorized the Corps of Engineers to construct the Mississippi River locks and dams because of the rapid growth of population, agriculture, and industry in the Upper Midwest after 1900. By 1920, railroads could not handle all the goods produced and demanded by Midwesterners and often charged monopoly rates. The Mississippi River, once the principal artery of commerce in the Midwest, was inadequate for modern shipping needs in its natural condition. And as shipping costs increased, the growing numbers of Midwest businessmen and farmers demanded a cheap and efficient transportation system. Without such a system, they believed, their region could not compete in either national or international markets. For this reason, they argued, the Midwest would stagnate; its booming cities would become prairie towns again, and its economy would not mature

Figure 2. Lock and Dam 10 at Guttenburg

Since the mid-19th century, the Corps had improved the Mississippi River for navigation through dredging, snagging and clearing, and channel constriction. The latter procedure began with the authorization of the 4 1/2-foot channel in 1878 and continued with the 6-foot channel in 1907. Channel depth was based on the low-water year of 1864; ideally, if another year as dry as 1864 occurred, there would be at least 4 1/2 or 6 feet of water for navigation. The Corps constricted the river with wing dams and the closing of side channels. Together, these measures forced the river down a narrower passage, allowing it to cut through sand and debris in the main channel. The Corps also completed Lock and Dam No. 1 in the Twin Cities, in 1917, and Lock and Dam No. 2 at Hastings, Minnesota, in 1930, because wing dams were inadequate in these areas. The 4 1/2- and 6-foot channels sufficed for rafting lumber and for the shallow draft packets, tows, and barges of the late 19th and early 20th centuries, but could not meet the demands of modern business and agriculture.

Commercial use of the Upper Mississippi River declined after 1892 as the timber industry --- its primary user --- exhausted the region's forests. In 1892 lumbermen shipped a record 5,113,913 tons of logs (see Fig. 3) and lumber on the river between St. Paul and the mouth of the Missouri River. By 1916, the total for all goods shipped on this reach of the Mississippi River fell below 1 million tons annually and did not recover until the 1940s.

Other factors aggravated the Midwest's transportation problem. With the completion of the Panama Canal in 1914, goods could be shipped more cheaply between the East and West Coasts than from the Midwest to either coast. The Midwest had, in effect, moved economically farther from the coasts than the coasts were from each other. As a result, Midwest businesses could not compete as easily with businesses on the seaboards. Some Midwesterners believed that since the Federal Government had built the Panama Canal, it should compensate them with a 9-foot channel on the Upper Mississippi River.

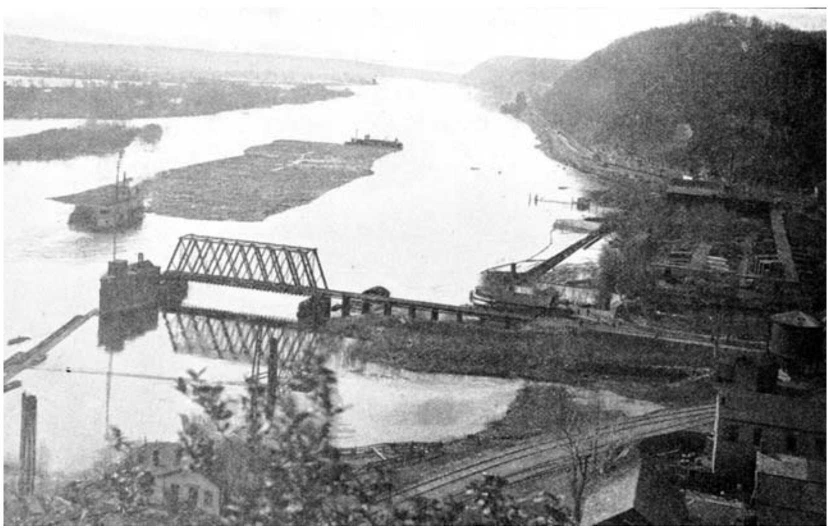


Figure 3. Raft of logs moving downstream past McGregor in 1905. Point Anne appears in the upper right corner of the pictures, Pikes Peak on the horizon near the center.

In the early 1920s, the costs of shipping in the Midwest increased further. The Interstate Commerce Commission, in the Indiana Rate Case of 1922, determined that the Mississippi River was not an effective transportation route and ruled that railroad rates should no longer be set against the lower waterway rates. When freight rates rose again, several important Minneapolis businesses moved to a region with lower transportation costs.

Rising transportation rates struck Midwest farmers hard. American agriculture had been in a depression for most of the 1920s. With higher freight rates, the purchasing power of farmers decreased and their crops became less competitive, strapping them even further.

While shipping on the Upper Mississippi River declined, traffic on the lower river increased. New towboats and barges, with drafts of eight and one-half feet, could haul two to four times as much cargo as freight trains. These new developments in shipping on the lower river demonstrated the promise of a deep channel on the upper river, but the new towboats and barges could not operate on the shallower Upper Mississippi River. Goods had to be transferred to smaller towboats and barges, increasing shipping costs greatly. This breaking of bulk, as rivermen called it, discouraged use of the Upper Mississippi River. Because of this limited and costly transportation network, many Midwesterners feared that their region would stagnate or decline. Not only would businesses decide not to locate in the Midwest, those already there would leave.

As a result, businessmen, civic leaders, politicians, and farmers joined to fight for the 9-foot channel project. The principal champions of the project were Secretary of Commerce and later President Herbert

Hoover, Minnesota Senator Henrik Shipstead, and businessmen such as retired Colonel George C. Lambert, S.S. Thorpe, C.C. Webber, and A.C. Wiprud. Secretary Hoover believed that improving America's inland waterways would solve the farm crisis and better integrate the nation's economy. More than any other advocate he made the 9-foot channel a national issue.

Senator Henrik Shipstead led the fight for the project in Congress, not only for its authorization but for its funding after the stock market crash of 1929. Lambert, Thorpe, Webber, Wiprud and others, working for the Upper Mississippi and St. Croix Improvement Commission, the Upper Mississippi Waterway Association, and the Minneapolis Real Estate Board, mobilized businessmen and farmers from New Orleans to Minneapolis in support of the project. By 1927, they had succeeded in getting a survey for die feasibility of a 9-foot channel on the Upper Mississippi River, and by 1930, Congress had authorized the construction of 24 locks and dams from Red Wing, Minnesota, to near St. Louis, Missouri.

The Great Depression, however, threatened to postpone construction. Hoover, now President, withdrew his support for the project because he did not believe in deficit spending, and he approved only small expenditures for the project. Fortunately for the Midwest, his successor, Franklin Roosevelt, not only recognized the project's commercial importance, but he saw it as an opportunity to put thousands of unemployed citizens to work. In contrast to Hoover, Roosevelt accepted deficit spending as a way to improve the economy. In 1933, he signed the National Industrial Recovery Act, providing $51,000,000 for the project through the Public Works Administration, $33,500,000 of which became available immediately. Now that the Corps had money for the project, it had to work out the details of building such a massive undertaking.

Project Design Considerations

The Mississippi River posed unique problems for the Corps of Engineers. While the Corps had completed a 9-foot channel project on the Ohio River in 1929, the Mississippi River required a different approach. In response to the problems encountered on the Upper Mississippi River, the Corps developed many innovative and precedent-setting solutions. As the project advanced, the Engineers incorporated experiences learned along the way. Consequently, the locks and dams embody a history of dam engineering technology.

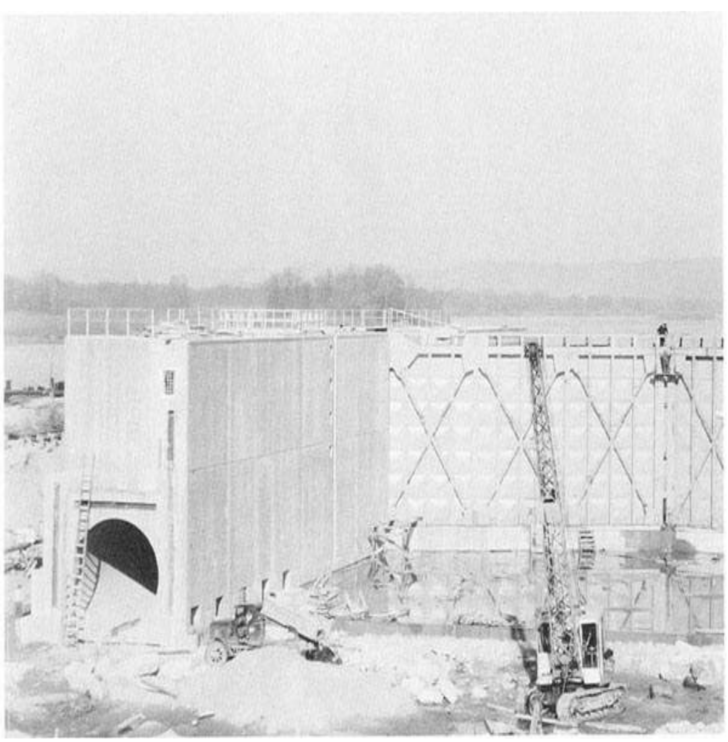


Figure 4. Mississippi River lock under construction.

After intensive surveys on the Upper Mississippi River and an extensive inspection of dams in Europe and the United States, the Corps of Engineers decided to build a lowcrest, non-navigable dam. High, fixed dams would have flooded the railroads, farmlands, and buildings in or just above the floodplain. And navigable dams --- dams that allowed open river navigation during high stages --- such as the Chanoine wicket dams of the Ohio River, could not be used on the Mississippi River because of the short duration of high stages. While low crest dams were more expensive, they were more dependable, easier to maintain and repair, safer to operate, and sustained an operational channel better than navigable dams (Fig. 4).

The selected dam contained a number of elements: dikes, spillways, and both Tainter and roller gates. Each type of gate had been used in dams before, but general dam engineering practice discouraged the use of both types in one dam. By incorporating both gates into their dams on the Mississippi River, the Corps established a precedent in dam engineering.

Invented by Wisconsin lumberman Theodore Parker and patented by Jeremiah B. Tainter in 1886, Tainter gates (Fig. 5) became the principal component of the dam. The Corps chose these gates for the main part of the dam because they were cheaper than roller gates and still offered dependable operation. Tainter gates, however, were ineffective for spans greater than 35 feet, and some channel openings had to be wider than this to accommodate the passage of ice and debris. Also, Tainter gates were difficult to maneuver during cold weather because ice often formed on them. Roller gates solved both the problems of length and icing.

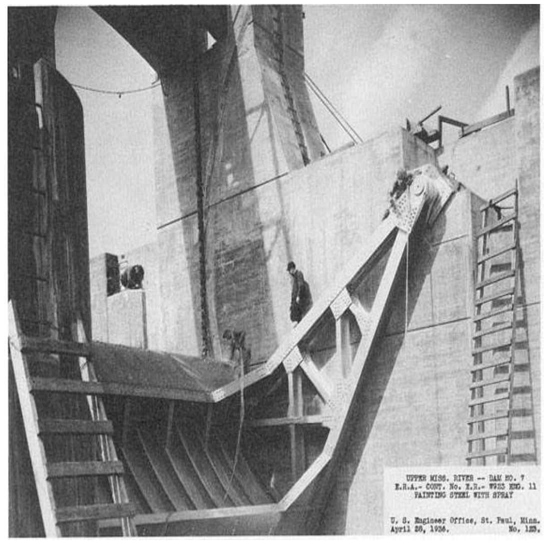


Figure 5. Photo of a Tainter gate as used on Mississippi River dams.

Swedish engineer M. Karstanjen invented the roller gate (Fig. 6) about 1900, and the Krupp and M.A.N companies, in Germany, patented it. The gates are large cylinders with toothed ends that mesh with an inclined track set into the piers at the ends of the gate. Large, electrically operated gears on top of the piers raise and lower the gate. While roller gates had not been used extensively in the United States, Scandinavian countries had used them for many years under severe ice conditions. Roller gates offered the greatest assurance of operation in freezing weather with a span of 80 feet or more between the supporting piers.

"In general," the Engineers concluded, "the dam will be composed mainly of Tainter gates, with a sufficient number of roller gates to pass running ice and drift, and to provide ample capacity for the greatest flow likely to occur during the winter months." To ensure the greatest economy in design, construction, and operation, the Engineers recommended that gate size be standardized. Consequently, all the New Deal era Tainter gates in the St. Paul District are 35 feet wide, and all the roller gates, except Nos. 4 and 5, are 80 feet wide. The roller gates at dams 4 and 5 are only 60 feet wide because they were the first two built in the District, before the mid-1930s when advances in roller gate technology allowed for wider gates.

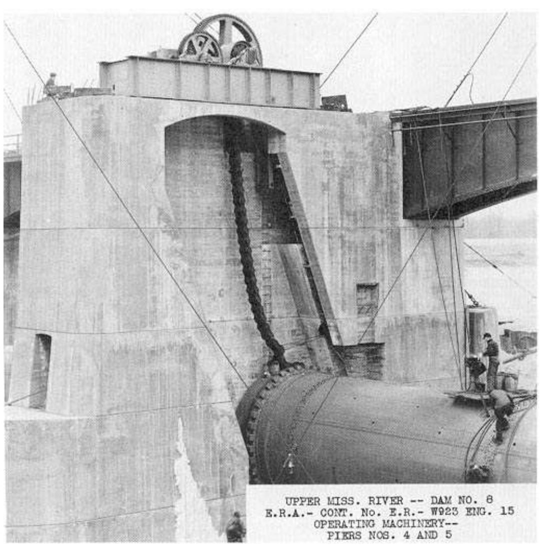


Figure 6. A roller gate as used in the Mississippi River dams.

The Corps patterned the Mississippi River locks after those on the Ohio River. All of the New Deal locks are 110 feet wide by 600 feet long, and the lock chamber fills through the opening of Tainter gate valves in the lock walls. The use of these gates as valves was characterized as "somewhat unusual."

Unusual, unique, and innovative are terms that characterize the 9-foot channel project on the Upper Mississippi River. To deal with the unusual conditions on the river, the Corps built models of most of the project's elements. According to Martin Nelson, chief of the Corps hydraulic laboratory at the University of Iowa, Iowa City, during the planning and construction of the 9-foot channel, the Corps built models to study the feasibility and operational limitations of roller and Tainter gates, and to gather information on the "hydraulic loadings on which to base the structural design…." They also fabricated small scale models to examine how to improve the hydraulic systems for the locks. And, Nelson reported, the Corps undertook model experiments on "such problems as the feasibility of discharging water over protected sand dams; the effect of percolation through sand foundations on the conditions of failure; determination of coefficients of discharge of weirs, gates, orifices, tubes, etc." The use of model studies was a new development in the 1930s, and, Nelson claimed, "Confidence in this tool of engineering has been greatly aided in this country by the attitude of the Corps of Engineers which has used it as a means of solving some of the most complex problems involved in river flow."

Commercial Navigation: The Vision Realized

During one of America's worst depressions, Congress provided the Corps of Engineers with over $170 million to build the Mississippi River 9-foot channel project. While the project created jobs for thousands of men and women, not even its proponents justified it solely as a make-work project. Its validation depended upon the development of commercial navigation on the Upper Mississippi River.

Commercial traffic on the river began increasing even before the entire project had been completed. ***Old Man River***, the Corp of Engineers St. Paul District newsletter, reported that river traffic for 1937 had expanded 100 percent over 1936 and increased even more in 1938. While World War II stalled the Mississippi River's commercial development, navigation on the river soared after 1945. Within 5 years of the wars end, shipping on the river more than doubled from 4 1/2 million tons to 11 million tons. By 1960, it had more than doubled again to over 27 million tons. Today, barges carry nearly 80 million tons of goods annually on the Upper Mississippi River. Energy commodities --- petroleum products, coal, and coke --- spurred the revival of river commerce. Grain shipping increased slowly, however. Not until the mid-1950s did grain comprise a significant portion of the commodities transported on the river.

Figure 7. Modern tow locking through a Mississippi dam.

Today, agricultural products account for nearly one-half of all goods shipped on the Upper Mississippi River. Proponents of the 9-foot channel project based their projections for the Mississippi River's commercial expansion upon towboats of up to 2,000 hp and tows of some 14,000 tons. Today, towboats of up to 5,000 hp and tows carrying more than 22,000 tons operate on the Upper Mississippi River (Fig. 7). The variety of barges has increased as greatly as their capacity. Open barges carry coal, tank barges haul petroleum, and covered barges transport grain and other perishable cargoes. Some barges have foot-thick linings of specially treated balsa wood for carrying liquid methane gas at minus 258 degrees Fahrenheit, and other barges transport molten sulfur at temperatures of 300 to 350 degrees. Specialized barges also haul carbon black, anhydrous ammonia, and cement. The variety of barges indicates the diversity of goods shipped on the Upper Mississippi River today. See Figure 8 for a comparison of the sizes and cargo carrying capacities of trucks, trains, and barges.

The Mississippi River 9-foot channel works as those who had envisioned it predicted. Both farmers and urban consumers benefit from the project. Bulk shipping of energy products has reduced the costs of consumer products and of manufacturing goods. The cost of shipping agricultural products also has fallen with the river as a dependable means of transport. Because of the 9-foot channel, the Midwest has a cheap and reliable transportation route providing both an outlet for its products and an inlet for the goods it needs.

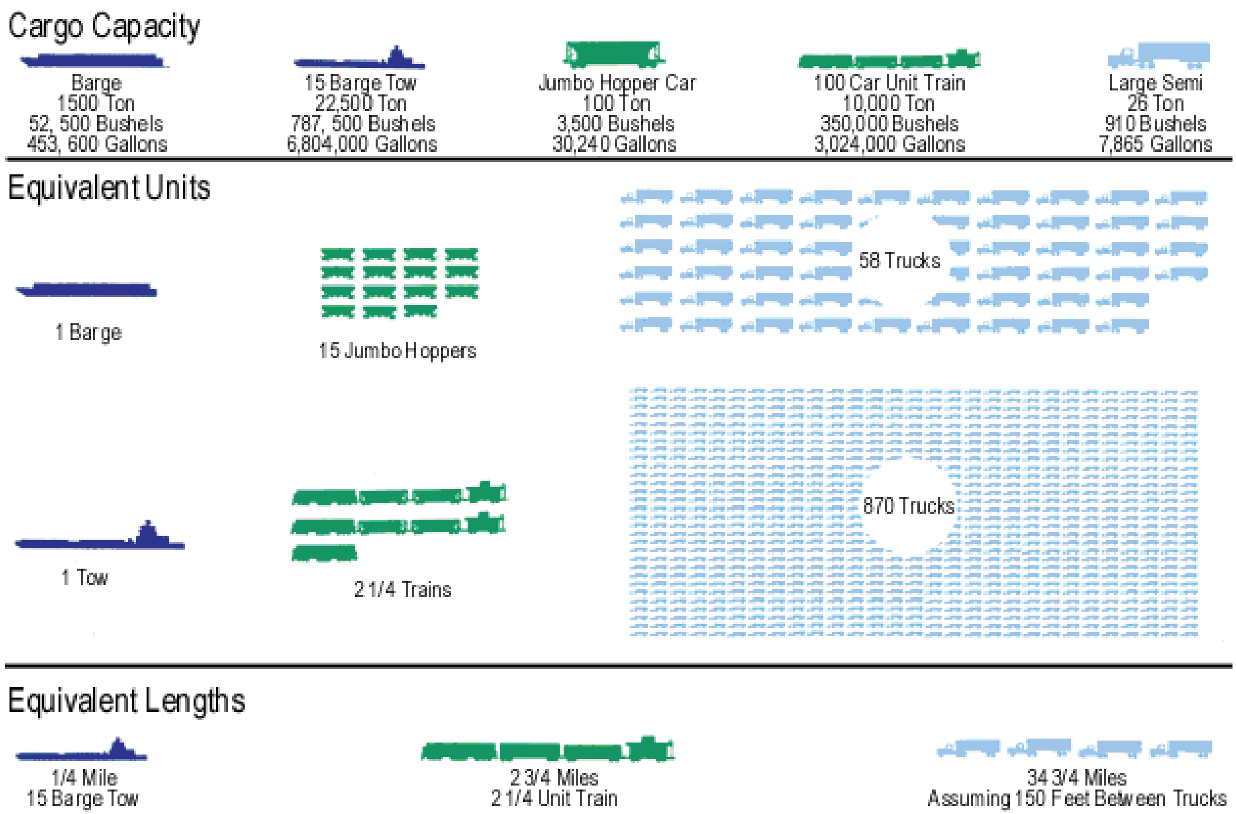


Figure 8. Comparison of carrying capacity and size of river barges, trains, and trucks.

The Future

The Corps of Engineers has begun a major rehabilitation effort for most of the 9-foot channel locks and darns. Under this project the St. Paul District will spend approximately $170,000,000 over the next 15 years to repair and upgrade the 50-year old structures. This effort will insure at least fifty more years of navigation on the Upper Mississippi River.

The 9-foot channel project is part of the country's 25,500 miles of navigable inland waterways. The Mississippi River and its tributaries account for approximately 9,000 miles of this system and constitutes its largest segment. Together, our waterways integrate the regions of the United States into an economically productive whole.

The Environment

National and local conservation groups feared that the 9-foot channel project would destroy the fish and wildlife habitat of the Upper Mississippi River valley. Clearly, the 9-foot navigation channel has changed the environment of the river and its floodplain dramatically. What was a large, free-flowing river with numerous side channels and extensive floodplain forests is now a series of reservoirs separated by small stretches of the old riverine habitat. However, the navigation project has created an environment that is richly diverse and productive for natural resources.

Today, the U.S. Fish and Wildlife Service manages two national wildlife refuges on the Upper Mississippi River. Congress formed the Upper Mississippi River Wildlife and Fish Refuge and the Mark extending 560 miles southward along the river bottoms from Wabasha, Minnesota, to St. Louis, Missouri, comprise these two refuges. The States of the Upper Mississippi River also manage wildlife and fish refuges.

By the 1960s, however, Weaver Bottoms was silting in. Water flowing from the main channel of the Mississippi River entered the bottoms from side channels, depositing sand and sediment. To arrest this deterioration, to provide long-term dredged material disposal sites, and to reduce dredging requirements in the main channel, the Corps, in cooperation with the Fish and Wildlife Service, has closed off the side channels and has started building islands of dredged material in the bottoms. The islands will reduce wave action in the bottoms, improving water clarity and encouraging aquatic plant growth. Thus, the Weaver Bottoms project will preserve an important wildlife refuge while maintaining the 9-foot navigation channel.

The Corps is also working to preserve and record prehistoric and historic sites affected by the 9-foot channel project. Humans have lived in the Upper Mississippi River Valley for 10,000 to 12,000 years. In a 1982 study for the St. Paul District, researchers identified more than 1,000 historically and architecturally significant sites and recorded over 1,400 prehistoric archeological components in the District's portion of the valley alone. Some of these sites, ranging from ancient Indian villages to the locks and dams themselves, are now on the National Register of Historic Places.

Recreation

The chain of lakes or pools created by the 9-foot navigation channel provides opportunities for a variety of recreation activities including sightseeing, fishing (Fig. 9), and hunting. Each year, millions of visitors enjoy the natural resources of the Upper Mississippi River; in 1987, they logged more than 19,000,000 visitor hours in the St. Paul District.

Over 130 years ago, tourists from the East boarded steamboats in St. Louis and ascended the Mississippi River to St. Paul. They came to see the "untamed West," with Indian villages along the banks of the river, to enjoy the river's pristine landscape and high bluffs, and to view St. Anthony Falls. So many Easterners took part in these excursions that they became known as the "fashionable tour." Today, the fashionable tour is a ride on paddleboats such as the Mississippi or Delta Queen or an excursion in a small pleasure craft.

Figure 9. Fishing on the Mississippi River

Boating is one of the most popular summer activities on the Upper Mississippi River. Some recreationists enjoy brief outings on the river while others sail down to the Gulf of Mexico. A number of small-boat harbors, built by the Corps and turned over to local interests, facilitate boating on the river.

Recreational use of the Upper Mississippi River valley is not limited to the waterway. The Great River Road, a continuous system of highways that parallels the river, allows tourists to follow the routes of early explorers, have a picnic lunch at a scenic viewpoint, visit prehistoric Indian village sites, explore historic trading posts and forts, and spend a pleasant evening in a modern campground.

UPPER MISSISSIPPI RIVER NATIONAL WILDLIFE & FISH REFUGE

modified from U.S. Fish & Wildlife Service document RF3-32579-1-11/86
John Lindell, District Manager
U.S. Fish & Wildlife Service
Upper Mississippi Refuge
McGregor District Office
McGregor, IA 52157

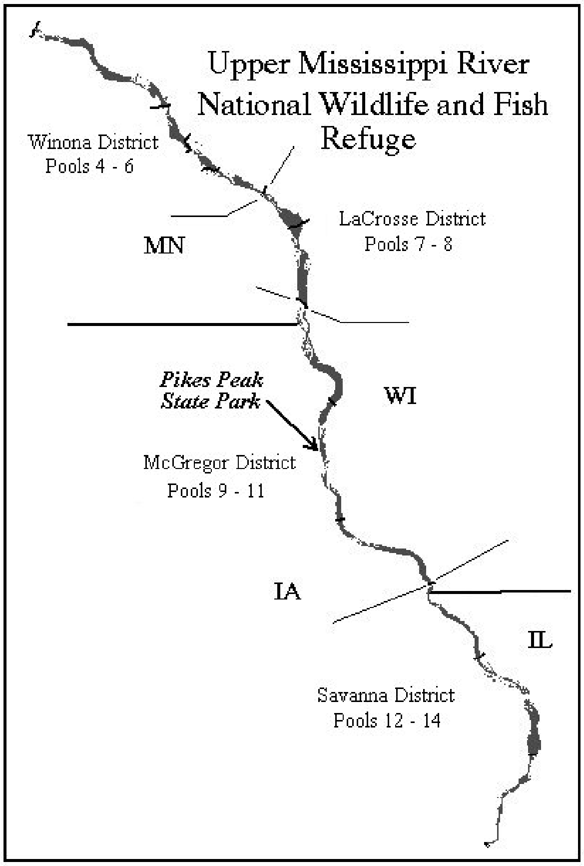


Figure 1. Map of the Upper Mississippi Refuge and limits of Districts.

Introduction

The upper reaches of America's mighty Mississippi River have seen many changes since their exploration by French missionaries and traders. Cities and towns now occupy the sites of historic Indian villages and trading posts. Modern highways have replaced the ancient trails along the riverbanks. Legions of small watercraft, yachts, and ponderous barges travel the waterways. A lock and dam system maintains a 9-foot navigation channel. Yet the visitor viewing the great valley from the bluffs today still notes much of the Upper Mississippi's wilderness beauty as the early explorers saw it. The great cliffs still loom above the river. A carpet of woodlands shrouds the cities and other evidences of man's presence. Fish and wildlife still abound in many places, and the Father of Waters continues to roll ever southward to the Gulf of Mexico.

The Upper Mississippi River National Wildlife and Fish Refuge was established by Act of Congress on June 7, 1924. Original acreages for the project were acquired through purchases, donation, and by withdrawal from the public domain. The area was later enlarged by additional land acquisitions of the U.S. Army Corps of Engineers for navigational improvements. These additional tracts are managed as a part of the refuge. Today the Upper Mississippi Refuge consists of about 200,000 acres of wooded islands, waters, and marshes extending more than 260 miles southward along the river bottoms from Wabasha, Minnesota, to nearly Rock Island, Illinois. The river bottoms forming the refuge are from 2 to 5 miles wide. This great river refuge demonstrates man's ability to preserve scenic, recreational, and wildlife resources amidst the needs of modern civilization.

The Upper Mississippi Refuge is unique among wildlife conservation areas. Its boundaries are the longest of any refuge in the lower 48 states, for it extends hundreds of miles along the river in four states – Minnesota, Wisconsin, Iowa, and Illinois. Containing differing life zones and climactic conditions, some 270 species of birds, 57 species of mammals, 45 species of amphibians and reptiles, and 113 species of fish are found here. Eleven dams and locks within the refuge boundaries form a series

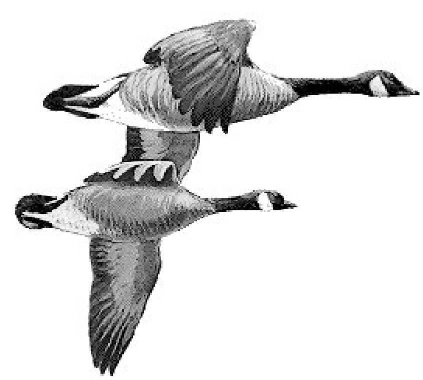


Figure 2. Canada Geese are common Upper Mississippi Refuge visitors *.

of pools that vary from 10 to 30 miles long. The dams have raised water levers, creating a maze of channels, sloughs, marshlands, and open lakes over the bottomlands. Excellent stands of aquatic plants have developed, creating habitat for waterfowl and other wildlife.

The Upper Mississippi Valley is a major migration route for birds. Among the more spectacular seasonal flights are those of the waterfowl. Thousands of tundra swans stop at favorite resting areas during the Spring flight. Large numbers of canvasbacks use the refuge, especially during Fall migration. At times, up to 75% of the canvasback continental population may be seen on Pools 7 and 8 (between Genoa and Trempealeau, Wisconsin) alone. Other diving ducks – principally lesser scaup, ringnecks, redheads, buffleheads, and ruddies – gather on open pools above the dams. Mallards, wigeon, gadwall, teal, and other surface-feeding species are found in the shallow backwaters along the riverbanks. The Mississippi River bottoms are favorite haunts of the wood duck (Fig. 3). Thousands of these brilliantly marked birds feed in the protected sloughs and shallows and nest in the hollow trees along the islands and bluffs.

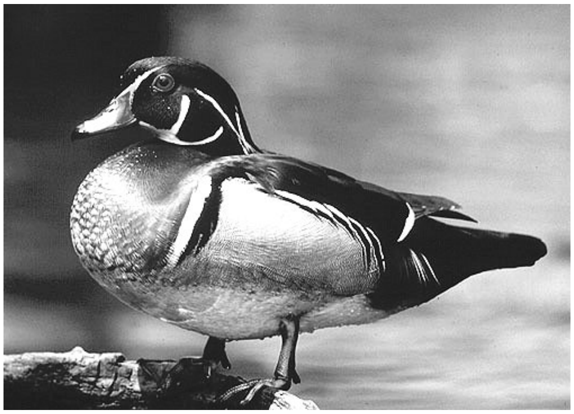


Figure 3. Wood duck are commonly viewed Upper Mississippi River Refuge residents *.

The bald eagle, our national emblem, nests and winters in numbers on the Upper Mississippi Refuge. These majestic birds concentrate below the dams or near the mouths of tributaries where fish provide a ready food supply. Spectacular migrations of other birds are noted during spring and fall when hordes of warblers, vireos, thrushes, and sparrows drift through the trees and shrubs of the river islands and bluffs. Whip-poor-wills and pileated woodpeckers call in the remote woodland areas.

The refuge bottomlands harbor myriads of marsh and water birds such as herons, egrets, bitterns, and rails. Many large rookeries may be observed in more remote reaches where hundreds of great blue herons and egrets raise their young.

Major furbearers along the Mississippi include muskrat, mink, beaver (Fig. 4), otter, raccoon, skunk, weasel, and fox. A few nutria have appeared in recent years. Other mammals include gray and fox squirrels, cottontails, jackrabbits, and white-tailed deer, which are abundant in the timbered areas, plus about 40 smaller non-game animals.

Figure 4. Beavers also live along the river and backwaters of the Mississippi River Refuge.

Visiting the Refuge

The Upper Mississippi Refuge offers unsurpassed opportunities for sightseeing, outdoor recreation, and nature study. It accommodates some 3 million visitors annually for such activities as wildlife observation, environmental education, boating, fishing, hunting, bird study, and sightseeing.

The river valley is rich in historical lore. Traces of ancient mound-building tribes are found along the bluffs and bottomlands. Signs and markers point out the sites of old Indian battlegrounds, villages, forts, trading posts, and the routes of early explorers. Black Hawk, the famous Sac and Fox chief, fought here. Names like Marquette and Dubuque recall early French settlement and influence in the valley.

Figure 5. McGregor District Office of the U.S. Fish and Wildlife Service Upper Mississippi Refuge, located on Highway 18 just north of Marquette.

McGregor District

The McGregor District of the Upper Mississippi Refuge was established in 1924. The District's jurisdiction stretches for 97 miles along the river, including 78,441 acres around Navigation Pools 9, 10 and 11. The District serves about 910,000 visitors annually. The McGregor office (Fig. 5) is located just a few miles north of the park and about 1 mile north of McGregor, Iowa, on Highway 18. It also houses a Visitor Contact Station with displays and written information. To contact the office:

U.S. Fish & Wildlife Service
Upper Mississippi Refuge
McGregor District Office
P.O. Box 460
McGregor, IA 52157
Phone: (319) 873-3423
Fax: (319) 873-3803

Additional information about the Upper Mississippi River National Wildlife & Fish Refuge can be obtained at any of their offices, including the Refuge Headquarters in Winona, Minnesota, or district offices in Winona, LaCrosse, Wisconsin; Savanna, Illinois, or at McGregor.

** Figures 2, 3, and 6 modified from U.S.G.S. Photo Archive.*

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

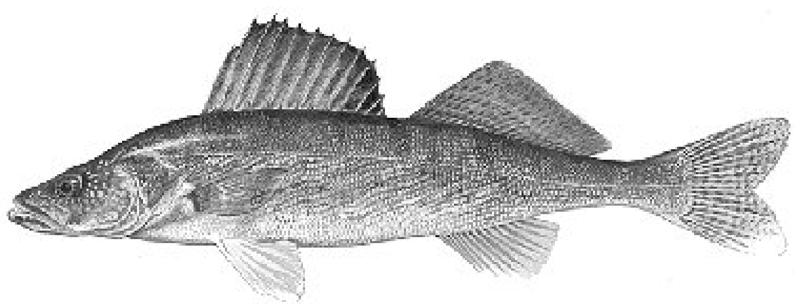


Figure 6. The Walleye is a favorite Mississippi River game fish *.

Stizostedion vitreum vitreum

The largest U.S. member of the perch family, the walleye has a record weight of 25 pounds. They occur throughout central and eastern continental North America from the freshwater areas adjacent to Hudson Bay southward to extreme northern Mississippi and Alabama and stocking continually extends their range. Walleye inhabit open waters of large and small lakes, reservoirs, and the deep pools of streams; and voraciously feed on other fishes, insects and crustaceans. The walleye is considered to be one of the best eating of all freshwater fishes. Spawning occurs at night, sometimes in extremely shallow water. *USFWS*

EFFIGY MOUNDS NATIONAL MONUMENT

prepared by Raymond Anderson
information provided by U.S. National Park Service
modified from http://www.gorp.com/gorp/resource/us_nm/ia_effig.htm

Introduction

Effigy Mounds National Monument is located in the northeastern corner of Iowa on the western bank of the Mississippi River. The park covers 1,481 acres of land in Clayton and Allamakee counties with the headquarters located 5 miles north of Prairie du Chien, Wisconsin and McGregor, Iowa. The park is geographically divided into two areas, the first is the Headquarters Section which includes the North and South units. The second area, Sny Magill rests on Johnsons slough of the Mississippi River approximately 11 miles south of the Headquarters unit. The 100 mounds in the Sny Magill unit represent the largest concentration of mounds in one compact group. The majority of the remaining mounds lie on the ridge tops of the North and South units.

Figure 1. Effigy Mounds National Monument Visitor Center. Within the center, you can view a video about the park and the mound builders, walk through their museum and ask questions of our rangers. Just outside of the newly remodeled center and across the bridge, you can find three conical burial mounds, constructed in the Hopewellian period, about 2000 years ago

The Monument is located in a rarely-glaciated zone scarred by the cutting action of rushing streams on their journey to the mighty Mississippi. The North and South units are mainly upland areas with steep bluffs and open fields. These areas rest 900 feet or more above sea level and make up the highest areas of the monument. The steep slopes, flood plains and waterways make up the latter half of the North and South units. The lowest portion of the monument is at the mouth of the Yellow River, at an elevation of approximately 600 feet above sea level.

Along the high bluffs and lowlands in the Upper Mississippi River Valley are numerous prehistoric Indian burial mounds of a type unique in North America. Though different groups of prehistoric Americans built burial mounds at various times and places, only in southern Wisconsin and adjacent areas in Illinois, Minnesota, and Iowa were they built in the shapes of birds and other animals. Effigy Mounds National Monument, designated on October 25, 1949, was established to preserve the earth mounds found in northeastern Iowa. Within the monument's borders are 191 known prehistoric mounds, 29 in the form of bear and bird effigies and the remainder conical or linear shaped. At Effigy Mounds the visitor can visualize prehistoric man carefully forming each earth effigy to receive the body of the departed, selecting by ritual the most fitting bird or animal form for this solemn purpose. Some mounds are monumental; one, the Great Bear Mound, is 70 feet across the shoulders and forelegs, 137 feet long, and 3½ feet high.

History of Effigy Mounds

Toward the end of the last glaciation, about 12,000 years ago, Paleo-Indians-hunters similar to other early people east of the Rocky Mountains-came into northeast Iowa. The way of life of these early hunters was comparatively simple. Small groups pursued and killed huge elephantine mammals and now extinct forms of the bison. Their weapons were darts, tipped with leaf- shaped stone points, and hurled with spear throwers (Fig. 2). They probably lived and hunted in groups of closely allied units. If they built houses, archeologists speculate they used a very rudimentary shelter of brush or skin. Remains of these earlier Indians have not been found in the monument, but scattered evidence of their presence appears in the vicinity in the form of dart points of types known to have been made by early peoples elsewhere. Their part in the prehistory of the area is noteworthy, for it represents the beginning of the human story of which we are a part.

The early hunter tradition can be traced through several thousand years. Eventually changes in and additions to the living habits of the Indians caused them to produce tools suited for woodworking. Archeologists have found the ax, adz, and gouge - all attesting to changes in the adaptation of the Indians' way of life from the plains to the forest. Wild rice, nuts, fruits, berries, and fresh-water mussels, laboriously gathered, made up a large part of their food supply; and fishing also may have been important. The animals they hunted included the deer, bear, and bison. Implements and weapons attributed to these people have been found along the Mississippi River; some have come from the riverbanks along the monument's eastern boundary. The discovery of numerous tools and weapons suggests a large population and a relatively prosperous life.

Religious practices, magical in character, were important to these people. Shamans, who aimed at bending the forces of nature to man's will, greatly influenced their actions and activities. These men conducted ceremonies, which they hoped would bring success in hunting and increase the number of game animals. They also worked to prevent natural disasters and drive away sickness. Bone and copper awls were used for sewing. Possibly they wove baskets and matting, for earlier groups knew a form of weaving. It is thought the women wore clothing of tanned hides, moccasins, and jewelry of bone, shell, or copper. Men wore similar jewelry, and breechcloths and moccasins, and painted their bodies for additional adornment.

Red Ochre Culture

The oldest mounds in the Mississippi Valley belong to the Red Ocher Culture. One mound excavated in the monument produced evidence linking it with this culture, and was dated, by the radiocarbon technique, as being about 2,500 years old. Bundle burials had been placed on a floor covered with red ocher, and burial offerings included large chipped blades, straight-stemmed and corner-notched spear or dart points, and spherical copper beads. The spear thrower was still the chief weapon, and projectile points continued in the same styles as their antecedents. Among the innovations, pottery was an important item. Their first pottery was crude, thick, and heavily tempered with coarse pieces of crushed rock. Toward the end of the period, pottery became thinner and was decorated with wide, indifferently applied, incised lines. Pottery of this type has been found in the monument.

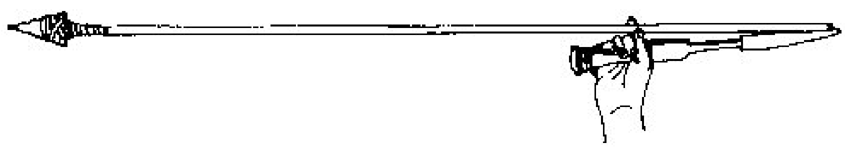


Figure 2. The spear thrower was a prominent weapon of the people of the Red Ochre Culture.

Hopewell Culture

The next major cultural division is noted in pottery and the use of many materials obtained from distant sources. The Indians seem to have elaborated their material possessions and intellectual life gradually, following a trend apparent through the Midwest. The remains from this period are called Hopewell, a culture dating from 100 B.C. to A.D. 600. Pottery and projectile points collected in the monument show a relationship to certain Hopewellian types. Indians of this period used mica from the Appalachians, obsidian from the Rocky Mountains, seashells from the Gulf of Mexico, and copper from the Lake Superior region. Several mounds excavated in the monument are of the Hopewellian period. While certain ones contained traits identified with the Hopewell, the evidence was not as abundant as is usually found in similar centers of Illinois and Ohio. Three of these Hopewellian mounds are adjacent to the visitor center. The Effigy Mounds people occupied the land now within the monument from a time overlapping the Hopewellian period until almost historic times. Their cultural remains indicate they differed from the Hopewellians chiefly in constructing mounds in effigy forms, using copper for tools rather than ornaments and burying their dead with few if any intentional offerings of a lasting nature. Whatever their burial customs, these people probably differed little from their predecessors in terms of economic and everyday life. Archeological excavations indicate the Effigy Mounds people were probably supplanted about 1300 or 1400 by Indians of the Oneota Culture. These people placed a strong emphasis on agriculture and on life in larger villages.

Oneota Culture

The pottery, economic orientation, and certain facets of the religious life of the Oneota indicate a more southerly cultural ancestry. Some of their villages have been identified with a historic tribe-the Ioway, from whom the State takes its name. For the most part, the Ioway villages were north and west of the present monument boundaries, but scattered finds, consisting of pottery fragments, indicate they made at least temporary use of lands in what is now the monument. They probably hunted in the area and they may have had transient camps in some of the rock shelters. With the advent of the fur-trade era, Indian occupation of the land now within the monument came to an end.

Figure 3. Sketch of the Marching Bear Mound Group. Animal shaped mounds were built only between 600 AD and 1300 AD. These mounds are effigies or images of the animals believed to be important to the people living here during that time. This group containing ten "bears," three "birds," and two linear mounds is one of the largest groups of effigies still remaining.

Historic Period

Louis Joliet and Father Marquette were the first white men to reach the northeast Iowa region while exploring the Wisconsin and Mississippi rivers in 1673. Others followed - exploring, building forts, and developing Indian trade. The first known mention of the Effigy Mounds area appears in Jonathan Carver's "Travels Through the Interior Parts of North America in the Years 1766, 1767, 1768." He tells of leaving his traders at the mouth of the Yellow River while he himself ascended the Mississippi. The next mention of the area implies that a few habitation sites had appeared at the mouth of the Yellow River. During the historic period the mounds on the bluff tops and in the valley went unnoticed. In 1881, however, two men - Theodore H. Lewis and Alfred J. Hill - began an ambitious survey of the mound groups of the Mississippi River Valley. The Lewis-Hill surveys produced excellent maps of the mounds found throughout the valley and the southern United States. Among the groups they mapped in 1892 are some now within the monument, including the Marching Bear Group (Fig. 3) and a number of mounds which were destroyed before the monument was established. On August 10, 1949, the first 1,000 acres to be included in Effigy Mounds National Monument passed into Federal ownership. Another 204.39 acres were conveyed to the United States by the Iowa General Assembly on April 14, 1951. An Act of Congress on May 27, 1961, added about 263 acres and 99 mounds to the monument. Approximately 10% of the mounds have been excavated. Current emphasis is on preservation and non-destructive mound study

Other Area Attractions

Besides its unusual archeological attraction, the area contains interesting historical and scenic values and a varied vegetation and wildlife. The monument is located across the Mississippi River from historic Prairie du Chien, Wis., an important point in the exploration and settlement of the Upper Mississippi valley. The military road from old Fort Crawford at Prairie du Chien to Fort Atkinson near Fort Atkinson, Iowa, passes through the monument. For over a century, sightseers have enjoyed the superb panoramas of the Mississippi River country along the monument's cliff-bordered eastern boundary. The forests, the wildflowers, ferns, and other plants, and the varied bird and other animal populations at Effigy Mounds represent a biological community not found elsewhere in the National Park System.

Visiting the Monument

Effigy Mounds is located five miles north of McGregor and three miles north of Marquette, Iowa on Iowa State Highway 76. Bus parking is available at the Visitor Center. In 1999 81,614 people visited the monument. Upon arrival, you should stop first at the visitor center where museum exhibits and an audiovisual presentation explain the prehistory, history, and natural history of Effigy Mounds. The visitor center is open daily, except Christmas Day, from 8 a.m. to 5 p.m. (7 p.m. in summer). A 1-hour walk on the self-guiding Fire Point Trail leads to representative examples of major features within the monument, including the Little Bear Mound, Hopewellian mounds, and scenic viewpoints along the 300-foot-high bluff tops. Trailside exhibits and markers tell the story of the mounds, or explain the natural features. Guided walks along the trail by park rangers are given on a scheduled basis from Memorial Day to Labor Day. A longer walk is possible by following the Hanging Rock Trail to other points of interest. Those who plan to visit in a group should make advance arrangements with the superintendent for guided walks. There are no camping or picnicking facilities within the monument. You can obtain accommodations in nearby towns. . Both picnicking and camping facilities are available at Pikes Peak State Park and Yellow River State Forest. Restaurants and lodging facilities are available in the local communities.

Effigy Mounds National Monument
151 Hwy 76
Harpers Ferry, IA 52146
(319) 873-3491

WYALUSING STATE PARK AND AREA HISTORY

prepared by Raymond R. Anderson
with information from Friends of Wyalusing State Park
http://www.wyalusing.org/

Introduction

Wyalusing State Park, a crown jewel of the Wisconsin state park system, is situated in rural Grant County in southwest Wisconsin, pearched on a bluff overlooking the confluence of the Mississippi and Wisconsin rivers 500 feet below, and directly across the Mississippi River from Pikes Peak State Park..

The Friends of Wyalusing State Park have described the events and people that acted to crataet the beautiful park. Ancient seas, glacial meltwaters, mound-building Indians, explorers, fur-traders, and farmers are some the of the people and events in the long and colorful history of the area we now call Wyalusing State Park.

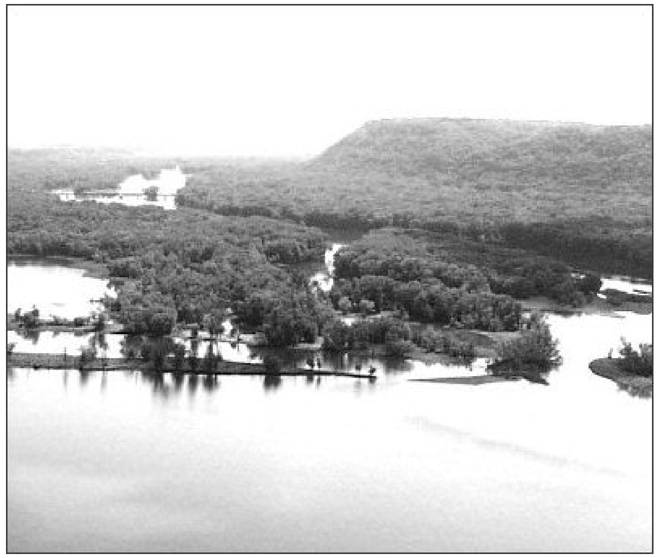


Figure 1. View of Wyalusing State Park, just south of the Wisconsin River, as seen with the Mississippi River in the foreground from the Pikes Peak overlook.

Geology

Some two billion years ago very hot, molten minerals cooled and crystallized to form granite which now lies far beneath the park's surface. Beginning about 600 million years ago, a series of dramatic earth movements caused a succession of shallow seas to spread over North America. Over these long years the seas deposited a thick "sandwich" of sediments—which eventually became sedimentary rock. Many rivers, including the present Wisconsin and Mississippi rivers, cut into this sandwich over a 400-million-year period. Bluffs and ridges were left behind that now tower 500 to 600 feet above the rivers. As you hike the park trails downward from the bluff tops, you are walking back in time. Each layer of dolomite (limestone), shale, and sandstone is older than the layer above it.

Native Americans

People began arriving here about 11,000 years ago, as the glaciers retreated. Many left evidence of their life and culture behind. The Red Ochre Culture appeared around 1000 B.C. They were followed by the Hopewell Indians and the Effigy Mound builders. Archeologists tell us that these groups were the builders of the many mounds on Sentinel Ridge, Spook Hill and other areas of the park. Burial of the dead was one reason Woodland Indians constructed mounds. Most of the dome-shaped, conical mounds contain skeletons. Effigy mounds, those shaped like deer, bears, birds, turtles, and other animals, were more than just a simple burial method. Construction may have been religious, an indication of territorial possession, or a ceremonial activity. We may never know. It's interesting to speculate about why the mounds were built and exciting to see that they still exist after hundreds of years. Historic Indians (those encountered by the first Europeans) considered the region near the mouth of the Wisconsin River a "neutral" land. At least fourteen different tribes lived in the area or visited to trade.

Some features in the park have been named for Indians of the region. **Green Cloud Picnic Area** is named for the Winnebago Chief who led the last band of Indians to camp in the park. **Eagle Eye Bluff, Yellow Thunder Point**, and **Big Chief Bluff** are colorful names that honor those people who lived here long ago. Other areas in the Park received names for the way they were used by Indians. **Signal Point** was used for signal fires. Indian sentries use **Point Lookout** to keep watch on the rivers. Chert (flint) was gathered form arrowheads along what is now **Flint Ledge Trail**.

Europeans

Journeying from Green Bay via the Fox and Wisconsin rivers, the first Europeans to enter the area were Father Jacques Marquette and Louis Joliet. They recorded seeing the confluence of the Wisconsin and Mississippi rivers on June 17, 1673. Their exact vantage point is unknown, although it is likely they saw it from one of the bluffs in the park. A marker at **Point Lookout** commemorates this event.

Figure 2. The Knob Shelter in Wyalusing Park. Image from Friends of Wyalusing State Park (http://www.wyalusing.org/). Original artwork by Dale Carlson, the elementary art teacher in the Wyalusing area

Fur Traders

A few short years after the arrival of Marquette and Joliet, French voyageurs came here to trade with the Indians. Rivers were the most efficient means of transportation. Pelts worth millions of dollars passed through the area as first the French, then the British, and finally the Americans made their living by trapping and trading.

Buried Treasure

An intriguing story of buried treasure in the park dates back to the fur-trading era. As the legend goes, bandits stole a quantity of gold from payments at Fort Crawford in Prairie du Chien. With soldiers pursuing them, the thieves were forced to bury the loot. Only one of the bandits survived and then just long enough to give a general description of the hiding place. If we can believe this tale, "…on a high bluff near the mouth of the Wisconsin River" lies tens of thousands of dollars in gold.

Miners

News of mineral deposits, primarily lead, brought more people to the area. A man could literally "make a fortune overnight." The early lead miners burrowed into hillsides searching for ore and used their "mines" for living quarters before more suitable housing was constructed. Because of this practice they were nicknamed "Badgers." Thus the nickname for Wisconsin residents came to be. There were some mining ventures in the park; however, none were know to be successful.

Farming

As the region became more settled, land was cleared on the tillable areas of the park and farming became a lifestyle. One humorous tale of these pioneer farming days tells about some of the questionable uses of the park's resources. Many of the early settlers raised hogs, letting them run wild in the winter to forage on acorns. This practice led to several years of "hog-rustling." Local farmers finally discovered that two men were butchering their animals, storing them in Sand Cave where ice kept them cold until late in the spring, and then rafting them to Prairie du Chien when the rivers opened. Early farmers supplemented their income by cutting and selling firewood to the steamboat operators that traveled the rivers. A backwater (slough) adjacent to the park is named "Woodyard Slough" for this reason.

Figure 3. Homestead Shelter in Wyalusing Park. Image from Friends of Wyalusing State Park (see Fig. 2 caption).

Creation of Wyalusing State Park

The idea to create a park at the junction of the Mississippi and Wisconsin rivers was both a local movement and a statewide initiative. The Robert Glenn family, who owned the land, promoted the concept of a park around the turn of the century. At about the same time, the state Legislature commissioned a report on the subject of state parks for Wisconsin. The report, completed in 1909, recommended four sites for the state for immediate consideration for acquisition. This area was one of the four recommended. The purchase was approved by the Legislature in 1912, and the park established in 1917.

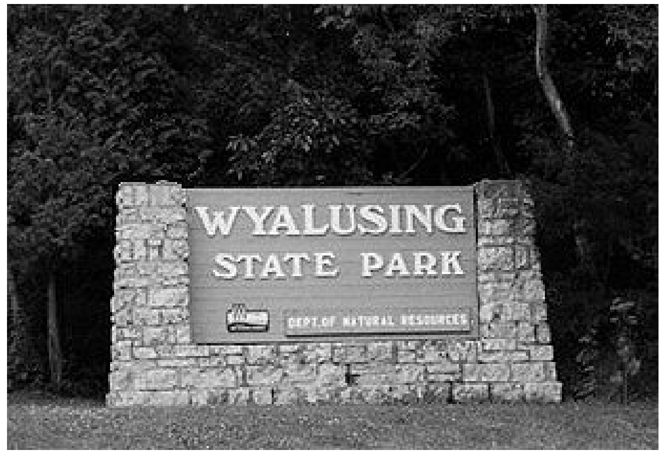


Figure 4. Sign at entrance to Wyalusing State Park.

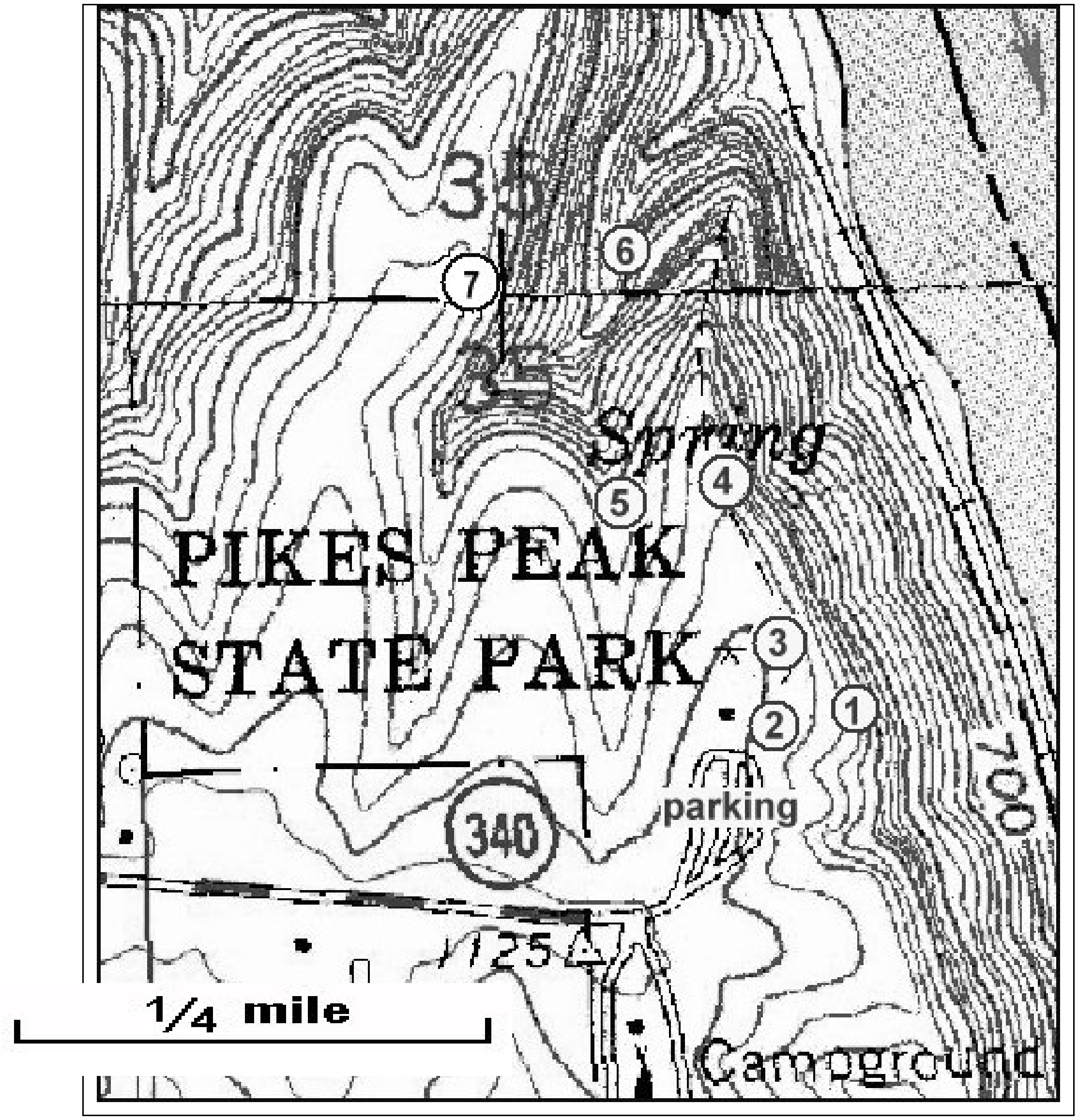
The park was first named Nelson Dewey State Park and later changed to Wyalusing. Wyalusing is a Munsee-Delaware Indian word meaning "home of the warrior. Since the original purchase, land has been added to the park with preservation of this unique area of Wisconsin as a primary goal. The park now encompasses 2674 acres. Visitors can enjoy camping, hiking, nature education programs, bicycling, cross-country skiing, fishing, and many other outdoor activities in the park.

Wyalusing State Park
13342 County. Highway C
Bagley, Wisconsin 53801.
Phone: (608) 996-2261.

FIELD TRIP STOPS

Aerial Photograph of Pikes Peak State Park

Morning Stops



Topographic map of the southern portion of Pikes Peak State Park showing the locations of **Stops 1 – 7**, the Field Trips morning stops.

FIELD TRIP STOPS

Hike to Mississippi River Overlook Structure

Stop 1: Overlook of the Mississippi River Valley at Pikes Peak State Park. Directly across the Mississippi River is the confluence of the Wisconsin River, and Wisconsin's Wyalusing State Park to the south. The view from this point is the same view depicted in the diorama in Iowa Hall at the University of Iowa Museum of Natural History in Iowa City (see Plate 1, p.34-35.

Stop 1: Introductions of Field Trip Leaders

by Ray Anderson, Iowa Department of Natural Resources, Geological Survey Bureau

Quaternary Geology of the Paleozoic Plateau Region of Northeastern Iowa

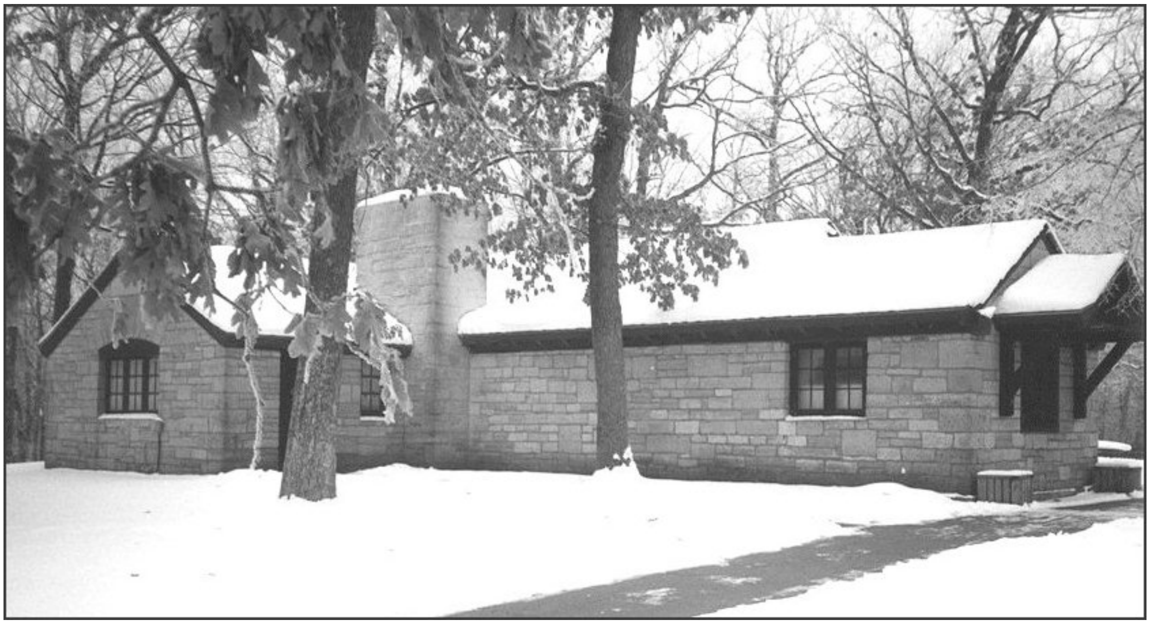
by Stephanie Tassier-Surine, Iowa Department of Natural Resources, Geological Survey Bureau

See discussion on pages 37-42.

Hike to Concession Stand Area

Stop 2. History of Pikes Peak State Park

by Jim Farnsworth, Park Ranger, Pikes Peak State Park



Stop 2. The Concession Building at Pikes Peak State Park was built in the 1930s by the Civilian Conservation Corps (CCC).

Pikes Peak State Park, McGregor, and the surrounding region has experienced a long and colorful history since Father Marquette and Louis Joliet first viewed the area as their canoe reached the mouth of the Wisconsin River and its confluence with the Mississippi (see Plate 1, p. 34-35). Read more about this history on pages 61-67. Also, read about the colorful history of McGregor (P. 69-70), the Ringling Brothers of circus fame who lived in McGregor (p. 71-73), how the U.S. Army Corps of Engineers controlled the Mississippi River (p. 75-81), the Upper Mississippi River Fish and Wildlife Refuge, that includes the river below the park (p. 83-85), nearby Effigy Mounds National Monument (p.87-90) and the park across the river, Wisconsin's Wyalusing State Park (p.91-93).

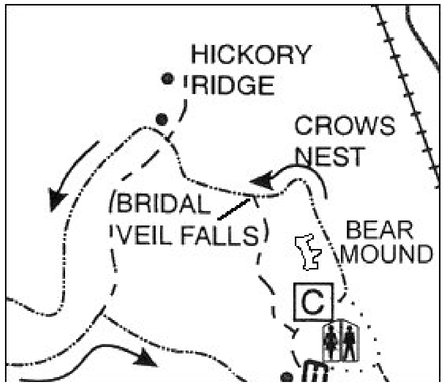
Hike to Bear Mound

Stop 3. Introduction to Archaeology of Pikes Peak State Park and Discussion of Bear Mound

by Bill Green, State Archaeologist, Office of the State Archaeologist

See discussion of Archaeology of Pikes Peak State Park (pages 53-59).

Hike Out Boardwalk to Crow,s Nest Area



Stop 4: General Discussion of Botany of Pikes Peak State Park

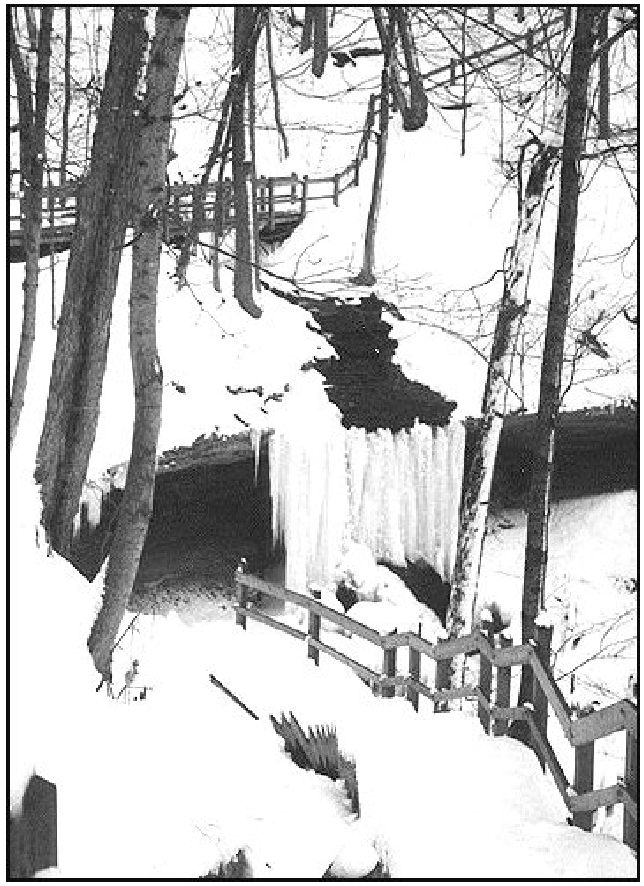
by John Pearson, Senior Environmental Specialist, Iowa Department of Natural Resources.

The walk along the paved trail and boardwalk from the Bear Mound (Stop 3) to the Crows Nest (Stop 4) passes through a wooded upland that is typical of much of Pikes Peaks State Park. The Crows Nest is located in a "glade". This semi-open, prairie-like rocky ridge extending upslope and down-slope from the Crow's Nest is principally developed on Galena Limestone. While at the Crow's Nest we will have a discussion of the interesting plants in the park and possibly take a short hike to examine a few of the rarer plants that live in the area. Read more about the Vegetation of Pikes Peak State Park on pages 43-48.

This large oak tree is one of many beautiful trees that can be observed at Pikes Peak.

Hike to Bridal Veil Falls

Bridal Veil Falls derives its name from the icy veil it creates in the winter



Stop 5: Discussion of Mesic Forest Communities in Pikes Peak State Park

by John Pearson Senior Environmental Specialist, Iowa Department of Natural Resources.

We will stop at the head of the falls for a discussion of the mesic forest communities in Pikes Peak State Park with State Ecologist John Pearson. See pages 43-48 of this guidebook for a detailed discussion of Pikes Peak vegetation

The photograph on the right is a view over Bridal Veil Falls down the drainage

General Discussion of the Bedrock Geology of Pikes Peak State Park

by Brian Witzke, Geological Survey Bureau, Iowa Department of Natural Resources

We will also take an opportunity, while at Bridal Veil Falls, for a quick review of the bedrock geologic units that we will be examining at Pikes Peak State Park. Geological Survey Geologists Brian Witzke, Bill Bunker, Robert McKay, and Greg Ludvigson will share their insight on the park's geology. Bridal Veil Falls itself cascades over a resistant dolomite ledge in the McGregor Member of the Platteville Formation. A thin section of the Platteville Shale is poorly exposed a few feet below the waterfall and the St. Peter Sandstone lies below it.

Discussion of Andrew Clemens Sand Art

by Richard J. Langel, Geological Survey Bureau, Iowa Department of Natural Resources

One of the many interesting historical stories in the Pikes Peak area developed about 200 feet down the hill from Bridal Veil Falls. In the area called Pictured Rocks, where spectacular iron staining colors the basal portion of the St. Peter Sandstone and where Sand Cave can be found, a local artist collected colored sand to create spectacular sand art. Rich Langel describes the work by Andrew Clemens on page 33 of this guidebook, and several of his pieces are reproduced in Plate 2.

Hike Down Bridal Veil Drainage To Sand Cave (Difficult Hike ! ! !)

Stop 6: Ordovician Strata; Bridal Veil Falls Down to Sand Cave, The Pictured Rocks Area

by Brian Witzke and Bill Bunker, Geological Survey Bureau, Iowa Department of Natural Resources

The trail down the drainage below Bridal Veil Falls to Sand Cave is not maintained. It is a very steep dirt trail that is very slippery when wet or icy, and it is almost 300 feet of vertical, down then back up! You should carefully evaluate your abilities to make this hike. We will limit the number of people that we take down to visit this stop; or, if the conditions are not favorable, we may skip this trip stop.

Sand Cave is located near the base of the St. Peter Sandstone in an area of spectacular iron stains and cements. Was it excavated by Native Americans, and perhaps enlarged by Andrew Clemens?

STOP 6. ORDOVICIAN STRATA; BRIDAL VEIL FALLS DOWN TO SAND CAVE, THE PICTURED ROCKS AREA

Brian J. Witzke and Bill J. Bunker
Geological Survey Bureau
Iowa Department of Natural Resources
Iowa City, Iowa 52242-1319

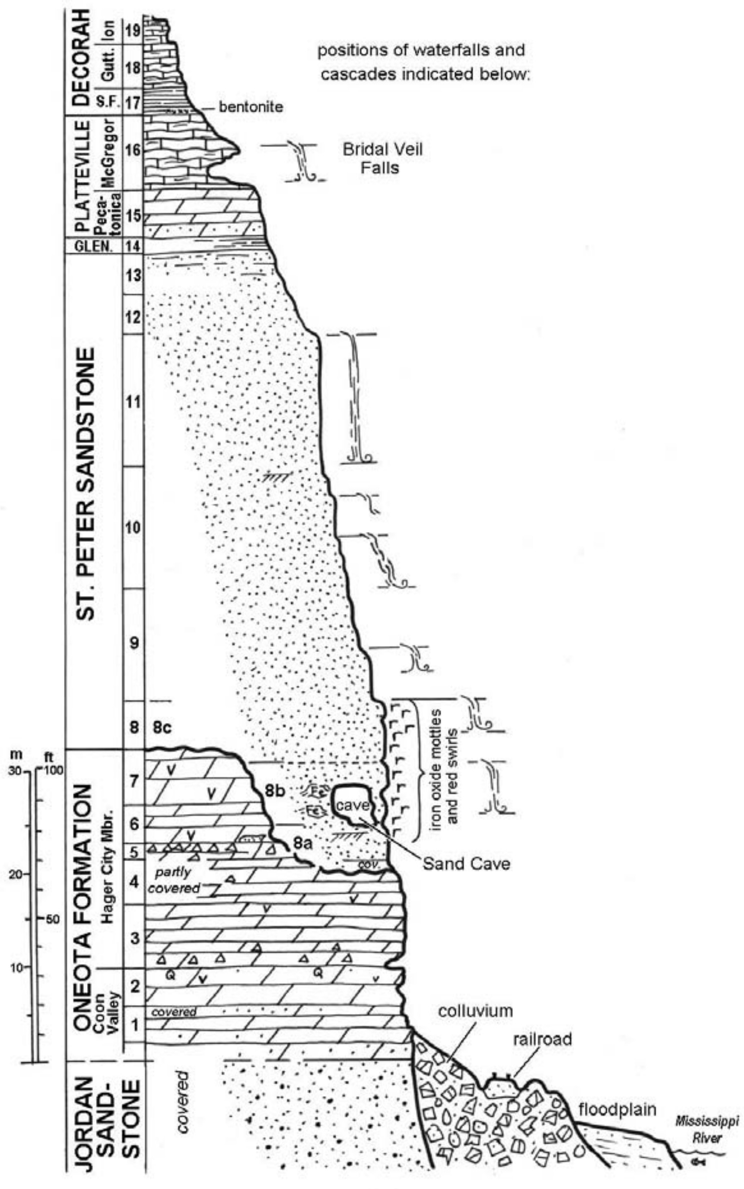


Figure 1. Geology along the unnamed drainage that includes bridal veil falls and the Pictured Rocks / Sand Cave area.

Note: Well maintained trails lead to the upland drainages above Bridal Veil Falls, and there is also an easy trail access to the area beneath the rock overhang which forms the lip of the falls. However, the trail which leads from the falls down the steep drainages and ravines to Sand Cave is no longer maintained, and the trek down to Sand Cave is not recommended for those trip participants who may have difficulties on the steep and sandy slopes below. This trek covers nearly 300 feet of vertical section, so be forewarned that it is more than just a casual climb coming back up the trail slopes after we visit Sand Cave. In addition, the steep slopes in the park are often covered by a thin veneer of fragile woodland plants, so off-trail hiking is strongly discouraged. The stream drainage that begins above Bridal Veil Falls cascades and downcuts its way down the flanks of Pike's Peak to the Mississippi River below. The picturesque bluff and slope exposures of St. Peter Sandstone along this drainage-way have been termed the "Pictured Rocks," a name whose origin should be evident as we proceed down the trail.

Decorah Formation

The upland drainages above the lip of Bridal Veil Falls expose ledges of limestone which belong to the Decorah Formation. The drainage along the trail about 200 feet south of Bridal Veil Falls exposes some of the basal shale layers of the Decorah Formation (Spechts Ferry Shale), including an altered volcanic ash bed (Deicke K-bentonite). Most of this basal shale, however, is covered by limestone talus and vegetation. This shale interval forms a layer that is relatively impervious to the movement of groundwater, and several small springs can be seen issuing from near the base of the overlying Guttenberg limestone ledges. The more resistant wavy-bedded Guttenberg limestones are better exposed above. These distinctive fossiliferous limestone beds deserve a closer look, and some of the less weathered or vegetated surfaces reveal a variety of brachiopods and other fossils. We even identified a complete trilobite fossil (*Isotelus*) in this area. Farther up these drainages are seen limestone ledges of the upper Guttenberg and Ion members.

Platteville Formation and Glenwood Shale

Bridal Veil Falls straddles a portion of the Platteville Formation. The overhanging ledge which forms the lip of the falls as well as the underlying recessive cave-like re-entrant underneath the falls are developed within the upper Platteville Formation, McGregor Member. The typical thin wavy-bedded limestone layers are well displayed here. The base of the waterfalls occurs near the base of the McGregor Member, and underlying lower Platteville strata of the Pecatonica Member are not well exposed below. However, some dolomite ledges of the Pecatonica Member are seen in the cascading drainage below the falls, and near the base of the member the dolomite beds contain scattered embedded grains of quartz sand.

Unfortunately, the thin interval of green-gray Glenwood Shale is completely covered at this locality. This shale interval can be seen to cap the St. Peter Sandstone at other nearby localities.

Figure 2. A cliff exposure of St. Peter Sandstone below Bridal Veil Falls.

St. Peter Sandstone

A remarkably thick succession of St. Peter Sandstone can be accessed following the drainage below Bridal Veil Falls downstream to Sand Cave. Portions of the St. Peter cannot be safely accessed, however, especially the steep-walled areas beneath the next waterfalls below Bridal Veil Falls.

The St. Peter Sandstone is a relatively monotonous and homogeneous succession of poorly cemented quartz sandstone. It is commonly so soft and friable that the term "sandstone" almost seems a misnomer. Nevertheless, the sandstones "harden up" a bit on outcrop as the sandstone exposure surfaces "case harden" by the relatively recent (and probably ongoing) precipitation of iron oxide and calcium carbonate cements. Because of this surface hardening the St. Peter sandstone beds can be held up in nearly vertical cliff faces in places. The tremendous overall homogeneity of the sands further serves to incorporate thick intervals of sand into massive units that lack clear bedding planes. Because bedding planes commonly follow surfaces marked by lithologic (rock type) breaks (for example, limestone to shale), the overall lithologic homogeneity of the St. Peter is further underscored by the paucity of clear bedding within the sandstone succession.

St. Peter sandstone lithologies in the northeast Iowa area are dominated by very fine- and fine-grained sand with lesser quantities of fine- to medium-grained sand. Coarse sand (and sometimes gravel) is locally present in the basal part, and thin horizons (especially in the upper part) may contain coarse and even very coarse sand (associated in part with pyritic hardground surfaces). A detailed grain-size distribution within a sandstone succession commonly requires considerable trenching and destructive sampling. Because of this, it was deemed unacceptably destructive to the delicate mosses, liverworts, ferns, and other plants that grow on the picturesque sandstone faces to proceed with such a study.

The St. Peter Sandstone at Pikes Peak State Park includes the thickest known interval of the formation exposed anywhere in the Midwest, and thicknesses are known to vary between 90 and 223 feet in thickness within the park. The St. Peter succession we will examine for this field trip stop exceeds 200 feet in thickness. However, even thicker St. Peter Sandstone sections are known from the subsurface (known from well penetrations) at places in Illinois and Iowa (to 400 feet thick in Jackson County). As discussed previously in this guidebook, these thick St. Peter sections are known to fill deep valleys that were incised into the underlying dolomites of the Prairie du Chien Group (and locally into Cambrian strata) during a long period of erosion which preceded St. Peter deposition. The lower valley filling phase of St. Peter deposition, which includes the bulk of the succession seen at Pikes Peak, probably represents fluvial and estuarine aggradation of sands. The later stages of St. Peter deposition (termed the Tonti Member in nearby Wisconsin) occurred within shallow-marine environments as the interior seaway encroached across the region.

The highest portion of the St. Peter Sandstone is partially exposed in the sloping drainage below Bridal Veil Falls (units 12 and 13 on Figure). Unlike lower strata, the sandstones in the upper part are slightly argillaceous (contains clay). The Glenwood shale occurs above these argillaceous sandstones, but the shale is covered at this locality. A precipitous change in slope appears below these upper sandstone units, and the steep-walled faces displays a waterfall in the drainage immediately below Bridal Veil Falls. These picturesque but precipitous sandstone cliffs are very difficult to access and will not be attempted for this trip. Moving down the trail a series of sandstone exposures can be seen along the slopes and chasms of the stream drainage (units 9 and 10 on Figure). Faint low-angle crossbeds were observed in the upper part of this interval, formed by the action of water currents. Most of the interval is a homogeneous succession of massive sands, with little apparent internal structure.

The most interesting part of the St. Peter succession is found in its lower part (unit 8 on Figure) as Sand Cave is approached

Figure 3. An exposure of the basal portion of the St. Peter Sandstone in the Pictured Rocks area near Sand Cave. The red and orange banding created by iron oxide staining and cements can be seen in the face exposed in the upper center of the photo. A close-up of this area is reproduced in color in Plate 3.

along the winding and precipitous trail. This lower interval is marked by peculiar but strikingly beautiful secondary red-colored alteration bands characterized by sweeping swirls and mottles of iron oxide mineral precipitates. These dramatic patterns of red are laterally discontinuous, and are expressed in varying abundance throughout the sandstone succession of Unit 8. Geologists term such red swirls "Leisegang bands," whose origins relate to redox boundaries associated with groundwater flow along the eroding bluffline. Reduced iron in solution within the groundwater is oxidized and precipitated as iron oxides as these fluids approach the surface. These red-mottled sandstones of the lower St. Peter are well displayed within and around Sand Cave, an interesting shallow cave developed into a prominent overhanging sandstone face. The mouth of the cave is about 12 feet in diameter and extends into a portion of the sandstone that shows a particularly prominent development of red iron oxide cements. The development of a cave in these massive sandstones seems geologically anomalous, and its occurrence would not be predicted by any obvious geological conditions present at this particular site. However, the reason for the development of Sand Cave may not be directly geologic in scope. Of note, ancient peoples that inhabited this region used red ochre for ceremonial and mortuary purposes, and the red iron oxide pigments seen in Sand Cave could have been easily collected as a source for red ochre. It seems possible that generations of Archaic and Woodland peoples may actually be responsible for the creation of Sand Cave. Even in historic times, people continued to remove the beautiful red sands from Sand Cave. However, please leave the sand in place for others to enjoy (NO Collecting!).

The basal part of the Unit 8 sandstone succession below the mouth of the cave (8A) as well as the strata above and within the cave (8B) occur at the same elevation as a series of dolomite exposures of the Oneota Formation a short distance downstream. These relationships indicate that the pre-St. Peter erosional channel cut across the Oneota dolomites marking the margin of that channel in this area. Over 40 feet of local erosional relief along the Oneota-St. Peter surface is therefore interpreted in this small area. Based on the varying thickness of the St. Peter Sandstone, over 130 feet of relief occurs along this surface within Pikes Peak State Park. The actual erosional contact between the St. Peter channel-filling sandstones and the adjacent and subjacent Oneota dolomite ledges is not clearly shown in the Sand Cave area, but sandstone fills (probably within karstic openings associated with the ancient channel incision) are seen in the dolomites downstream from the cave (especially lower unit 6). In addition to the dramatic red mottles and swirls within St. Peter unit 8, the lower beds (8A) display possible ESE-trending crossbeds, and above the cave mouth (top of 8B) a prominent bedding surface (one of the few in the succession) is marked along a thin siltstone bed.

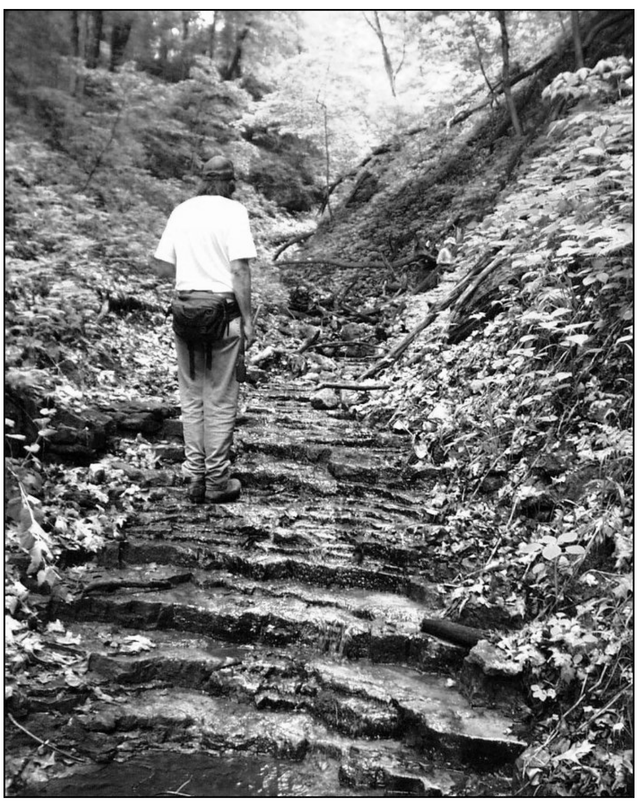


Figure 4. Ledges of Oneota Fm. Dolomite below Sand Cave.

Oneota Dolomite

Although we will probably not proceed any further than Sand Cave, the stream drainage continues down to the Mississippi River and exposes a series of dolomite ledges belonging to the Oneota Formation, lower Prairie du Chien Group (Fig. 4). The Shakopee Formation of the upper Prairie du Chien Group has been completely removed by erosion in this area. The Oneota ledges expose most of the stratigraphic succession below, but some portions of the formation are not visible beneath the local cover of colluvium (especially units 1 and 4). The dolomites are composed mostly very fine and fine dolomite crystals, and original sedimentary fabrics are hard to resolve. More coarsely crystalline dolomite beds are seen especially in unit 6. The dolomite beds are commonly vuggy (large open pores in the rock), and portions of the Oneota interval contain chert nodules in varying abundant (unit 5, lower unit 3). The lowest portion of the exposed Oneota section is dominated by finely crystalline dolomite (units 1, 2); quartz crystal lined vugs are found near the top. Some embedded quartz sand grains occur within the lowest dolomite ledges. The lower interval, although very poorly exposed, may represent part of the Coon Valley Member.

We will return up the drainage from Sand Cave to our starting point at Bridal Veil Falls. Please be as careful as possible not to further disturb the delicate plant communities and crumbling sandstone ledges along the way.

Hike to Hickory Ridge Mound Group

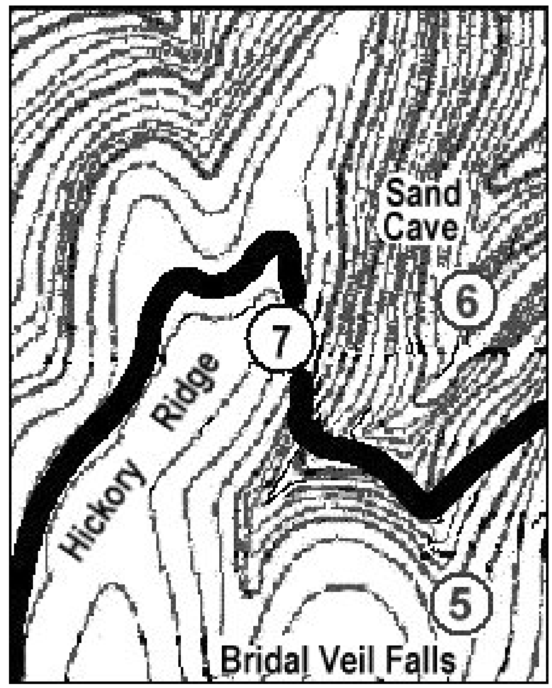
Stop 7: Discussion of Pre-History and Archaeology of Pikes Peak State Park and Hickory Ridge Mound Group

by Bill Green, State Archaeologist
Office of the State Archaeologist

A series of linear and conical mounds can be seen on Hickory Ridge. These mounds have an interesting History. Don't miss this stop. For more information on the discussion on the Archaeology of Pikes Peak State Park by Bill Green (pages 53-59) and a discussion of Effigy Mounds National Monument (pages 87-90).

Discussion of the Dry Forest Community in Pikes Peak State Park

by John Pearson, Senior Environmental Specialist, Iowa Department of Natural Resources.



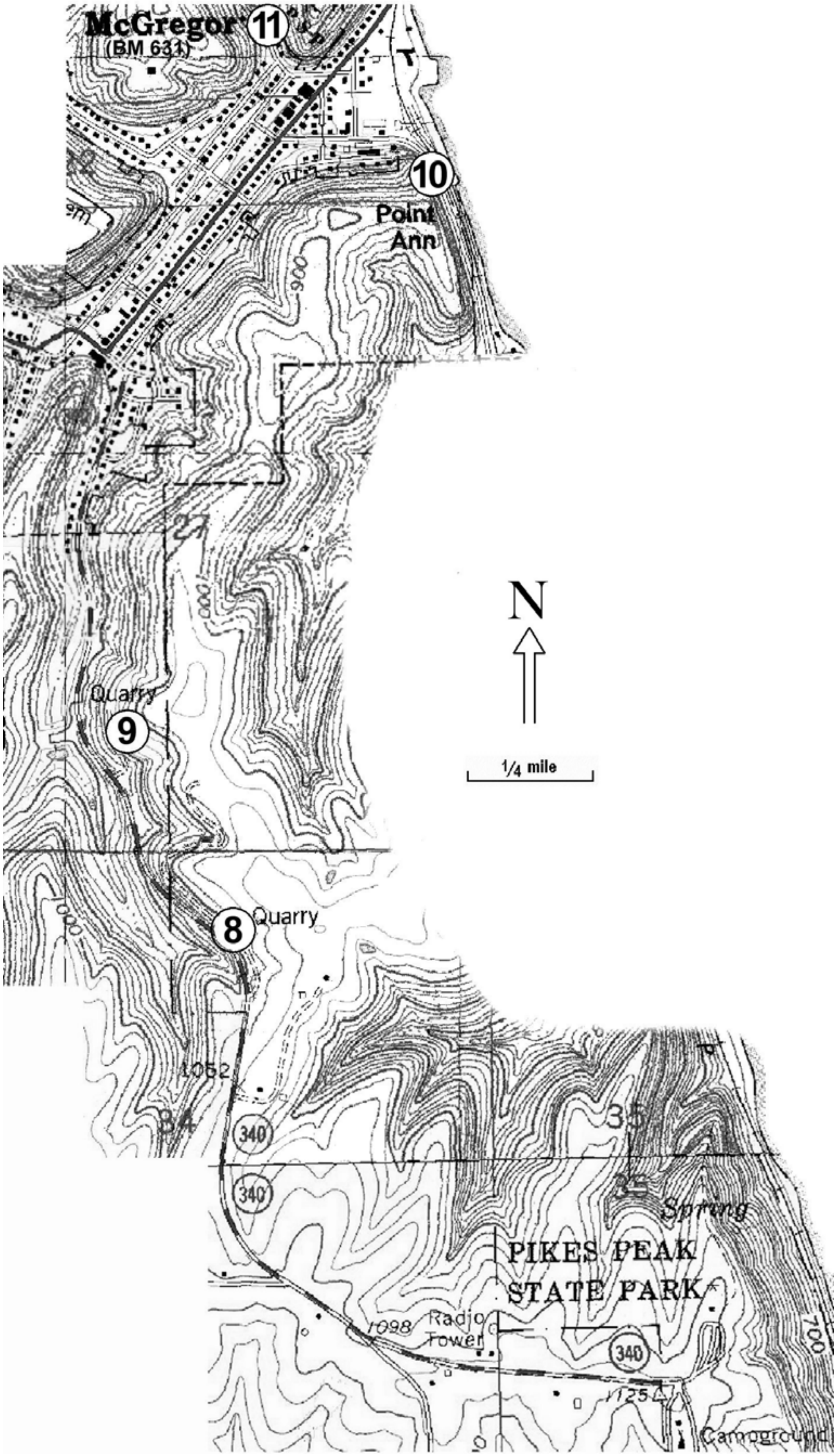
Route from Bridal Veil Falls and beyond.

Also at this stop, State Ecologist John Pearson will lead a discussion of the dry forest community that is present along Hickory Ridge. Read more about the Vegetation of Pikes Peak State Park on pages 43-48. As we move on from this stop John will continue his discussion of the park's plant communities as we follow the trail loop to the southwest and return to the Parking Area

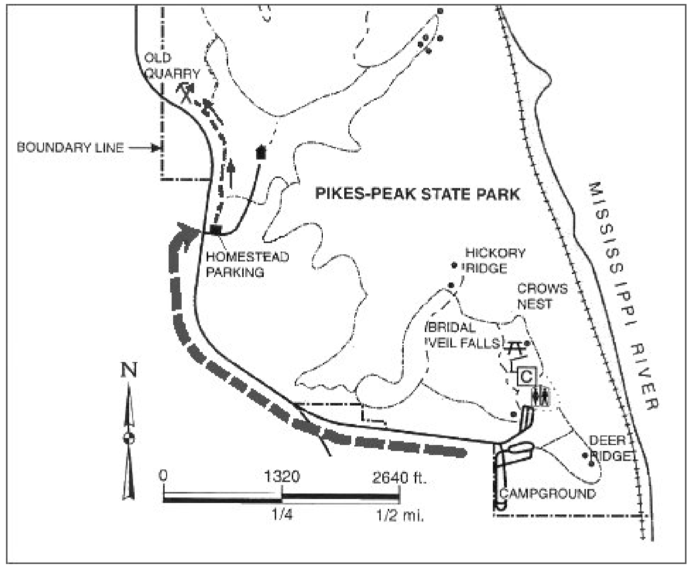
Hike South and West Along Trail Loop and Return to Parking Area

LUNCH STOP

Afternoon Stops



Depart Parking Area and Drive to Homestead Parking Area on West Edge of Park



Hike North Along Trail to Old Quarry

Stop 8. Dunleith Formation at the Old Pikes Peak Quarry

by Brian Witzke and Bill Bunker
Geological Survey Bureau, Iowa Department of Natural Resources

The Old Pikes Peak Quarry is located on the western edge of the State Park, but within the Park's limits. Dolomites of the Dunleith Formation, lower Galena Group, are exposed in the quarry. Although the collecting of rocks within a State Park is strictly prohibited, Park Ranger Jim Farnsworth has graciously granted permission for GIS Field Trip participants to collect at this site during the field trip. Should you choose to return to this quarry at a later date, you must obtain permission to collect samples from the Park Ranger.

The photograph to the right shows the trail head from the Homestead Parking Area to the Old Pikes Peak Quarry.

STOP 8. DUNLEITH FORMATION AT THE OLD PIKES PEAK QUARRY

Brian J. Witzke, Bill J. Bunker
Geological Survey Bureau
Iowa Department of Natural Resources
Iowa City, Iowa 52242-1319

Note: We will follow the trail from the Homestead parking area into an abandoned quarry (Old Quarry) which exposes a portion of the Dunleith Formation. Please be cautious in the quarry, as some of the rock is unstable and could pose a danger to people below.

The uppermost bedrock strata represented in Pikes Peak State Park belong to the Dunleith Formation of the lower Galena Group, an widespread formation regionally characterized by limestone and dolomite strata, cherty in part. This old quarry area is one of the best places to look at these strata in the park. Along the highway below the quarry is a roadcut section that displays strata of the underlying Decorah Formation. The roadcut section includes part of the same strata exposed at nearby McGregor Quarry (see Stop description), and general features will not be repeated here.

The quarry floor is actually developed on a limestone bed in the uppermost part of the Ion Member of the Decorah Formation. A shallow excavation below the quarry floor displays the subjacent green-gray shales which characterize much of the Decorah. This interval includes large stony bryozoans, similar to the *Prasopora*-bearing units at the McGregor Quarry. Unfortunately, the contact between the Decorah and Dunleith formations is not clearly visible at the Pikes Peak Quarry, but it lies a very short distance above the quarry floor within a thin covered interval at the base of the quarry wall.

The Dunleith Formation at this quarry is subdivided into three members: 1) a lower interval, argillaceous in part, comprised of calcitic dolomite and dolomitic limestone (Beecher Member); 2) a middle interval of vuggy dolomite with numerous nodules of white to gray chert (the Eagle Point Member); and 3) an upper unit of vuggy dolomite, generally free of chert (Fairplay Member). These strata are dolomitized and recrystallized to varying degrees, which serves to clearly separate them from the shales and limestones of the underlying Decorah Formation.

The Beecher Member differs from overlying Dunleith units at this quarry in containing dolomitic limestones, part slightly argillaceous. Fossils are poorly preserved by recognizable in this interval. Irregular hardground surfaces are identified in the member, marking episodes of nondeposition on the seafloor. The Eagle Point Member is distinguished by an abundance of chert nodules, usually seen as light colored cherty bands within the vuggy dolomites. Two intervals with enigmatic receptaculitid fossils are also seen in this member. Strata of the Fairplay Member generally lack chert at this quarry, except at its very base. These upper dolomite ledges are, in part, porous and highly weathered, although a prominent zone of common receptaculitid fossils is seen here (unit 18). Higher strata of the Dunleith Formation are found within Pikes Peak State Park, and overlying Dunleith units are identified in the upland water well near the south entrance. These include the Mortimer (cherty dolomitic limestone), Rivoli (cherty dolomitic limestone and dolomite), and Sherwood (non-cherty dolomitic limestone) members.

Figure 1. The Old Pikes Peak Quarry is badly overgrown by trees and other foliage, but the rocks of the Dunleith Fm. can easily be accessed.

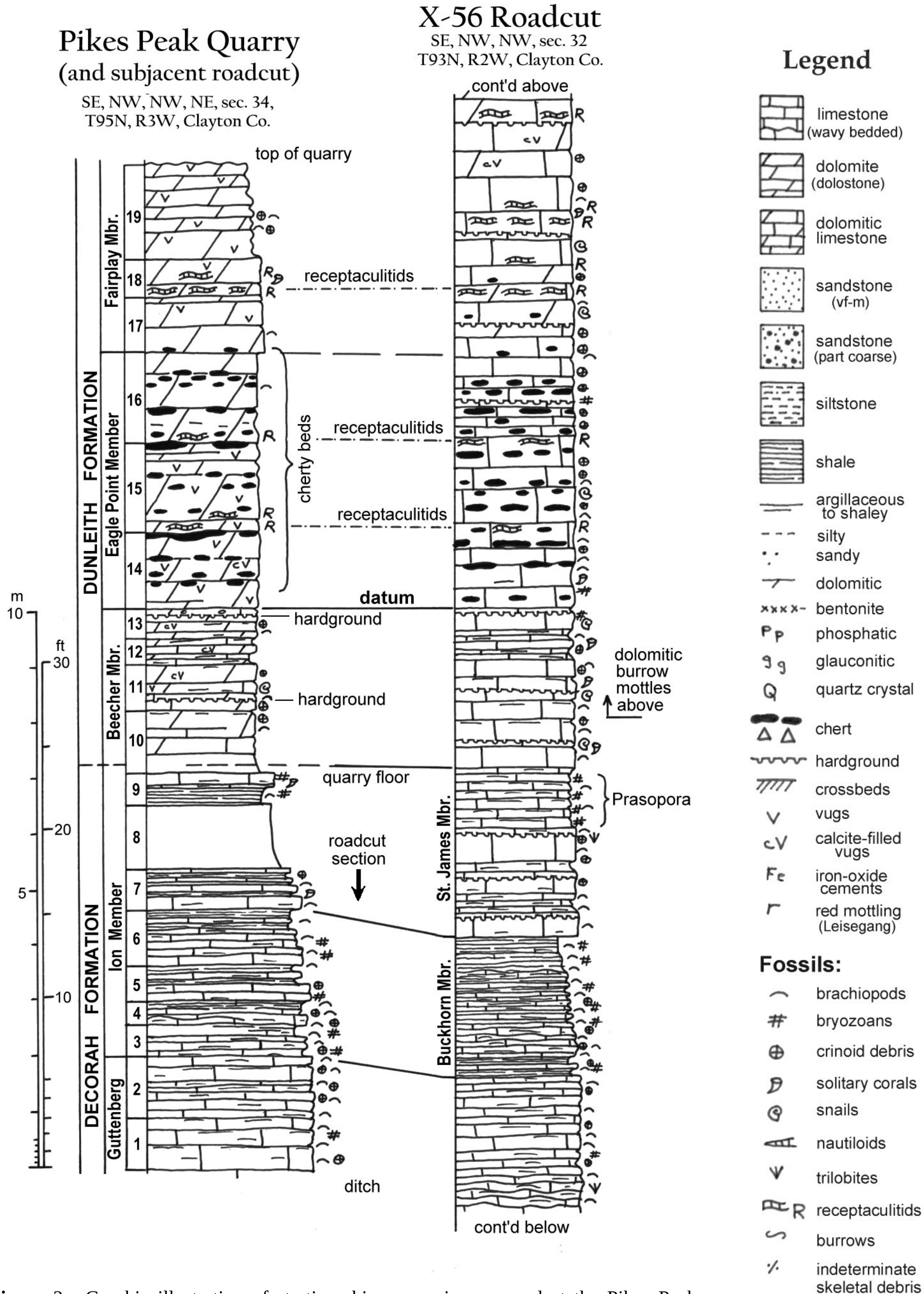


Figure 2. Graphic illustration of stratigraphic succession exposed at the Pikes Peak Quarry. Correlative strata exposed at the X-56 roadcut north of Guttenberg is included for comparison.

PIKES PEAK QUARRY AREA

SE NW NW NE sec. 34, T95N, R3W, Clayton Co., Iowa
measured by Brian Witzke and Bill Bunker, Sept. 13, 2000
abbreviations as for McGregor Quarry section

GALENA GROUP
DUNLEITH FORMATION

Fairplay Member

Unit 19. Dolomite, sugary crystalline, in thick to medium beds, some fossil molds, vuggy; interval is weathered and recessive upward to highest portions of quarry; brachiopods and crinoid debris (silicified in part) noted 54-73 cm above base of unit. Maximum thickness 1.7 m (5.6 ft).

Unit 18. Dolomite; lower bed 25 cm, dense, less sugary, scattered vugs; upper bed 47 cm, more sugary than lower bed, vuggy; lower bed with common molds of receptaculitids (*Fisherites*) to 18 cm long, most common in upper 13 cm of lower bed; upper bed with scattered receptaculitids and silicified horn coral in lower 15 cm. 72 cm (2.4 ft).

Unit 17. Dolomite, sugary textured in part, vuggy, burrow mottling; bedding breaks at 49 cm above base and top of unit; lower 17 cm with coarse sugary stringers (dolomitized packstones), scattered brachiopods noted 40 cm above base; scattered small chert nodules (to 5 cm thick) 6 cm above base of unit; resistant unit forms cliff face. 1.0 m (3.3 ft).

Eagle Point Member

Unit 16. Dolomite, very finely crystalline, coarser and more sugary textured dolomite within thalassinoid burrow networks in upper 1 m, indistinct burrow mottling observed below; porous interval, scattered small indeterminate fossil molds and pin-point porosity, vuggy in lower part; bedding breaks at 60 cm above base and at top of unit; nodular chert bands (smooth to chalky cherts, white to pale gray) up to 5-7 cm thick noted at 16, 60, 103, 114, 125 cm above base; wispy argillaceous streaks 27-38 cm above base of unit; receptaculitid molds (*Fisherites*) 11 cm above base of unit; scattered brachiopod molds noted 1.0 m above base. 1.62 m (5.3 ft).

Unit 15. Dolomite, sugary textured, vuggy; bedding breaks at 26, 133, 145 cm above base and at top of unit; nodular chert bands (smooth, white to pale gray) to 8 cm thick noted at 43, 83, 108 cm above base of unit; prominent smooth chert band up to 10-14 cm thick at top of unit (a silicified mudstone); receptaculitid molds (Fisherites) noted at 15 and 30 cm above base of unit. 1.65 m (5.4 ft).

Unit 14. Dolomite, sugary textured,, common vugs (1-112 cm), scattered calcite void fills; bedding break 48 cm above base and top of unit; discontinuous nodular chert bands (smooth to chalky chert, white to pale gray) to 4 cm thick noted at 48, 62, 94 cm above base; top of unit marked by prominent thick chert band, masses of chert to 16 cm thick and 1.5 m in lateral extent. 1.38 m (4.5 ft).

Beecher Member

Unit 13. Dolomite, calcitic, part sugary textured, recrystallized, calcite void fills common; argillaceous bedding breaks 12 and 34 cm above base, argillaceous to shaley break 41 cm above base, argillaceous streaks 17 and 38 cm above base; probable hardground surface 7 cm below top of unit locally capped by intraclasts (to 2 cm); prominent bedding break and lithologic change at top of unit; poorly-preserved brachiopods and crinoid debris noted. 50 cm (1.65 ft).

Unit 12. Dolomitic limestone to calcitic dolomite, recrystallized, calcite void fills common; bedding breaks 6 and 11 cm above base; lower 20 cm and upper 13 cm of unit characterized by recessive thinly bedded lithologies with argillaceous streaks. 47 cm (1.55 ft).

Unit 11. Dolomitic limestone to calcitic dolomite, more dolomitic in upper bed; recrystallized sugary textures in part; calcite void fills scattered in middle part, porosity locally filled by poikilotopic calcite cements in upper bed; bedding breaks at 31 and 52 cm above base and top of unit; argillaceous to shaley parting at 52 cm above base, 31-52 cm above base is limestone with wavy argillaceous streaks; irregular hardground surface 21 cm above base; poorly-preserved fine skeletal debris includes scattered brachiopod and crinoid debris, large gastropod (*Maclurites*) noted 40 cm above base. 88 cm (2.9 ft).

Unit 10. Dolomite, calcitic, recrystallized sugary texture, argillaceous streaks in upper 9 cm with calcite void fills; bedding breaks at 44 and 28 cm below top, prominent bedding surface at top; scattered brachiopod and crinoid debris. Upper 75 cm (2.45 ft) of unit is exposed, approximately 40 cm (1.3 ft) covered at base of quarry walls; Dunleith-Decorah formational contact occurs within covered interval.

DECORAH FORMATION

Ion Member (includes Buckhorn and St. James members of Illinois classification)

Unit 9. Shale and limestone; top 20 cm is limestone ledge, wkst, slightly argillaceous, slightly dolomitic, fossils include fragmented skeletal debris, scattered large trepostrome bryozoans, horn coral; lower 38 cm is shale dominated, green-gray, calcareous, contains some thin limestone lenses (to 4 cm thick), horizontal burrow mottles, scattered broken skeletal debris, scattered brachiopod and bryozoan material. Limestone ledge forms quarry floor, local excavation into quarry floor exposes up to 58 cm (1.9 ft) of unit 9; contacts with overlying and underlying strata not accessible.

Unit 8. Covered interval, approximately 1.2 m (3.9 ft). Based on section in nearby McGregor Quarry, this interval is composed of interbedded limestone and shale.

Unit 7. Limestone, argillaceous; wkst; lower 25 cm forms limestone ledge; 25-32 cm above base is shale, green-gray; upper 43 cm includes ledges of limestone, burrowed in part, separated by thin shales; lower limestone ledge with large brachiopods (strophomenids), upper beds with brachiopods (orthids, strophomenids). 75 cm (2.45 ft); covered above; unit 7 and underlying strata accessed in roadcut immediately below quarry.

Unit 6. Limestone ledges interbedded with shale; lower 70 cm is limestone dominated, argillaceous wkst, part slightly nodular, pkst stringers at 31, 45, 53, 68 cm above base of unit, thin shale interbeds; upper 35 cm is interbedded limestone and shale, limestone is argillaceous wkst to pkst (in lenses), becomes shale dominated in upper part of unit; fossils include whole shell and fragmental brachiopods (*Sowerbyella*, strophomenids, dalmanellids, other orthids), small stick bryozoans. 1.05 m (3.45 ft).

Unit 5. Limestone ledges in lower half, argillaceous, wkst, bioturbation, fossils include brachiopods (*Sowerbyella*, *Strophomena*, *Dalmanella*, other orthids), bryozoans (small stick-like forms, larger trepostomes), scattered crinoid debris; upper half of unit forms recessive slope, much shalier, interbedded thin limestones, shale reentrant at top. 62 cm (2 ft).

Unit 4. Limestone and shale; lower 15 cm is limestone, wkst, very argillaceous to shaley, forms nodular ledges, brachiopods, crinoid debris; 15-32 cm above base is shale slope with scattered limestone lenses; top 10 cm is thin limestone ledges with shale partings, wkst to fragmental pkst, fossils include brachiopods (*Sowerbyella*, *Strophomena*, orthids), crinoid debris. 42 cm (1.4 ft).

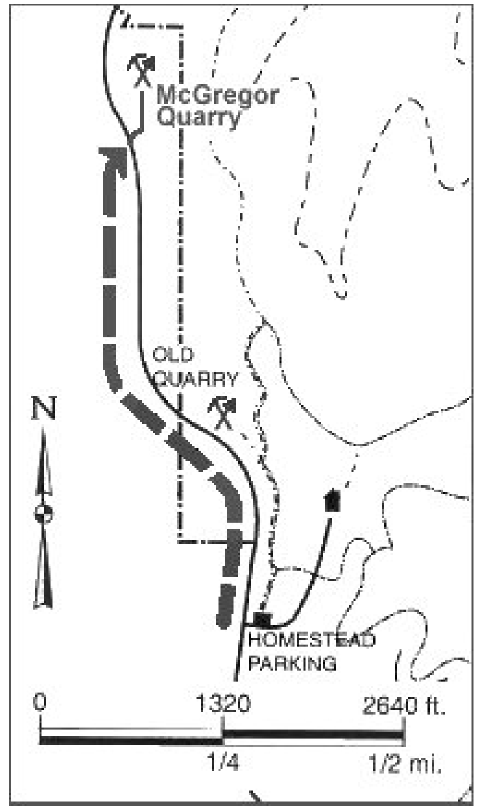
Unit 3. Limestone and shale; lower 31 cm is interbedded limestone and thin shale, argillaceous, wkst with pkst stringers and burrow fills, basal 8 cm is shaley; upper 25 cm forms a partly covered slope, shale dominated; fossils include brachipods (*Sowerbyella*, *Strophomena*, *Dalmanella*, other orthids, rhynchonellids), bryozoans (small stick-like forms, trepostomes in upper shale), scattered crinoid debris. 56 cm (1.8 ft).

Guttenberg Member

Unit 2. Limestone ledges, wkst to pkst, interbedded pkst lenses (1-6 cm), slightly argillaceous; prominent bedding breaks at 56 and 91 cm above base and top of unit, nodular to wavy bedding in lower part; fossils include whole shell to fragmental brachiopods (*Sowerbyella*, strophomenids, orthids), small stick bryozoans, scattered crinoid debris. 1.1 m (3.6 m).

Unit 1. Limestone ledges, wkst, some pkst, slightly argillaceous; bedding breaks at 40 and 70 cm above base and at top marked by argillaceous to shaley partings; some horizontal burrows; fossils include brachiopods (*Sowerbyella*, *Strophomena*, orthids), stick bryozoans, scattered crinoid debris. 92 cm (3 ft); unit extends to ditch below roadcut section.

Depart Parking Area and Drive North, Turn into McGregor Quarry, West Edge of Park



The turn off Highway 340 into the McGregor Quarry is easy to miss, so keep alert. The drive into the quarry is gated and locked, but McGregor city officials have given us access for the field trip.

Stop 9. Platteville and Decorah Formations at the McGregor Quarry

by Brian Witzke, Greg A. Ludvigson
Geological Survey Bureau, Iowa Department of Natural Resources

STOP 9. PLATTEVILLE AND DECORAH FORMATIONS AT THE MCGREGOR QUARRY

Brian J. Witzke and Greg A. Ludvigson
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Iowa Department of Natural Resources
Iowa City, Iowa 52242-1319

Norlene R. Emerson
University of Wisconsin
Madison, Wisconsin

Note: We appreciate the cooperation of the City of McGregor in providing access to this now abandoned quarry. McGregor utilizes this quarry area for certain types of fill and disposal. The quarry lies just outside of the park boundary, but the strata exposed here are generally better displayed than the same units within the park (as at Bridal Veil Falls). Quarries are potentially dangerous places, and the trip leaders will advise a safe approach to the spectacularly complete succession of Platteville and Decorah formations (see Figure). Fossil and rock collecting by trip participants is possible at this quarry site (collecting of any kind is not permitted in the park).

ST. PETER SANDSTONE AND GLENWOOD SHALE

The short road leading from the highway into the quarry and the adjacent slopes and drainages expose strata of the upper St. Peter Sandstone. These sandstone strata are overwhelmingly composed of quartz sand, although some clay material is present in the uppermost sandstones. Low-angle crossbeds are faintly visible in some of the homogeneous fine-grained sandstone beds. The thin Glenwood Shale interval occurs above the St. Peter Sandstone, although it is rarely exposed due to its soft and easily weathered character. A portion of the Glenwood Shale, a green-gray noncalcareous shale, is visible in a small exposure on the north side of the entrance road.

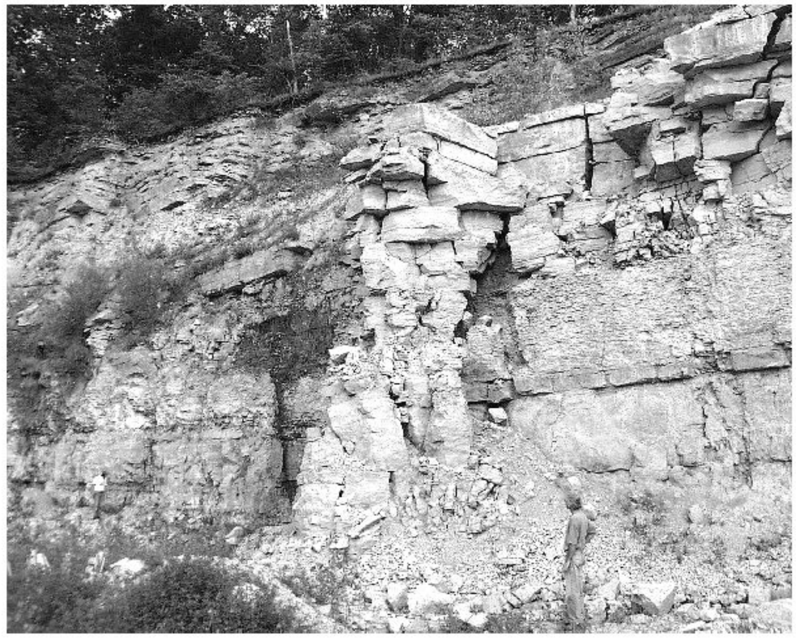


Figure 1. Photograph of the McGregor Quarry west of Pikes Peak Park.

PLATTEVILLE FORMATION

The prominent quarry walls at this locality belong to the Platteville Formation, and the floor of the quarry is developed on the basal unit of the Platteville Formation. The lower portion of the quarry walls exposes dolomite strata of the Pecatonica Member. Although it may not be immediately apparent, most of these dolomite beds contain small molds of fossil material, now left as hollow spaces in the rock. The basal unit contains some scattered quartz sand, and the overlying beds contain some argillaceous (clay) and shaley material. The Illinois Geological Survey has subdivided the Pecatonica Member (which they elevate to a formation in Illinois) into several smaller-scale stratigraphic units, and some of these units are recognized at the McGregor Quarry (Chana, Dane, New Glarus members; see Figure and unit descriptions). A widespread hardground surface (a submarine disconformity surface) is seen at the top of the Pecatonica Member.

The upper portion of the Platteville Formation differs significantly from the underlying Pecatonica dolomites, and is primarily composed of fossiliferous wavy-bedded limestone beds capped by an interval of dolomitic limestone. This interval has been named the McGregor Member, whose name derives from the City of McGregor; this quarry locality is herein designated the type locality of the member. These strata are spectacularly fossiliferous, with exceptional preservation of a diverse assemblage of bottom-dwelling invertebrate animals represented. The wavy-bedded interval is commonly referred to as the Mifflin Member (or formation) in Minnesota and Illinois, but these beds are generally included as part of the McGregor Member in Iowa. Trip participants are encouraged to examine these limestones and their contained fossils. Brachiopod shells, trilobite fragments, snails, crinoid debris, bryozoans, and large ostracodes are especially abundant. The upper dolomitic limestone ledges (units 13-16) have been termed the "Grand Detour" Member (or formation) in the Illinois classification, but the use of this stratigraphic term may not be appropriate in northeastern Iowa. The upper part of Unit 16 includes dense extremely fine-grained limestone that breaks with a glassy fracture; this lithology is often associated with the Quimbys Mill Member of the upper Platteville Formation at localities in Wisconsin and Illinois, a unit also termed the "glass rock" by the historic lead miners in the Lead-Zinc district. It is possible that these upper strata at the McGregor Quarry may correlate with a much thicker upper Platteville interval in Illinois which includes the Grand Detour, Nachusa, and Quimbys Mill formations.

The top of the Platteville is marked at the quarry bench above the main quarry walls. The contact with the overlying Decorah Formation is a sharp planar surface capped by a pale colored (whitish to yellow-orange) bentonite about 1 to 2 inches thick. This is the Deicke K-bentonite, and widespread volcanic ash layer found throughout the eastern and central United States and northern Europe. At this quarry, the Deicke bentonite marks the base of the Decorah Formation.

DECORAH FORMATION

Strata of the Decorah Formation (lower Galena Group) are nicely displayed in the upper part of the quarry above the upper bench. These strata are further discussed in the contribution by Ludvigson et al. in this guidebook. We will access this section by walking up the wooded ridge, and carefully descend a slope into the upper quarry. Immediately above the Deicke bentonite is a thin limestone bed with a truncated hardground surface at its top; this hardground includes small vertical borings made by an unknown animal, and a truncated shell of a large nautiloid cephalopod can be seen on this surface. This thin interval represents one of the southernmost known exposures of the Carimona Member, a limestone unit that reaches thicknesses to about 6 feet in Minnesota. Southward from Pikes Peak, the Carimona limestones are generally absent in the Iowa outcrop.

The overlying interval of green-gray calcareous shale, which is partially covered in places, includes scattered thin beds and lenses of brachiopod-rich limestone (some containing other fossils, especially bryozoans). Layers of individual shells are also seen in places within the shales. This shale interval is known as the Spechts Ferry Shale, the lower member of the Decorah Formation, and it is the most widespread shale unit in the formation. A second bentonite, the Millbrig K-bentonite, occurs a short distance above the base of this shale, but it may require some digging to expose it.

Wavy- to nodular-bedded limestone strata occur above the Spechts Ferry Shale, and these comprise the Guttenberg Member of the Decorah Formation. These beds resemble in many respects the limestones of the underlying McGregor Member, and their contained fossils are equally spectacular. Large blocks of Guttenberg limestone are evident in places in the quarry talus, and beautifully preserved brachiopods and other fossils can be seen. The wavy beds of the Guttenberg are separated by thin shaly layers and partings. Although not evident at this site, probably due to oxidation and weathering, these thin shaley layers are composed of organic-rich brown shale. Skeletal grains (especially brachiopods) generally become more abundant but more broken and abraded upward through the Guttenberg, and upper Guttenberg strata lose the wavy-bedded aspect and are seen in more horizontal beds. Two thin bentonites (altered volcanic ashes) may be present in the Guttenberg succession at this quarry. The Elkport K-bentonite is seen immediately below the wavy bedded interval, in the upper part of a thin phosphatic limestone and shale unit (termed the Garnavillo Member in the Illinois classification). A thin light-gray shale in the upper Guttenberg may represent the Dickeyville K-bentonite.

The upper part of the Decorah succession at the quarry contains notably more shale than underlying Guttenberg strata, and this interval is known as the Ion Member in Iowa. Unlike the Guttenberg, the Ion includes significant amounts of green-gray calcareous and fossiliferous shale. These shales interbed with argillaceous to shaley limestone beds, many containing abundant brachiopods and other fossils. A shaley zone near the top includes scattered large bryozoans, including the hemispherical form known as *Prasopora*. *Prasopora* occurs at this stratigraphic position across a broad area of the Upper Mississippi Valley.

DUNLEITH FORMATION

The highest beds in the quarry differ significantly from underlying Decorah strata and are included within the Dunleith Formation of the Galena Group. These beds are notably less argillaceous and more dolomitic. Strata of the Dunleith Formation are best seen in the nearby Pikes Peak Quarry (see Stop description).

The stratigraphic succession of the Platteville and Decorah formations seen at the McGregor Quarry can be closely compared with other sections in the region. A graphic section of the McGregor Quarry and

X56 roadcut section north of Guttenberg is illustrated in the Figure to provide a basis for such stratigraphic comparisons. Many individual beds and units can be correlated across large areas (like those shown on the figure), indicating that similar processes effected deposition across vast regions of the seafloor. Even so, a general northwestward increase in shale content in Iowa and Minnesota within the Decorah Formation indicates that shale source areas and shorelines once lay in that direction. Clays derived from those areas did not reach into the far offshore areas, where limestone deposition prevailed. As those land areas were inundated by the expanding seaway, shale influx ceased altogether later during Dunleith deposition.

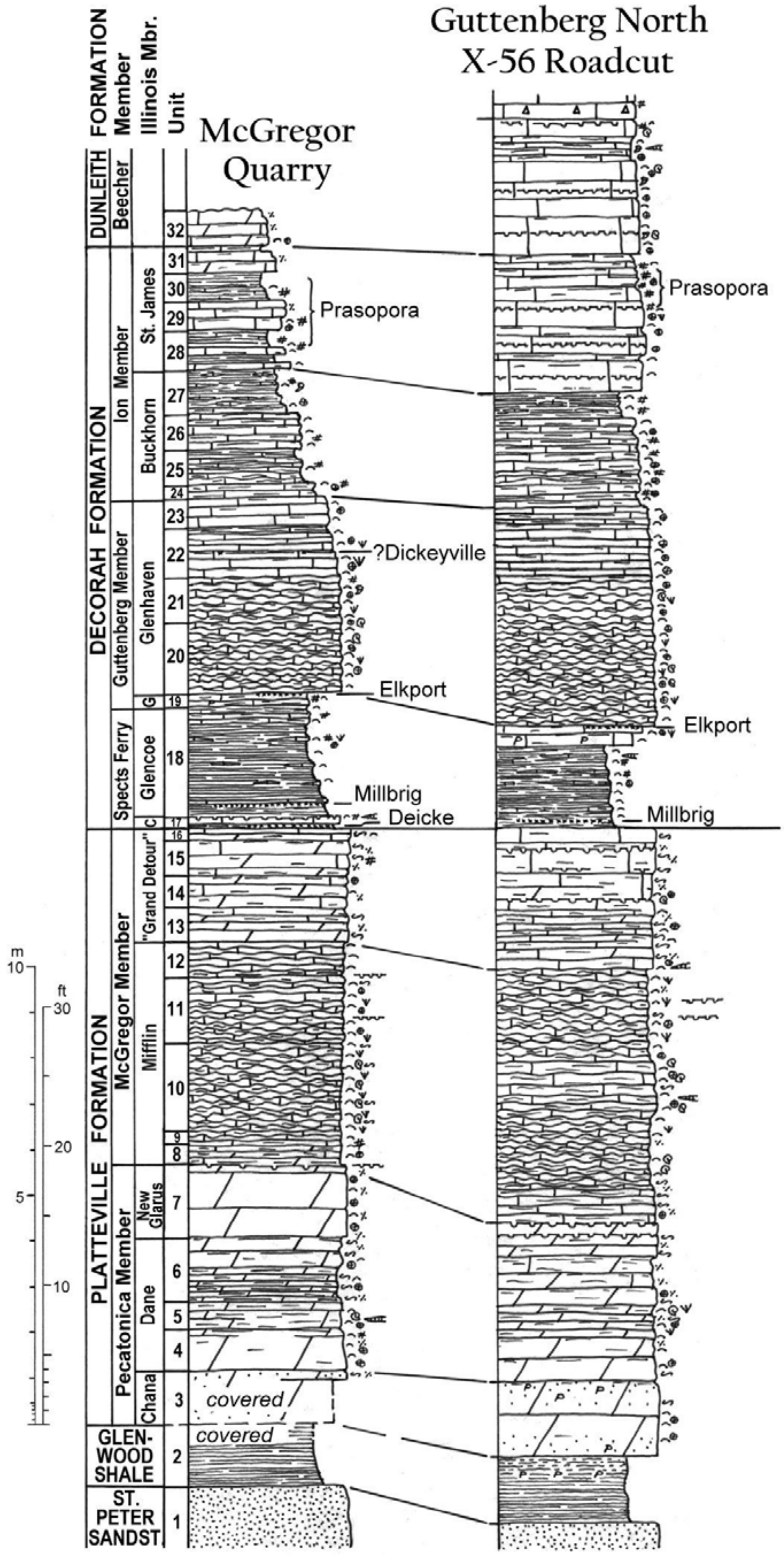


Figure 2. A Graphic illustration of stratigraphic section exposed at the McGregor Quarry. See legend for explanation of symbols used. The X56 roadcut section north of Guttenberg is included for comparison.

MCGREGOR QUARRY

NE SE SW SEC. 27, T95N, R3W, CLAYTON CO., IOWA

description based on two separate measured sections, one by Norlene Emerson (Univ. Wisconsin) and the other by Brian Witzke, Greg Ludvigson, and Chris Schneider (7/6/2000).
Abbreviations: pkst (packstone), wkst (wackestone), indet. (indeterminate), lt (light), calc. (calcareous, calcitic).

DUNLEITH FORMATION

Beecher Member

Unit. 32. Dolomitic limestone to calcitic dolomite, skeletal pkst and wkst-pkst, includes brachiopodal pkst in upper ledges; unit displayed in weathered ledges 8-24 cm thick, base of units marks change to more dolomitic lithologies, varying degrees of weathering have produced oxidized and porous fabrics; thin argillaceous partings at 13, 28, and 52 cm above base of unit; calcite void fills present in lower beds, porosity fillings of poikilotopic calcite cements common in upper 40-50 cm. Crinoid debris and indet. brachiopods noted. Maximum exposed thickness 77 cm (2.5 ft).

DECORAH FORMATION

Ion Member (= Buckhorn and St. James members of Illinois classification)

Unit 31. Limestone, dolomitic in part, skeletal pkst and wkst-pkst, part argillaceous (wavy bedding streaks), forms ledge capped by shaley reentrant, 11 cm thick lt.gray calc. shale at top; additional shaley break 23 cm above base of unit; crinoid and brachiopod debris present, part burrow mottled. 57 cm (1.87 ft).

Unit 30. Shale and shaley limestone,lt gray to green-gray, calc., more calc. in lower half; forms recessive unit, top 28 cm is the shaliest and most recessive portion; some interbedded limestone beds include skeletal pkst lenses (28-32 cm below top); skeletal grains scattered to common in shale, especially below upper recessive interval; scattered brachiopods (orthids, *Sowerbyella*), scattered to common trepostome bryozoans include subhemispherical *Prasopora* (1.5-2.5 cm diameter), shaley burrows noted in pkst. 65 cm (2.13 ft).

Unit 29. Limestone, argillaceous, slightly dolomitic, wkst-pkst, primarily a fine skeletal pkst in upper 17 cm, includes lenses of brachiopod-bryozoan debris lower 15; wavy argillaceous to shaley partings especially in lower half; unit forms limestone ledges; green-gray argillaceous burrow mottles scattered to common; fossils include scattered large trepostome bryozoans (including hemispherical *Prasopora*), brachiopods (whole valves and broken debris includes orthids, dalmanellids, rhynchonellids), crinoid debris. 67 cm (2.2 ft).

Unit 28. Limestone ledges, interbedded with green-gray shale: basal 18 cm is limestone ledge, pkst. with broken fossil hash at top (brachiopods include strophomenids, orthids, dalmanellids; horn corals); shaley reeentrant 12-30 cm above base, contains thin lenses of burrowed pkst.; 30-40 cm above base is argillaceous wkst-pkst, burrowed, containing brachiopod pkst at top; 40-48 cm above base is limestone bed, brachiopod-rich pkst. in thin stringers (sowerbyellids, orthids), bryozoans (including subspherical *Prasopora*); 48-55 cm above base is argillaceous limestone bed, wkst to skeletal mudstone, scattered brachiopods (*Sowerbyella*) and large trepostome bryozoans; 55-72 cm above base is a shaley recessive interval, calcareous shale, green-gray to lt gray, contains thin discontinuous shaley limestone beds (2-5 cm thick), scattered to common skeletal debris; top 15 cm includes an argillaceous limestone bed (wkst-pkst) at base with 6 cm shale at top, brachiopods and bryozoans noted (including subspherical *Prasopora*). Total thickness 87 cm (2.85 ft).

Unit 27. Interbedded limestone and shale; lower 30 cm is limestone dominated with shaley partings, nodular bedded in part, thin pkst stringers internally, basal 6 cm is abraded-grain pkst, argillaceous horizontal burrows; upper part is shalier, interbedded pkst stringers and lenses, abraded-grain hash to whole-shell, common argillaceous burrow mottles, recessive especially upward; fossils include crinoid debris, brachiopods (Sowerbyella, Hesperorthis, strophomenids, dalmanellids, orthids, rhynchonellids), bryozoans (large encrusting trepostomes, flat-branching forms), solitary rugose corals. 1.0 m (3.3 ft).

Unit 26. Limestone ledges, interbedded shaley partings, argillaceous wkst to pkst, part with broken skeletal grains, pkst in stringers and lenses, interbedded shaley partings, nodular bedded in part (includes argillaceous mudstones), horizontal burrow fabrics present; fossils include crinoid debris, brachiopods (*Sowerbyella*, orthids, strophomenids, rhynchonellids), bryozoans (flat-branching and small forms). 70 cm (2.3 ft).

Unit 25. Limestone, argillaceous, wkst to pkst, some nodular-bedded mudstone to wkst in middle to upper parts, fragmental skeletal stringers present; part shaley, top 20 cm is shaley recessive; part burrowed; very fossiliferous, including crinoid debris (some coarse), brachiopods (*Sowerbyella*, orthids), bryozoans (trepostomes, small flat-branching forms). 75 cm (2.45 ft).

Unit 24. Limestone, argillaceous wkst, part with burrowed pkst stringers; upper 15-20 cm is pkst, less argillaceous; whole brachiopods (*Sowerbyella*, orthids), crinoid debris, bryozoans. 30 cm (1 ft).

Guttenberg Member (units 20-23 = Glenhaven Member, unit 19 = Garnavillo Member of Illinois classification)

Unit 23. Limestone ledges, wkst to pkst, part slightly argillaceous, 10 cm thick brachiopod packstone along upper surface; horizontal beds, dominantly fine skeletal pkst; some thallassinoid burrow mottles; fossils include crinoid debris, small bryozoans, brachiopods (*Sowerbyella*, orthids, strophomenids). 60 cm (1.95 ft).

Unit 22. Limestone ledges, wkst, pkst stringers and lenses, some mudstone; horizontal beds (6-30 cm thick), scattered to common burrows; thinner bedded and slightly argillaceous in upper 20 cm; 51 cm above base of unit is a 5 cm light gray clay (possibly the **Dickeyville** K-bentonite); fossils include crinoid debris, brachiopods (strophomenids, orthids, *Rhynchotrema*), trilobite debris. 1.1 m (3.6 ft).

Unit 21. Limestone, wavy to nodular bedded (5-10 cm thick), mudstone to wkst with stringers of pkst; interbedded with irregular brown shale layers (1-6 cm); thicker limestone bed 7-22 cm above base (wkst-pkst); slightly darker colored than unit below; fossils include crinoid debris, brachiopods (*Rafinesquina*, others), small bryozoans, rare horn corals. 94 cm (3.1 ft).

Unit 20. Limestone, wavy to nodular bedded, mudstone to wkst, discontinuous stringers of brachiopod-rich pkst (more common upward, absent in lower 17-20 cm); upper 30 cm with fine skeletal pkst lenses; wavy limestone beds intercalated with irregular wispy brown shale layers (1-4 cm); prominent overhang at base; fossils include articulated crinoid stems (especially in lower part), crinoid debris, rare gastropods, trilobite fragments, brachiopods (*Sowerbyella*, *Strophomena*, *Rafinesquina*). 1.5 m (4.9 ft).

Unit 19. [28/]/ Limestone, thin to nodular bedded, interbedded with green-gray shale, mudstone to wkst, burrowed (some pkst-filled), phosphate-enriched (apatite grains present); shaley in upper part with lenses of skeletal pkst (includes trepostome bryozoans); top 3 cm is yellow-orange bentonite layer (**Elkport** K-bentonite). 29 cm (11 in).

Spechts Ferry Shale (Member)

Unit 18. Shale, green-gray, calc.; interbedded in part with scattered brachiopod coquinas and pkst lenses of comminuted skeletal debris; thicker pkst lenses to 10 cm thick (discontinuous megaripple bedforms at 25 cm and 1.3 m above base); 11-48 cm below top limestone interval (discontinuous nodular mudst, brachiopod wkst-pkst lenses); approximately 30 cm above base is 3 cm thick bentonite (**Millbrig** K-bentonite); scattered horizontal burrows; shale becomes brown-gray near base; fossils dominated by brachiopods (*Pionodema*, *Strophomena*, *Rafinesquina*), some pkst lenses contain trilobite material, bryozoans (small stick-like forms, trepostomes). 2.3 m (7.5 ft). (unit 18 = Glencoe Member of Illinois classification).

Unit 17. Limestone-dominated unit; basal 3-4 cm is yellow-orange bentonite, feldspathized in part (Deicke K-bentonite); lower limestone 6-7 cm thick, lensoidal wkst-mudstone, shaley upward, locally dolomitic (with brachiopod molds, Rafinesquina, Protozyga); upper limestone 7-9 cm thick pkst, with mudstone-filled burrows, comminuted brachiopod and crinoid debris, purplish-brown color; upper surface is carbonate hardground (up to 2 cm relief), pyritic, Trypanites borings on surface, truncated nautiloid noted on hardground surface. Unit thickness 20 cm (8 in). (Unit 17 = Carimona Member of Minnesota classification).

PLATTEVILLE FORMATION

McGregor Member (dolomitic strata of units 13-16 included within the "Grand Detour Formation" of the Illinois classification; wavy-bedded limestones of units 8-12 included within the Mifflin Member (Formation) in the Illinois-Minnesota classification).

Unit 16. Limestone, part dolomitic, mudstone to fine skeletal wkst, argillaceous partings; top half of unit is sparse skeletal mudstone with scattered burrows; uppermost portion with thin pkst stringers. 30 cm (1 ft). (Uppermost interval of dense mudstones may represent the Quimbys Mill Member of the Illinois-Wisconsin classification).

Unit 15. Calcitic dolomite to dolomitic limestone, fine to medium crystalline in part; argillaceous to shaley partings every 2 to 10 cm; basal portion includes fine skeletal debris, wkst-pkst burrow fillings, trepostome bryozoan noted; upper portion includes fine skeletal wkst-pkst with argillaceous partings and green horizontal burrow fills, prominent bedding break at top. 80 cm (2.6 ft).

Unit 14. Dolomitic limestone, thin bedded with argillaceous to shaley streaks every 1-4 cm, wkst-pkst stringers (including brachiopods) in middle part; top 13 cm is less argillaceous, more coarsely crystalline wkst-pkst, very calcitic, with crinoid debris. 66 cm (2.16 ft).

Unit 13. Dolomite, calcitic, finely crystalline, irregular wavy to fracture bedding, argillaceous streaks, becomes more argillaceous upward (especially in upper 32 cm); scattered dolomitized skeletal stringers in middle part; horizontal burrow fabrics scattered through, some Chondrites-type burrows. 76 cm (2.5 ft).

Unit 12. Limestone, skeletal mudstone to wkst; upper 19 cm includes pkst; wavy beds separated by argillaceous partings (similar to below), thicker shale parting (1 cm) at base; well-preserved fossils include brachiopods (Hesperorthis, other orthids, Strophomena), large ostracodes (Eoleperditia). 75 cm (2.45 ft).

Unit 11. Limestone, dominantly skeletal mudstone to wkst, some pkst stringers; upper 93 cm includes fine abraded pkst intermixed with mudstone-wkst, some fine pkst beds (87-93 and 37-46 cm below top); unit displayed in wavy beds 2-6 cm thick, separated by shaley to argillaceous partings, slightly less argillaceous than unit below; possible darkened hardground surfaces 56 cm above base and at top of unit; scattered horizontal and subhorizontal burrows (some to 2 cm diameter); well-preserved fossils include brachiopods (orthids, Strophomena), crinoid debris, trilobite material, large ostracodes (Eoleperditia), small branching and encrusting bryozoans, gastropods. 1.43 m (4.7 ft).

Unit 10. Limestone, skeletal mudstone to wkst, scattered wkst-pkst stringers; wavy to nodular bedding throughout, beds 1-6 cm thick, 8-10 cm at bottom; beds separated by shaley partings, calc. gray to green-gray shales; scattered burrows, mostly small horizontal to subhorizontal burrows (1 mm diameter, some Chondrites-like), additional horizontal burrow forms (2-4 mm diameter); well-preserved fossils include brachiopods (orthids, strophomenids), trilobite material, large ostracodes (Eoleperditia), gastropod molds locally concentrated within some beds but not along bed surfaces (planispiral, low- and high-spired forms), small bryozoans locally in skeletal stringers. 1.91 m (6.25 ft).

Unit 9. Limestone,skeletal mudstone to wkst; basal 11 cm is a single bed, above is wavy-bedded 4-8 cm thick, separated by argillaceous partings; shaley parting at top; well-preserved fossils include brachiopods (Hesperorthis, other orthids, Strophomena), small bryozoans, trilobite material, large ostracodes (Eoleperditia), crinoid debris, gastropods (as above). 33 cm (13 in).

Unit 8. Dolomitic limestone, dominantly skeletal wkst, fine crystalline, in 5 beds separated by argillaceous partings, some finely-laminated argillaceous partings; irregular gray burrow mottling; top 10-12 cm marked by green-gray shaley interbeds and thin dolomitic limestones with calcitic skeletal stringers (brachiopods, crinoid debris), irregular stylolitic surface at base; base of unit is an irregular surface, probably a hardground. 43 cm (1.4 ft).

Pecatonica Member

Unit 7. Dolomite, fine skeletal molds, finely crystalline but some crinoidal material is dolomitized to coarse crystals; massive unit minor bedding breaks at 67 cm above base and 14 cm below top, locally overhanging at base; some secondary calcite void fills in fractures and as porosity-fillings by poikilotopic cements; skeletal material includes brachiopods and crinoid debris, fine molds are indeterminate fossils. 1.6 m (5.25 ft). (Unit 7 corresponds to the New Glarus Member of the Illinois classification).

Unit 6. Dolomite, argillaceous, skeletal molds, very fine to finely crystalline, burrow mottles, argillaceous content generally decreases upward; lower 72 cm is argillaceous to shaley (forms recessive interval) in beds 4-17 cm separated by argillaceous to shaley partings, skeletal molds, indeterminate small darker dolomitized grains, some skeletal stringers (brachiopods, crinoid and trilobite debris), horizontal burrows; interval 24-65 cm below top is less argillaceous, thicker bedded, more skeletal moldic (include pkst stringers), marked by shaley bedding break above, skeletal molds (crinoid debris, brachiopods), burrows (1-10 mm diameter), large burrows below shaley break; upper 24 cm is fine skeletal moldic, prominent shaley bedding break at top. 1.37 m (4.5 ft).

Unit 5. Dolomite, argillaceous, very finely crystalline, skeletal moldic, irregular wispy argillaceous partings (spaced 3-6 cm) display nodular to wavy-bedded aspect to unit; shaley partings at base, finer argillaceous partings in top 6 cm; fossil molds include brachiopods (orthids), crinoid debris, gastropods, nautiloid (noted 22 cm above base). 60 cm (2 ft).

Unit 4. Dolomite, very finely crystalline, skeletal-moldic porosity, some burrow fabrics, part slightly argillaceous, argillaceous partings in upper 13 cm; part with calcite void fillings; fossil molds include brachiopods, crinoid debris, bryozoans. 90 cm (2.95 ft). (Units 4-6 correspond to the Dane Member of the Illinois classification).

Unit 3. Dolomite, very finely crystalline, skeletal molds, burrow fabrics, small void spaces impart significant porosity; some embedded quartz sand present; prominent bedding break at top. Top of unit forms quarry floor; only 18 cm in upper part of unit was accessed. Unit mostly covered, total thickness estimated at 1.1 m (3.6 ft). (Unit 3 corresponds to Chana Member of Illinois classification).

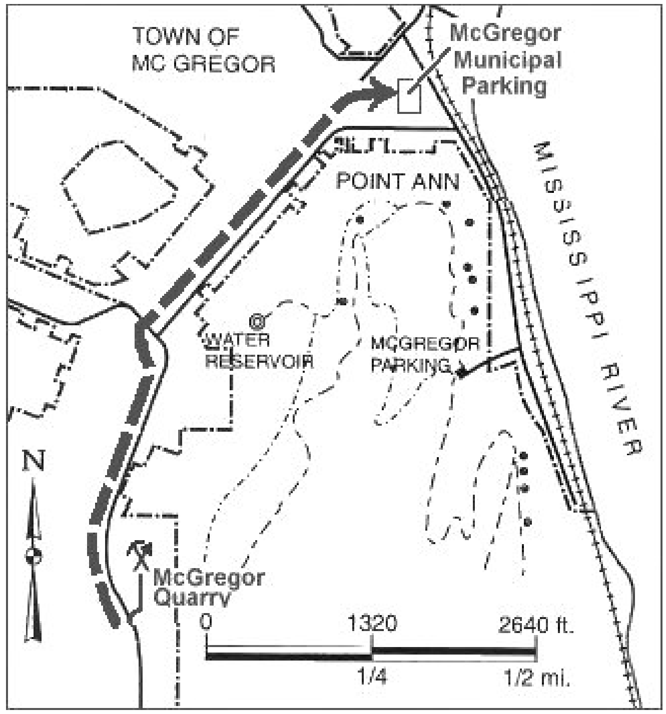
GLENWOOD SHALE

Unit 2. Shale, green-gray, silty, noncalcareous; lower part of shale interval exposed along roadway into quarry, immediately above sandstone. Estimated total thickness 1.3 m (4.25 ft).

ST. PETER SANDSTONE

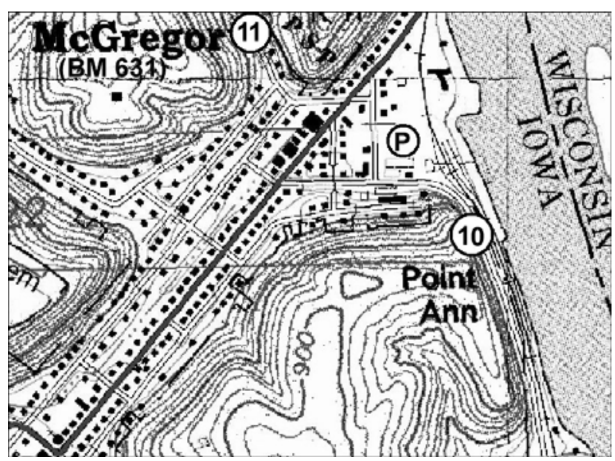
Unit 1. Sandstone, very fine- to fine-grained quartz sand, local iron-oxide cements in upper part, possible low-angle crossbeds in part; exposed along and on quarry roadway and in the adjoining ravines. Total thickness not accessed.

Depart the McGregor Quarry and proceed north into McGregor; Park in Municipal Parking Area Near Grain Terminal, Southeast Edge of Town



As we leave the main park area and go north we will descend along the covered valley wall passing only a few small exposures of Oneota Dolomite until we enter the town of McGregor. There is probably little, if any, Shakopee Formation along this route due to the localized deep truncation of the Prairie du Chien Group by the pre-St. Peter unconformity. At the south end of town several old lower Oneota quarries, now occupied by various buildings, are visible. Below the Oneota, at the north end of McGregor, the Upper Cambrian Jordan Sandstone is well exposed. The last stop of the trip will be in town to look at the upper part of the Jordan.

Hike to Exposure of Jordan Sandstone on Point Ann Near Grain Terminal



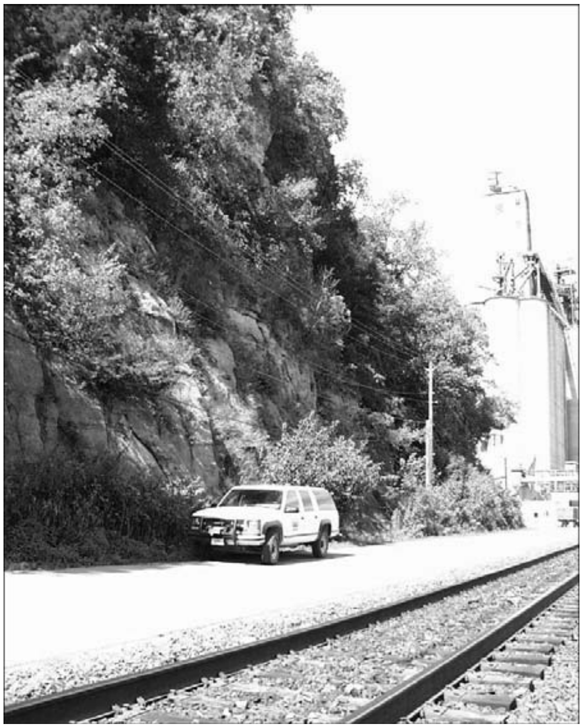
Stop 10. Overview of the Cambrian Jordan Sandstone in Pikes Peak State Park

by Robert McKay, Geological Survey Bureau, Iowa Department of Natural Resources

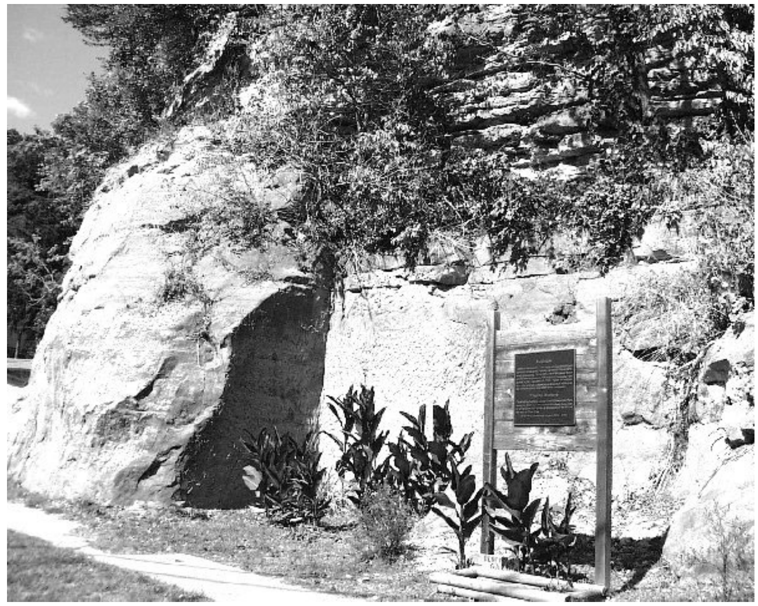
The area around Stop 10 is a very busy grain handling facility. The road is narrow and there is little room to stand in the ditch, so be aware of the automobile and truck traffic. Also, if you go near the railroad grade, be alert for train traffic.

The Jordan Sandstone, a unit that straddles the Cambrian / Ordovician boundary, is exposed only on the northern-most end of Pikes Peak State Park. To read more about the Jordan Sandstone, see pages 13-23 of this guidebook.

A measured section for the Pikes Peak North Exposure is reproduced in Appendix 1, page 125; a measured section for the Pikes Peak South Exposure is reproduced in Appendix 2, page 130.



Trip Stop 10. Jordan Sandstone at Point Ann.



Trip Stop 11. Jordan Sandstone at "A" Street in McGregor

Hike to A-Street Exposure on North Side of McGregor for Stop 11 (see map above)

Stop 11. The Jordan Sandstone at "A" Street in McGregor

by Robert McKay, Geological Survey Bureau, Iowa Department of Natural Resources

Please be aware of the traffic as you hike through town. Give the cars and the local residents the right-of-way. For a written description of Stop 10 see pages 20-21.

A measured section for the "A"Street Exposure is reproduced in Appendix 3, page 137.

Hike to Cave Near McGregor City Well Number 6

This is an optional Trip Stop, if time and light allows. Many caves were dug into the Jordan Sandstone by early residents for storage and packed with ice for use as cold storage. One is accessable on McGregor city property near City Well No. 6 (see photo to right).

Stop 12. Discussion of the Jordan Sandstone Caves in McGregor

by Robert McKay, Geological Survey Bureau, Iowa Department of Natural Resources

OPTIONAL FIELD TRIP STOP

(If Time and Daylight Allow)

Depart Parking Area and Drive North Along Mississippi River to Pikes Peak State Park McGregor Parking Ares

Hike Up Trial and Around Point Anne Loop

Various Stops for Botanical and Archaeological Features of Interest

by John Pearson, Senior Environmental Specialist, Iowa Department of Natural Resources.

and Brian Witzke, Geological Survey Bureau, Iowa Department of Natural Resources

APPENDIX 1. Measured Section for Point Ann North Exposure, McGregor.

Name: **POINT ANN NORTH OUTCROP (WS144)** *County:* **CLAYTON**
Company: **MCGREGOR, CITY OF**
IDALS Reg. #: **NOT APPLICABLE** *IDOT Code #* **NOT APPLICABLE**
Loc. (Q's): **SE SE SE** *Sec.* **22** *T.* **95N** *R.* **3W**
Quad: **PRAIRIE DU CHIEN (E45)** *Elevation:* 630 ft. at road level (base of section)
Loc. Rmrks: Outcrop on west side of road, at north end of the Point Ann ridge.
Descrip. By: Robert M. McKay *Date(s):* 5/11/1995&10/22/97
Descrip. Rmrks: Section measured and numbered from base upwards. Section begins at road level approx. 200 feet south of grain elevator/barge loading facility.
TFA = tangential foreset dip azimuth; TAA = trough axis dip azimuth; PFA = planar xs foreset azimuth
Previous Descrips. & Other Remarks: Same location as WS144 outcrop description by W.S. Schuldt, (1940) University of Iowa M.S. thesis

Unit	*Description*	*ft.*	*m.*
	Units 1 through 8 appear from road level as one massive, very thick bedded unit.		
1	Sandstone, f-c, minor vc as quartz and tan silty dolomitic lithoclasts, massive on outcrop, outcrop moderately lichen covered, internally highly cross-stratified, abundant trough cross-strata, sets highly truncated and range in thickness from 10-60 cm; xs in lower 2 m, TFA=185, 186, 199; TAA=241, 259; from 2-4 m TFA=141, 113, 232, 170, 189, 196; small bedding break at 5 m.	16.4 ft	5.0 m
2	Sandstone, f-c, minor vc quartz, intraclastic, intraclasts are 1-3mm tan dolomitic siltstone, one thick bed with no discernible stratification	1.31 ft	0.4 m
3	Sandstone, f-c, trace vc, quartzose, faint small-scale cross-stratification	0.49 ft	0.15 m
4	Sandstone, f-vc, quartzose, highly intraclastic, intraclasts 1-3mm tan dolomitic siltstone clasts, one medium bed with no discernible stratification	0.89 ft	0.27 m

5	Sandstone, f-c, trace vc, quartzose, moderately intraclastic with majority of intraclasts similar to below but basal 5 cm contains 1 by 8 cm flat pebble intraclasts with internal horizontal-planar laminations, unit displays horizontal stratification in poorly defined sets up to 5 cm thick, at 65 cm above base is a 3 mm round quartz pebble	3.02 ft	0.92 m
6	Sandstone, similar to unit 5 but with minor tabular cross-sets in upper part, PFA=314	1.12 ft	0.34 m
7	Sandstone, f-c, quartzose, moderately intraclastic, numerous sets 5-10 cm thick of horizontal to low-angle planar in lower part, and low angle troughs in upper part; upper 28 cm contains sandy siltstone flat pebble intraclasts to a maximum size of 1 by 6 cm. Top of unit marked a discontinuous zone of vertical Skolithos burrows which extend down from a laterally discontinuous 2 cm thick green silty, clayey sandstone *Offset measurements to the south approximately 30 m and up talus slope to continue the section*	3.21 ft	0.98 m
8	Sandstone, m-vc, quartzose, trace granules (quartzite) up to 4mm diameter, cross-stratified to horizontally stratified, sets up to 8 cm thick with low-angle foresets. Contains common dolomitic siltstone - very fine grained sandstone flat pebble intraclasts that are <1 cm to 7 cm in diameter by 0.5 cm thick.	0.98 ft	0.30 m
9	Sandstone, appears as a distinctive slightly recessive, thin bedded unit with distinct light tan color from unit below; dominantly silt & vf-f with approximately 30% m-c interstratified lenses & laminae, rippled & flasered-bedded with tan to light green laminated silty clay flasers and drapes to 1 cm thick, and discontinuous wavy to less well-developed silty/clayey/dolomitic flasers. Upper 10 cm tends to be horizontally to wavy laminated with same grain size distribution. Upper contact is very sharp and erosional.	2.07	0.63 m
10	Sandstone, m-c, vc, intraclastic; lower half is one tabular planar set up to 35 cm thick with erosionally scoured base with up to 10 cm relief, highly intraclastic in lower foresets with tan silty to vf sdy fpi to 8 cm; PFA= 22,15,75,35. Upper half consists of 2-3 sets 10-20 cm thick of planar to low angle tangential (probable truncated trough sets) xstrata; TFA=38,75,43 (dips of 27,13,25).	2.89 ft	0.88 m
11	*Skipped in numbering*		

12	Sandstone, interbedded cross stratified lenses & bioturbated beds; maximum lense length is 2.0 m. 12a (10cm) vf, minor f-m, moderately bioturbated. 12b (10 cm) f-m, lense with planar cross strata, lenses pinchout and/or thin laterally to thin 1-2 cm thick sand zones; lenses are often but not always overlain or draped by 0-2 cm thick layers of well laminated silt-vf ss. 12c (10-15 cm) vf-f, minor scattered m-c, moderately bioturbated with *Skolithos* (sample PAN 12). 12d (4-5 cm) silt-vf, horizontal to wavy laminated over unit below. 12e (15-16 cm) vf-f, minor scattered m-c, moderately bioturbated with *Skolithos*. 12f (2-12 cm) f-m, minor c, lenticular planar xs with planar foreset consistently to se-sw, PFA=215,141,157,190; occasional silt-vf ss fpi in lenses. 12g (4-10 cm) thin interbeds of horizontally laminated silt-vf ss, bioturbated vf-f ss and 1-2cm thick lenses of f-m (minor c) xs. 12h (0-6 cm) f-m, lensatic.	2.43 ft	0.74 m
13	Sandstone, thin interbeds of vf-f and f-c, horizontally laminated in part and moderately bioturbated in part that grade laterally to cross-strata. 13a (27-30 cm) lower 12 cm is xs sandstone, m grn, minor coarse, one set of tangential xs that pinches out laterally TFA=115, intraclastic with common silt to f dolomitic ss fpi from 0.5-4 cm, and lessor fpi up to 1 cm thick and 50 cm long, gradational into the upper 18 cm which is moderately *Skolithos* bioturbated very sandy dolomite to dolomitic sandstone , laterally continuous (sample). 13b (16-27 cm) Sandstone, f-c, minor vc and one felsite well-rounded pebble to 4.5 mm, dolomitic to very dolomitic, and intraclastic with dolomitic fpi tp 2 cm, displays faint trough xs with sets to 12 cm thick and up to 30 cm wide; locally 13b thickens to 27 cm and contains two cycles of fpg grading up to m-vc lenticular xs ss in troughs with set thickness 3-10 cm (sample). Laterally 13b becomes much less distinct and the overlying unit 13c appears to thicken to the south. 13c (13 cm) Sandstone f-c, minor vc, horizontal-wavy laminated with common and distinctive discontinuous tan silty laminae, laminae up to 1 mm thick and 10-15 cm in length, sparsely intraclastic in basal 5 cm.	2.0 ft	0.61 m

14	Dolomite, lower 25-30 cm is a dolomitic ss with common silty-sandy dolomite fpi and sand matrix of m-vc, displays discoidal vugs from intraclast weathering; grades upward to distinctive dolomite, vf xtln, vf-c sandy, quartzose, appears as slightly recessive, pink dolomite that is separated into 3 to 4 subbeds with the lowest subbed being the thickest, no visible primary sedimentary structures; sharp upper contact (sample).	1.97 ft	0.6 m
15	Sandstone, f-c, one thick unit but internally consists of sets 4-10 cm thick of small-scale (probable) trough xs, sets are discontinuous laterally, middle portion contains numerous light tan, thin-flake clay intraclasts 1-5 cm in length (channel sample grain size), TFA=43, 107, 119, 240.	3.48 ft	1.06 m
16	Sandstone, vf-m, minor c, intraclastic with siltstone to vf sandstone fpi up to 5 cm in diameter, stratification is horizontal-wavy and discontinuous	0.89 ft	0.27 m
	Additional Section This short section measured on 11/07/94. Was looking for contact between coarse-grained Van Oser facies and finer-grained facies above. The section begins about 1-2 m below top of telephone pole. Measured from bottom up.		
1a	Sandstone, light grey on weathered surface, thick to very thick bedded appearance, fine-coarse, minor vc, rounded, very weakly cemented, white-brownish on fresh surface, very porous, vertical east -west joints, local dolomitic cemented zones. Upper 60 cm contains common dolomitic and silty sandstone intraclasts which are generally flat pebble and less than 1 cm to 7 cm in diameter by 0.5 cm thick. Followed by transition zone into overlying facies.		
1b	Sandstone, fine-coarse, sm-sc-xs sets 0.5-1.0 cm sets, flasered with green clay flasers up to 1mm thick; very thin to thin bedded; unit is poorly sorted; sharp upper contact, recessive - generally covered.		0.08 m
2a	Sandstone, fine - medium, minor coarse, intraclastic with tan dolomitic siltstone flat pebble clasts 0.5 - 4.0 cm diameter. Also some tan dolomitic sandy siltstone matrix filling *Skolithos* burrows. This unit is the lower and poorly exposed half of one ledge-forming bed. Sample 2a (this sample has some green shale on the base from the underlying 1b interval).		0.14 m

2b	Dolomite, light grey, fine - coarse sandy, intraclastic with tan silty flat pebble clasts. This is the upper one half to two thirds of a ledge-forming unit which overall appears to vary in thickness between 30-33 cm. Sample 2b	0.15-0.20 m
2c	Dolomite, light grey, no internal fabric, vf-f xtln, silty to fine quartz sandy, rare m-c quartz sand, hard, well cemented. Sample 2c	0.08-0.10 m
2d	Sandstone, tan, vf-f, dolomitic, bioturbated. Sample 2d	0.05-0.06 m
2e	Dolomite, tan, silty to vf-f sandy, bioturbated	0.01 m
	Notes – examining section from a distance at road level it is apparent that there is a thinner bedded unit of approximately 2 meters that intervenes between the more massive bedded sandstones below and the base of unit 2. Unit 1 of the above section may be part of this thin bedded unit.	

APPENDIX 2. Measured Section for Point Ann South Exposure, McGregor.

Name:	**POINT ANN SOUTH OUTCROP (RM-4)**	*County:*	**CLAYTON**
Company:	**MCGREGOR, CITY OF**		
IDALS Reg. #:	**NOT APPLICABLE**	*IDOT Code #*	**NOT APPLICABLE**
Loc. (Q's):	**NW SW NW NW** *Sec.* **26** *T.* **95N**	*R.*	**3W**
Quad:	**PRAIRIE DU CHIEN (E45)**	*Elevation:*	630 ft. at road level (base of section)
Loc. Rmrks:	Outcrop on west side of road, at south end of the Point Ann ridge.		
Descrip. By:	Robert M. McKay	*Date(s):*	11/7&16/1994
Descrip. Rmrks:	Section measured and numbered from base upwards. Section begins at road level. TF = trough foreset dip azimuth; TA = trough axis dip azimuth WF=wedge foreset dip azimuth; PFA = planar xs foreset azimuth		
Previous Descrips. & Other Remarks:	No previous description. Conodont samples sent to Jim Miller SWMS Univ.; lith samples shelved at Oakdale		

Unit	*Description*	*ft.*	*m.*
1	Sandstone, grey on weathered outcrop, mostly poorly exposed, brown to white on fresh surface; fine-coarse grained; large-scale trough cross-strata in sets 10-30 cm thick; contains calcite cemented “popcorn-shaped” zone; TA = 237, 234, 253 measured 0.9 - 1.3 m below top of unit. Thickness calculated with tape & vertical angle measurement.	25.6 ft	7.8 m
2a	Sandstone, grey when weathered, white when clean, fine-medium, minor coarse, very friable, very poorly cemented; trough cross stratified in sets 5-10 cm thick and 10-30 cm wide, sets are deeply truncated.	0.98 ft	0.3 m
2b	Sandstone, generally finer grained interval; lower 25 cm appears parallel and horizontal to wavy laminae filling truncated surfaces. Middle 30 cm is well developed lenticular and flaser bedded siltstone to very fine sandstone with well developed silt to clay dominated lense drapes and flaser laminae. Small scale troughs with TA = 254, 185, 184. *Several photos*	2.13 ft	0.65 m
2c	Sandstone, white, very fine - medium, dominantly planar-parallel horizontal laminae to very low angle laminated which laterally appears as larger scale truncated trough cross strata.	0.33-0.49 ft	0.1-0.15 m

3a	Sandstone, intraclast conglomerate, matrix fine- to coarse-grained with trace very coarse, common dolositstone fpc 1mm-4cm with rounded edges. Unit truncates the upper part of unit 2. Some clasts may be exhumed and hardened burrow casts. The lower two thirds of unit is horizontal to low-angle planar stratified; upper two thirds may be truncated and filled by truncated wedge sets 7-10 cm thick with WF=341. Staratification is locally contorted over white sandstone of unit 2b. <u>Sample upper part 3a.</u>		0.2-0.33 m
3b	Dolostone, tan, very sandy with very fine- to coarse-grained sand, moderately bioturbated with *Skolithos* , burrows extend down into intraclast conglomerate of 3a.	0.33 ft	0.09-0.1 m
4	Sandstone, tan, fine- coarse, minor very coarse and trace granule to 3mm. Stratified in wedge sets generally 10 cm thick with common dolomitic flat pebble clasts (fpc) and numerous *Skolithos* tubes in more dolomitic laminae. Stratification within wedge-shaped sets is low-angle with 1-2 m wide laminae containing interlaminated dolomudstone to dolosiltstone laminae (probable IHS – inclined heterolithic lateral accretion laminae). Unit divided into 5 subunits, 4a-4e. *Several photos of intraclasts & Skolithos tubes*.	4.7 ft	1.43 m
4a	Sandstone, fine - coarse, trace very coarse, highly intraclastic; stratification in planar xs wedge-shaped sets 6-10 cm thick (PFA = 204, 214, 217). Intraclasts 1 mm - 4.5 cm, fpc of silty-sandy dolomite & dolomitic vf-f minor m-c sandstone; *Skolithos* tubes 2-3 mm thick by 1-5 cm long. (15-18 cm)	0.6 ft	0.15-0.18 m
4b	Dolostone, tan, extremely sandy to dolomitic sandstone, silt - m grained with minor coarse. Drapes over the wavy and truncated upper surface of 4a, thickens over trough-shaped lows in 4a and thins over thicker portions of 4a, horizontal-planar laminated (1-5 cm) <u>Sample RM4-4B</u>	0.1 ft	0.01-0.05 m
4c	Sanstone, fine- to coarse-grained, 6 to 7 sets separated by 1-6 cm thick dolomitic sandstone layers. XS sets display weak stratification, common intraclasts and *Skolithos* burrows. XS is not preserved enough to measure FA; sandy dolomitic layers are more intensely bioturbated. (50-52 cm)	1.65 ft	0.5-0.52 m

4d	Sandstone, silt to coarse, minor very coarse; lower third locally preserves tangential to trough foresets with sets 3-12 cm thick at 60 cm above base; several maximum foreset azimuths & dips TFs = 193, 214 w/ 25 dip,221 w/ 24 dip, 211 w/ 28 dip; remainder is poorly stratified to nonstratified with middle part being more dolomitic and strongly bioturbated; upper is clean fine to coarse, minor very coarse, with much less dolomite content, nonstratified, very faint burow traces; dolomitic sandstone in middle part displays some contorted bedding. (45 cm)	1.48 ft	0.45 m
4e	Sandstone, whitish to greenish color, recessive subunit, dominantly fine to coarse, minor very coarse. Thinly bedded with stacked 1-2 cm thick sets of wavy laminated finer and coarser sand with interbedded small-scale-low-angle tangential cross-laminae; one small scale TFA = 354; upper 5 cm with vertical *Skolithos*. (15-25 cm)	0.66 ft	0.15-0.25 m
5a	Thinly Interbedded Sandy Dolostone and Dolomitic Sandstone; Sandstone, very fine to medium, no coarse, occurs as sets of small scale trough cross-strata (FA = 350, 314, 183). <u>Ledge forming unit</u>. Thin dolostone interbeds are of lenticular tan dolomudstone with vertically oriented sand-filled mudcracks (one lense of dolomudstone only 1.0m across. Basal portion of unit is locally cutout and filled by intraclastic conglomerate. Upper 2-5 cm locally is extremely very fine to medium sandy, laminated dolostone; wavy laminae drape over ripple forms below (low-amplitude drapes of < 1 cm). *(Photos of mudcracks)*	0.56 ft	0.15-0.19 m
5b	Dolostone, occurs as a ledge former, generally seen as 3-4 distinct beds, but laterally may appear as one bed with prominent joints. Lower half is a very fine to medium grained dolomitic sandstone with minor coarse, nonstratified, bioturbated; upper half is a very sandy very fine to medium sandy dolomite with minor coarse sand. This unit is probably the same as orange-tan dolostone (unit 2) of section RM-172.	1.38 ft	0.39-0.44 m
6	Relatively uniform appearing unit on hillside with a 50 cm thick zone of popcorn cementation/weathering in lower 50 cm. Is slightly recessive from units below and above but has thin ledgy cementation especially in lower part. Units 6a-6c.	4.9 ft	1.45-1.54 m

6a	Sandstone, fine – coarse, minor vc but some sets are f-m. At least 8 wedge-shaped truncated sets of xs (16 degree foreset dip) FA= 290, 87, 117, 346, 315, 184. Some silty dolomudstone foreset laminae drapes, minor thin-flake intraclasts from doloforeset laminae, minor *Skolithos*. (70 cm)	2.3 ft	0.7 m
6b	Interlaminated SS & Shale, ss is f-m, minor c, wavy to horizontal interlaminated with green clay in lower part; lenticular to flaser laminated in middle with some ripple foreset preserved (RFA= 300) Upper part wavy interlaminated with approx 10% green clay. (25 cm)	0.82 ft	0.25 m
6c	Sandstone, vf-f, minor m, dominantly horizontal - wavy planar laminated with minor foresets in part (FA=124), very little clay, less recessive than units below, sharp upper contact. Minor thin dolomitic laminae, mostly very porous but moderately calcite cemented in part. (55-60 cm). (*Photo of unit 6/unit 7 contact*.)	1.87 ft	0.55-0.60 m
7a	First subunit in a thick prominent ledge-forming unit. Sandstone, f-c dolomitic to very dolomitc, fpc abundant up to 8 cm; very sandy dolostone clasts in base grades up to 5 cm thick set of horz planar tovery low angle xs with tangential foresets FA= 170, no bioturbated cycle cap. (26 cm) Sample RM4-7a.	0.85 ft	0.26 m
7b	Sandstone, intraclast conglomerate in basal 7 cm, grades sharply upward to vf-f grained horizontal-planar laminated sandstone with dolomite cement and dolomite peloids, minor bioturbation. (31 cm) Sample RM4-7b.	1.0 ft	0.31 m
7c	Dolostone, lower 32 cm is intraclast conglomerate, vf-m sandy; upper 88 cm is vf-m sandy peloidal dolograinstone. Upper stratification is dominantly horizontal-planar to wedge-shaped sets having very-low-angle and long (1-2 m) foreset laminae with wedge FA = 16, 28, 186. Less common interstratfied 6-7 cm thick tabular sets in upper part (with FA =150 with dip incline =27), usually separated by 2-4 cm thick horizontal-planar sets. Sample 7c-lower from lower 32 cm; sample 7c-upper from 50 cm below top.	3.9 ft	1.2 m
7d	Sandstone, white, slightly recessive, vf-f, friable, intraclastic.	0.46 ft	0.14 m

7e	Sandstone, dolomitic, hard, vf-m, ledge-former, lower 30 cm composed of basal 10 cm thick small-scale wedge set (FA=10) and overlain by 20 cm thick wavy to sm-sc-ripple xs. Remainder of unit is several wedge-sets of very low-angle to horizontal-planar xs to laminae (FA=205 and foreset dip 8 degrees)	3.5 ft	1.07 m
8	Dolostone, intraclastic grainstone, f-c sandy, hard, faint wedge-shaped set with FA = 133.	0.59 ft	0.18 cm
9	Sandstone, vf-f, dolomitic, bioturbated with *Skolithos*.	0.23 ft	0.07 m
10	Dolostone, light gray, f-c sandy mudstone, bioturbated	0.33 ft	0.07-0.12 m
11	Sandstone, f-c with less vc-pebbles, locally calcite cemented, intraclastic with silty dolomite intraclasts and green claystone intraclasts; one 2 cm disc-shaped quartzite pebble. Lower 10-15 cm is one laterally widespread tabular set with FA = 176, 149, 158 and 19 degree foreset dip angle. Upper part is also intraclastic with local trough-shaped set with TA = 265. 2 <u>Samples RM4 11, one from base</u>.	1.12 ft	0.34 m
12	Dolostone, coated-grian grainstone to ooid grainstone, extremely f-c quartz sandy; becomes well-developed ooid-grainstone upwards.	2.6 ft	0.7-0.9 m
13	Dolostone, very sandy f-c and highly intraclastic in lower 10 cm; grades upward to sandstone, f-c with some ooid to coated-grains, and a second intraclast conglomerate zone in upper half. <u>Sample 13b from upper part</u>.	1.02 ft	0.31 m
14	Dolostone, parted into three beds, coated-grain grainstone to ooid grainstone, f-c quartz sandy, common ooid quartz cores.	1.02 ft	0.31 m
15	Dolostone, intraclastic and f-c quartz sandy in basal part, grades upward to much less sandy ooid grainstone with horzontal-planar to low-angle cross-strata. Top of unit 15 is near top of steep bench with poorly exposed interval above this point.	1.87 ft	0.57 m
16	Covered Interval, top of covered interval is recessive bench along cliff.	1.97 ft	0.6 m
17	Dolostone, intraclastic coated-grain to ooid grainstone, very sandy; has a 6-12 cm thick laminated f-m grained quartz sandy dolomudstone cap.	1.12 ft	0.34 m
18	Sandstone, vf-m, very minor c, hard, very dolomitic grading upwards to less dolomitic; two tabular sets of cross-strata, FA = 156. Top of this unit is the base of prominent overhang.	1.54 ft	0.47 m
19	Dolostone, gray, non-sandy, f-m crystalline, 2 cyles of peloid grainstone with 1-2 cm thick mudstone cap.	0.82 ft	0.15-0.29 m

20	Dolostone, stromatolite boundstone, f xtln, non-sandy, wavy mat in lower part grading upward to small (2-4 cm across) LLH with 1-2 cm relief; wavy to low-relief mounded upper surface. Sample 20. Units 19 and 20 tend to appear on outcrop as a single thick bed.	0.82 ft	0.2-0.29 m
21	Dolostone, coated-grain to peloidal grainstone, vf-m sandy, sandier to intraclastic basal part; sharp contact over underlying stomatolite boundstone. This unit appears to grade, at least locally, to vf-m dolomitic sandstone in the upper 10 cm. Sample 21a and 21b.	1.3 ft	0.38-0.42 m
22	Silicified oncolite packstone ?, white, silicified oncolites? to nodules <1 - 2 cm in diameter, oval to spherical-shaped in dolomitic sandstone matrix; lower part appears to be oncolite packstone, upper part very sandy dolostone with ooid grainstone intraclasts. Sample 22 a and 22b from lower and upper parts. This bed appears to be a local marker bed as it is present at Point Anne Road parking area in the cliff face above the parking area.	0.59 ft	0.17-0.19 m
23	Dolostone, packstone, intraclastic with fpc to 6cm, vf-m sandy, upper 8-10 cm has diffuse white silicification throughout (possible pedogenesis ?, may correlate to Marquette West roadcut unit), sharp upper contact; also some elongate 1by 6 cm white chert nodules.	1.44 ft	0.44 m
24	Dolostone, oxidized brown, slightly sandy peloidal packstone - grainstone, slightly recessive, no discernable stratification, highly fractured with small equant pattern.	1.64 ft	0.5 m
	Offset section 30 m to the north.		
25	Dolomite, light grey, fine xtln, fine sandy, dense, hard, moderately vuggy, massive thick bed, ledge former.	3.44 ft	1.05 m
26	Dolostone, vertical honeycomb (sensu Adams, 1975) digitate stromatolite boundstone, wavy mat in lower 10-15 cm, grades upward to main digitate stromatolite.	1.64 ft	0.5 m
27	Dolostone, low-amplitude wavy stromatolite mat.	0.98 ft	0.3 m
28	Dolostone, fine-med xtln, dense, hard, intraclastic peloidal packstone.	0.98 ft	0.3 m
29	Covered interval	1.97 ft	0.6 m
30	Dolostone, inaccessible	0.98 ft	0.3 m
31	Dolostone, digitate stromatolite boundstone, (vertical honeycomb)	0.66 ft	0.2 m
32	Dolostone, grades from unit 31 below, stromatolite boundstone, llh, low wavy strom heads 30 cm diameter	1.48 ft	0.45 m
33	Dolostone, brown, ooid grainstone with white chert nodules, poorly exposed to covered	1.15 ft	0.3-0.4 m

34	Dolostone, stromatolite boundstone, low-amplitude llh in lower part grading up to wavy mat in upper part, white chert nodule band at top *The two white chert bands of unit 33 and 34 correlate to Marquette West Road Cut Section*	1.38 ft	0.42 m
35	Dolostone, intraclast conglomerate grainstone, intraclasts to 6 cm, fine- to coarse xtln, nonsandy (hand lense), sporadic 10 by 20 cm white chert nodules	0.98 ft	0.23-0.3 m
36	Dolostone, very light grey to very light green with brown mottles, appears as "white beds" from road level below, fine xtln, thin bedded, horizontal burrows common, upper 85 cm is slightly recessive, this facies continues upward an undetermined amount There is at least another 20 m of section exposed above this point in bold vertical cliff face	6.56 ft	2.0 m

Summary of Conodont Samples sent to Jim Miller at Southwest Missouri State Univ. on Sept. 29, 1999. Lith samples retained from all conodont samples			
Unit #	**Meters above Base of Section**	**Weight**	
11	16.0 m	2.3 lbs	
7C	13.7 m	2.3 lbs	
7A	12.7 m	2.15 lbs	
6B	11.7 m	1.9 lbs	
6A	11.3 m	2.0 lbs	
5B-3	10.9 m	2.0 lbs	Unit 5B correlates lithically to the 1'st dolomite bed at Mrs. Moes House, the upper part of unit 14 at Point Ann North, and unit 8 at the "A" Street Outcrop. Sample 5B-1 is from lower part, 5B-2 from middle, and 5B-3 from upper.
5B-2	10.8 m	2.2 lbs	
5B-1	10.6 m	2.3 lbs	
4E	10.3 m	1.7 lbs	

APPENDIX 3. Measured Section for "A" Street Exposure, McGregor.

Name: **"A" STREET OUTCROP** *County:* **CLAYTON**
Company/ Owner: **STATE OF IOWA**
IDALS Reg. #: **NONE** *IDOT Code #* **NONE**
Loc. (Q's): **NW NW SE SE** *Sec.* **22** *T* **95N** *R.* **3W**
Quad: **PRAIRIE DU CHIEN (E45)** *Elevation:* 674 at top; 640 at base
Loc. Rmrks: Outcrop on north side of "A" Street, downtown McGregor, Iowa; landscaped into "Bluffside Garden" during 1997 by the city.
Descrip. By: R.McKay with R.Anderson *Date(s):* 11/13 & 11/18/1997
Descrip. Rmrks: photos taken
Previous Descrips. & Other Remarks: no previous descriptions in files
TFA = tangential or trough foreset dip azimuth; TAA = trough axis dip azimuth; PFA = planar xs foreset azimuth

Unit	*Description*	*ft.*	*m.*
1	Sandstone, appears as massive unit but internally is highly cross-stratified; divided into two subunits; top of unit 1 marked, in vertical profile, by a moderate slope change to a recessive unit 2. Unit 1a (0-168 cm), f-m with only trace c at base, minor c throughout main part and moderate c in upper 20 cm, very friable & weakly cemented. Top of 1a is marked by moderately prominent low-inclined bedding plane (dips se at 5 degrees) and coarser grain size above. Most of unit is truncated trough cross-strata with sets typically 50-100 cm in width & 15-20 cm maximum thickness, but some sets to 150 cm wide. Troughs are best visible in upper half of 1a. A discontinuous 1 cm thick green clay layer is present along the base at north end of outcrop (near new garage) and rare, isolated green clay clasts are present in the lower meter also at north end. At 163 cm near cellar excavation is a 6 cm thick by 45 cm long lense of poorly sorted ss with grain size from silt to vc & trace granule to 3 mm, and common 1-3 mm green clay & tan siltstn intraclasts.	9.35 ft	2.85 m

1 cont'd	Unit 1b (117 cm), f-c, minor vc & rare qtzte granule to 3 mm, sparsely intraclastic (clasts are tan dolomitic sltstn & <5mm). Trough cross-strata more prominent & larger than in unit 1a, dominated by truncated trough sets 10-40 cm thick & up to 2.0 m wide. Unit 1 TAA = 214, 208, 184, 210, 222, 171, 207, 179, 197, 227, 244, 225; TFA=217, 104, 241. Samples at base, 50, 90, 100, 150, 163, 173, 220, 275, & 283 cm. All samples are extremely lightly cemented with silt-size dolomite rhombs that detach from quartz grains very easily.		
2	Sandstone, coarser and more intraclastic than unit below; slightly recessive profile; overlain by prominently horizontally stratified unit above. Unit thickness varies laterally from 95 cm thick at west end of outcrop to 26 cm thick at far east end by nearest building courtyard. On west end unit composed of 3 normal-graded & faintly low-angle planar/horizontally stratified to nonstratified sets that grade from m-vc, with minor 5 mm qtz granules at base to f-c, minor vc in upper part of sets. Lower portions of sets contain qtzte granules & are highly intraclastic; intraclasts are dolomitic silty-vf ss to 5 mm with rounded edges; coarser grained at east end with intraclasts to 7 mm. sample.	0.85-3.12 ft	0.26-0.95 m
3	Sandstone, with 3 subunits. 3a (0-28 cm) outcrop expression as a slightly protruding profile especially behind park sign, vf-m with rare c-vc, consists of 2-4 sets of trough cross-strata with minor silty flasers near top; thins laterally to 0 cm at east end of outcrop. 3b (60-125cm) generally recessive; sandstone, f-c with common silty ss intraclasts to 6 mm and minor ss intraclasts of coarse ss to 2 cm, dominated by low-angle planar strata, maximum thickness at east end. 3c (190 cm) at west end the lower 40 cm is recessive while remainder is prominent ledge-former; best cross-stratification is visible on west end by new garage while east end appears massive. Sandstone, f-c, minor vc, minor ss intraclasts up to 1 cm thick by 8 cm long; west end composed of 6 to 8 sets of trough to broad low-angle tangential cross-strata with set thickness between 8 and 40 cm; TFA= 330, 340, 295, 15, 189, 284, 355, TAA=219 *Offset section back to the east end of outcrop to the tree-rimmed ledge within alcove area.*	9.12 ft	2.78 m

4	Sandstone, light greenish white, (visually prominent recessive marker bed), sharp erosional lower contact, lowermost 3 to 5cm is discontinuous, unstratified and poorly sorted, vf-vc with minor qtz pebbles to 6 mm, and f ss intraclasts to 8 mm. Above that is somewhat laterally persistent 5-10 cm thick planar to low-angle tangential xs set with minor amount of deformed to overturned foreset laminae, PFA=98 (frames 16, 17). Remainder of unit is thin-bedded and lenticular to flaser-bedded vf-c with 10-20 % green clay drapes, laminae, and flasers; microlenses & flasers noted in sample. Includes two well-developed form-symmetrical ripple lenses in middle (frames 18, 19, 20).	1.61 ft	0.49 m
5	Sandstone, light greenish white, visually prominent whitish bed that is slightly protrusive; f-m, minor c, no dolmite crystal cement, green clay intraclasts at base, small scale lenticular ripple trough-xs with green clay & vf ss to silty flasers, drapes & discontinuos laminae, grades in upper part to wavy to crinkly to horizontally interlaminated ss and clay with clay laminae to maximum of 5 mm. Laminae slightly deformed by loading of overlying unit. Sample.	0.56-0.92 ft	0.17-0.28 m
6	Sandstone, f-c, trace vc & granule to 4 mm, generally nondolomitic but moderate amount of dolomite crystals are concentrated in Skolithos tubes within bioturbated zones. In center alcove area unit consists of two planar to tangential xs sets of subequal thickness that both pinch out laterally to the east (PFA=50^o on lower set & 60^o on upper set). Sets have highly intraclastic bases with common intraclasts 3-5 cm and some to 8 cm; intraclasts are weakly cemented tannish vf silty/clayey ss; lower set contains several isolated Skolithos tubes penetrating foreset laminae (marks zone of foreset reactivation). Laterally these two sets and the interset boundary grades to meter plus wide lenses with bioturbated tops and strongly bioturbated interlense zones. The more highly bioturbated zones are marked by a highly vuggy, recessive profile and an abundance of tannish-orange Skolithos burrows. Sample. Photos=2	2.26-4.1 ft	0.69 m-1.25 m

7	Sandstone, f-m, lessor c, 8 to 10 sets of xs up to 15 cm thick with interset bioturbated zones and remnant wavy to horizontal laminae. XS sets are commonly intraclastic.	4.49 ft	1.37 m
8	Dolostone, very sandy to dolomitic sandstone, appears on outcrop as three to four 10-12 cm thick beds; difficult to access. This is the top of the accessible section. *Note* Samples for conodonts from this unit were sent Feb. 24, 1999 to Dr. James F. Miller, Southwest Missouri State. Samples were actually collected from a more accessible point behind Mrs. Moe's house at 124 Main St. He found *Eoconodontus notchpeakensis* and *Proconodontus muelleri* in all 3 samples from this dolomite unit (conodont data in emails from J.F. Miller on May 4, 5, & 10, 1999).	1.41 ft	0.43 m

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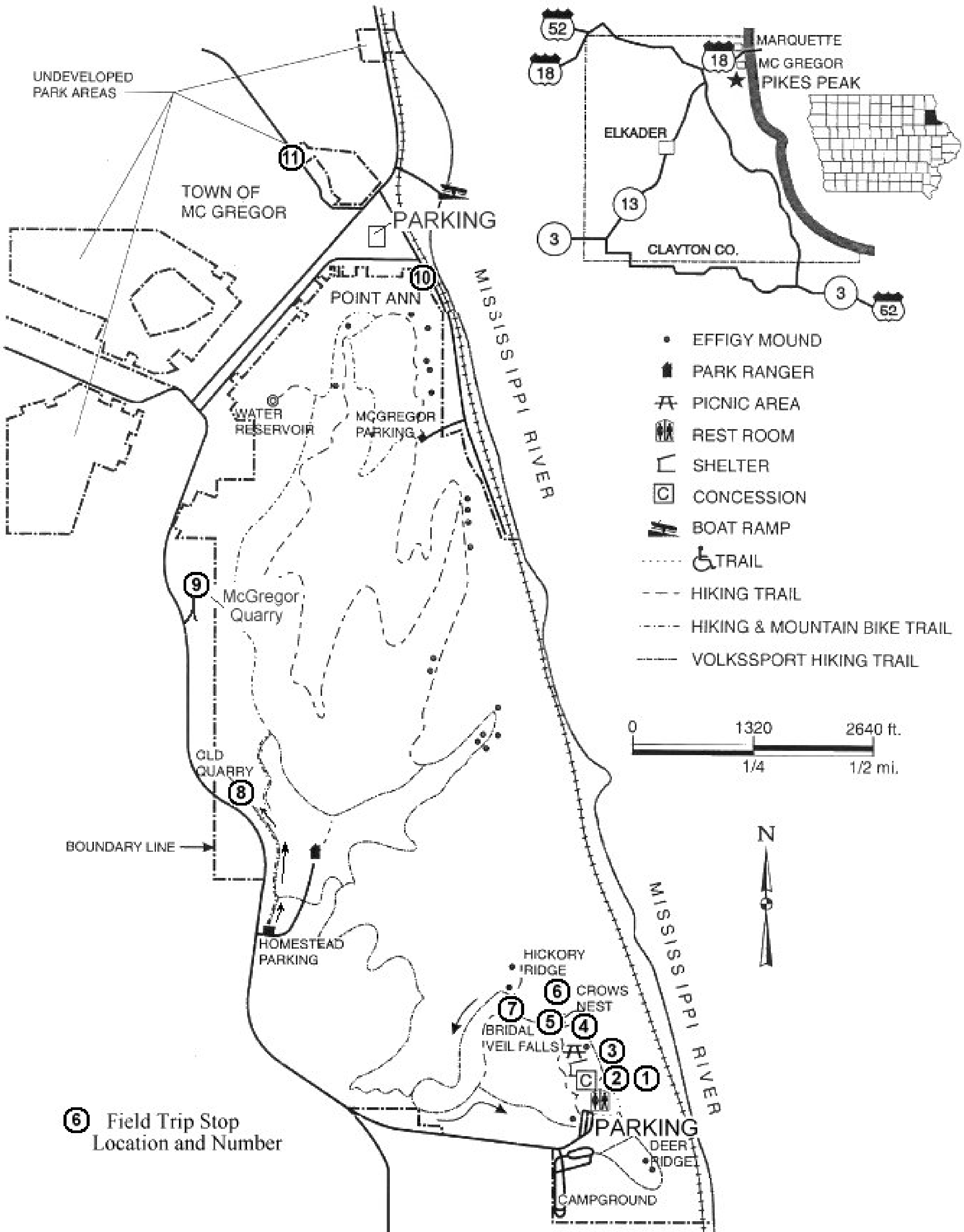

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