

GEOLOGY OF THE RED ROCK DAM AND VISITOR CENTER AREA, MARION COUNTY, IOWA

by Raymond R. Anderson



Geological Society of Iowa

April 28, 2007

Guidebook 80

Cover Photograph

The cover photo is a composite of two color infrared aerial photographs of the Red Rock Dam and surrounding area. The photographs are part of state-wide coverage obtained in the spring of 2002 as a multi-agency project coordinated by the Iowa DNR. The photographs are available on the Iowa Department of Natural Resources GIS Library.

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INTRODUCTION TO LAKE RED ROCK

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LAKE RED ROCK

With a normal pool area of 19,000 surface acres, Lake Red Rock is Iowa's largest flood control reservoir (Fig. 1). The reservoir is operated by the U.S. Corps of Engineers on the Des Moines River, about five miles north of Knoxville. At over 50,000 acres, Lake Red Rock and associated lands constitute Iowa's largest single expanse of public lands. The reservoir is a multi-use area; with camping, hiking, biking, nature areas and a visitor information center. The area encompasses 47,610 acres of U.S. government lands managed by the Corps of Engineers, 25,572 acres under long-term lease to the Iowa Department of Natural Resources (DNR) as a wildlife management area, as well as 2,218 acres managed by the DNR as Elk Rock State Park on the southern edge of Lake Red Rock. Additionally, the Marion County Conservation Board manages Roberts Creek and Cordova County Park, north of the lake.

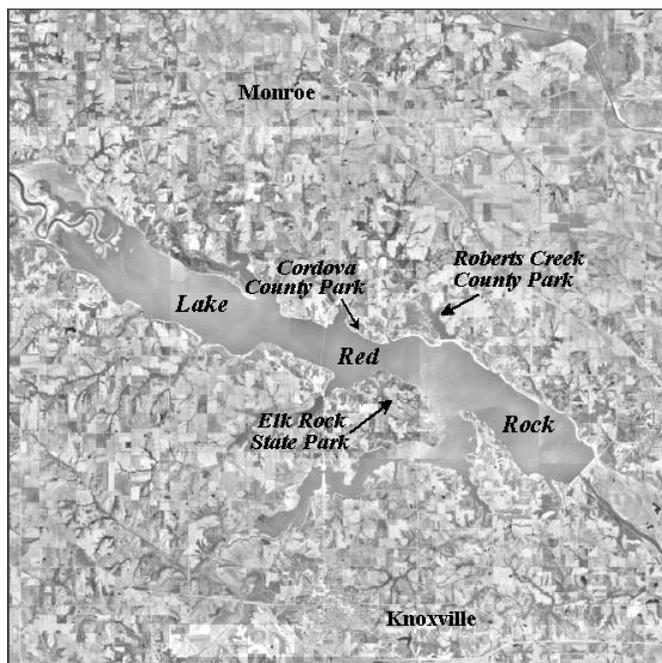


Figure 1. Composite of Digital Orthophoto Quadrangles of the Lake Red Rock Area (from Iowa Geographic Image Map Server).

The Red Rock Dam was authorized by the Congress for flood control purposes. After nine years of construction, the U.S. Army Corps of Engineers completed the mile-long earthen dam (Fig. 2) in 1969.

At the lake's standard elevation of 742 feet above sea level, it has a surface area of 19,000 acres of water. When heavy rains occur on the lake's 12,000 square-mile watershed, the lake can triple in size. Flooding in 1984 pushed the lake to a height of 779.62 feet above-sea-level, creating a 65,000-acre lake. The Red Rock project cost a total of 88 million dollars.

Approximately one-third of that amount was spent to purchase land around the site. Another third was spent to relocate 96 miles of the Wabash Railroad, 42 miles of highway, 2 miles of gas lines, 225 miles of electric lines, and 8 cemeteries. The final third was used to construct Red Rock Dam. The project was costly to build, but has paid for itself many times over. By protecting property, lives, and crops, an estimated 449 million dollars had been saved during 1969 to 1999. The construction of the dam and lake flooded a number of old villages along the Des Moines River, including the town of Red Rock which gave the lake its name.

While the primary purpose of the dam is controlling water levels on the Des Moines River, another important purpose has evolved over the last two decades. Lake Red Rock has become a premier location for enjoying uncrowded outdoor recreation opportunities. Over 50,000 acres of diverse habitat, from

sandy shoreline to wooded rocky bluffs, provides homes to hundreds of wildlife species. Large numbers of whitetail deer can be seen throughout the lake area, and river otters are occasionally seen along the shoreline. The large area of open water and extensive associated habitat attracts large numbers and varieties of birds, both permanent inhabitants and migrators. In her web publication on Birding the Red Rock Area, Ann Johnson (2002) states that “Although by most standards this area has been under-birded, about 300 species of birds have been found here in the past 20 years. With better coverage, who knows what might be found!” She goes on to mention a number of the bird species that have been reported in the area and she suggests the best localities to observe them. Birds included in her article include loons, grebes, herons, cormorants, ducks, pelicans, and gulls. Scarlet Tanagers, Kentucky Warblers Willow Flycatchers, Yellow Warblers, Bell's Vireos, Red-breasted Nuthatches and Long-eared Owls have been observed. She mentions shorebirds such as Buff-breasted and Baird's sandpipers, Sanderling and Ruddy Turnstone. Ms. Johnson notes that Peregrines Falcons are seen nearly every fall and a Cooper's Hawk nested here a few years ago. White pelicans migrate through the Lake Red Rock area every spring and fall, and large numbers of waterfowl migrate through the lake every spring and fall. Also present in large numbers are bald eagles, are observed during winter months (November through March).



Figure 2. Photo of Red Rock Dam looking to the northwest.

ELK ROCK STATE PARK

Upon completion of the Red Rock Dam in 1969, the United States Army Corps of Engineers leased land along the north shore of Lake Red Rock to the Iowa Conservation Commission in for construction of North Elk Rock State Park. This area has since been turned over to the Marion County Conservation Board and is now known as Cordova Park (Fig. 1). In 1978, the state obtained a lease for an additional 2218 acres of land on the south shore of the reservoir from the Corps of Engineers. This land was developed by the state as South Elk Rock State Park. Today known as Elk Rock State Park, this Iowa Department of Natural Resources facility offers has camping and picnicking facilities as well as equestrian and multi-use trails.

Today's field trip will examine geologic exposures near the visitor center on the southwest end of the Red Rock Dam.

GEOLOGY OF THE RED ROCK DAM AND VISITOR'S CENTER AREA

(modified from U.S. Army Corps of Engineers handout)

Raymond Anderson

Iowa Geological Survey

Landform Region

Lake Red Rock is located in central Marion County, Iowa, between the towns of Pella and Knoxville. The lake and Marion County both lie in the Southern Iowa Drift Plain landform region (Fig. 1). The topography of this area is steeply rolling hills, interspersed with areas of uniformly level upland divides, and level alluvial lowlands. It was developed in a terrain of Pre-Illinoian glacial drift (2.2–0.5 mybp) with a well developed Yarmouth-Sangamon paleosol (500,000–30,000 ybp) capped with moderately thick Peoria Loess (~20,000 ybp). The river provided a major drainage for meltwater from the Wisconsin Tazewell and Des Moines lobes (31,000–12,500 ybp) and was the source area for much of the Pisgah and Peoria loess in the region. Within the reach of the reservoir, the Des Moines River meanders through a flood plain one to two miles wide, with bluffs rising up to 150 feet above the valley floor. In pre-glacial or interglacial time, the valley was some 20 to 40 feet deeper than present, and founded on bedrock. As the ice retreated, the valley filled to its present level with glacial outwash and alluvium. This material was subsequently reworked and fine-grain sediment added by the modern Des Moines River. The valley now consists of alluvial silts and clays up to 14 feet thick, underlain by sands and gravels.

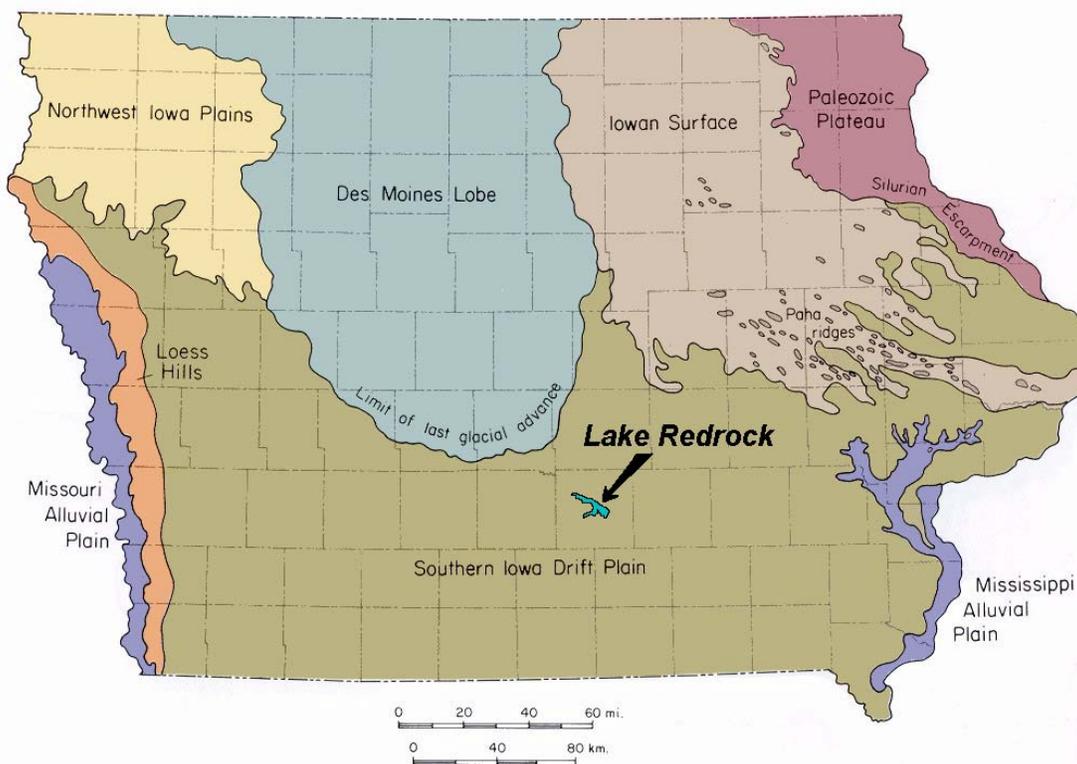


Figure 1. Map of Landform Regions of Iowa (modified from Iowa Geological Survey, 2000)

Quaternary Geology in the Area of the Red Rock Dam

The upland areas around Red Rock Lake are remnants of the Pre-Illinoian glacial drift plain surface. At least seven Pre-Illinoian glacial ice sheets advanced into the region between 2.2 and 0.5 mybp. The maximum advance reached central Missouri, with its limit marked by the Missouri River. Following the last advance of Pre-Illinoian ice, the region was subjected to a prolonged period (500,000-30,000 ybp) of erosion and weathering. This led to the development of the Yarmouth-Sangamon paleosol, characterized by deep weathering and a thick, rust colored, clay-rich b-horizon commonly called “gumbo till”. The overlying loess is composed of a basal Pisgah and upper Peoria formations. The Pisgah Loess was the product of the advance and retreat of the Wisconsinan Tazewell (Sheldon Creek) glacier between 20–30,000 ybp. The poorly developed Farmdale soil formed on the Pisgah Loess and can be identified in some exposures. The Peoria Loess, by far the thicker of the two, represents outwash from the subsequent Des Moines Lobe ice advance (14,000–12,500 ybp). Because the Farmdale soil was not well developed and has been erosionally removed in many areas, it is often difficult to differentiate these two loess units. Many river drainages in the Southern Iowa Drift Plain region have eroded through the loess and cut into or through the underlying glacial till. In many areas loess has eroded from ridge tops and moved down into the valleys, leaving the valley walls lined with colluvium, mixed with alluvial deposits on the toes of the slopes. Individual hill slopes developed in this loess colluvium often display a texture of finely etched rills or drainageways, giving a distinct ribbed or furrowed appearance to the terrain.

The underlying glacial till is made of unsorted, non-stratified clay, silt, sand, gravel and boulders. It is not unusual to see multiple glacial tills in large exposures. These individual tills may each display an upper oxidized and lower unoxidized zone, and some may even be capped with a paleosol. In rare instances a Pre-Illinoian loess deposit or a sand and gravel deposit may separate these tills. The upper-most glacial till is often capped by the Yarmouth-Sangamon paleosol, an oxidized, iron-stained zone of stony, clay-rich till. This paleosol (ancient soil), a residue composed principally of thick b-horizon clay and a stone lag deposit, can have a pronounced effect on local soil moisture, drainage conditions, and fertility. Rainwater and snowmelt percolating through the loess moves laterally or is perched when the impervious clay is reached. This water commonly creates seeps or springs on hillsides where these paleosols are exposed. These thick paleosols are sometimes called “gumbotil” where exposed because they become sticky and slippery when wet.

In the vicinity of the Redrock Dam, bluffs and valley walls are covered with varying thickness of glacial till, which are generally covered with several feet of loess. However, the apparent loess exposure in the bluff to the right of the administration building and the radio tower is actually a bedrock exposure, a thinly laminated weathered siltstone that contains random masses of un-weathered sandy limestone up to several cubic yards in size.

Bedrock Geology in the Area of the Red Rock Dam

The area around the Red Rock Dam is underlain by bedrock of Pennsylvanian and Mississippian age (Fig. 2). Rocks of the Des Moines Series of the Pennsylvanian System (approximate age 310 mybp) are the most common rocks encountered. However, the Des Moines River has incised through these Pennsylvanian units downstream and in the immediate vicinity of the dam, so the bedrock below the flood plain alluvium is the St. Louis Formation, Mississippian System, approximately 320 mybp.

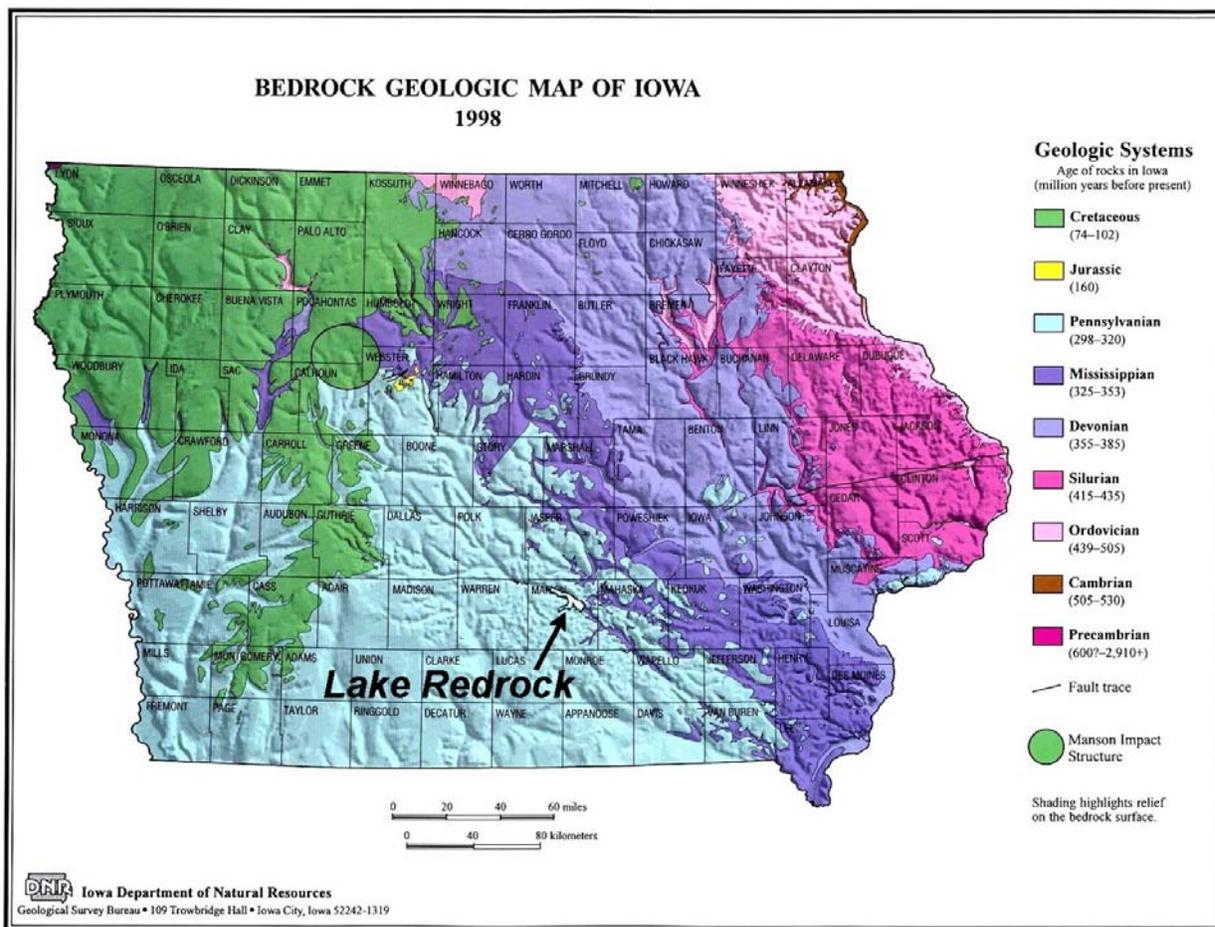


Figure 2. Bedrock Geologic Map of Iowa (modified from Iowa Geological Survey, 1998)

Pennsylvanian Strata

Pennsylvanian Cyclothems

Pennsylvanian rocks in the Red Rock area, and throughout Iowa, comprise of repetitive, sequential deposits of sediment called cyclothems (Fig. 3). Cyclothems are primarily shales with inter-bedded, strata of sandstone, siltstone, limestone, and coal. Some limestone and coal strata can be persistent over considerable areas. An idealized cyclothem displays a distinctive vertical sequence of lithologic members. Each member represents a particular phase of deposition during a single cycle of relative sea-level change, called “transgression-regression”. Generally, the model begins with a basal sandstone (1) of beach or channel origin which grades into a gray, sandy shale. This then grades into a lighter gray mudstone or underclay (fireclay) (2) which acts as a substrate for coal (3) forming vegetation on a coastal plain of low relief. At this point, rising sea levels or subsiding landmass, drown the coal forest, and shallow marine shales (4) are deposited. As the water deepens, calcareous muds form limestone beds (5) until deep water shales (6) are laid down in deep, quiet water. As the seas recede, the sea shallows and becomes oxygenated leading to the deposition of gray marine shale (7), the sea shallows further until the sea floor rises to

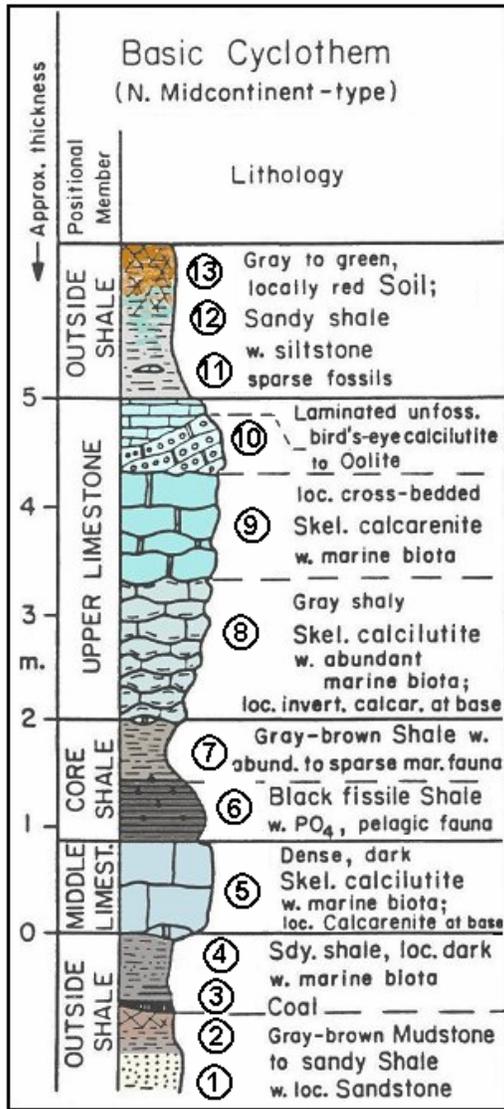


Figure 3. Idealized Pennsylvanian Cyclothem (numbered units are described in the text).

the euphotic zone, where the sunlight permits the production of calcium carbonate and the deposition of shaly limestone with a restricted fossil assemblage (8). As the sea continues to shallow, oxygenation and the penetration of sunlight increases, producing a more normal marine environment with a diverse fauna, increasing the production of limestone, overwhelming the shale deposits (9). The sea becomes very shallow, reducing water circulation and producing a hypersaline, reduced oxygen environment inhabited by algae and other carbonate mud producing organisms (10). This is followed by still shallower water, where few organisms can survive and shale is deposited (11). These marine shales may combine with terrestrial sand from nearby rivers and may become more calcareous to the extent that fresh water limestone may be deposited, often as nodules which can expand a continuous bed. (12) These will eventually grade into terrestrial shales (13), similar to (1) repeating the cycle again. As many as 100 cyclothem are present in the Pennsylvanian rocks of Iowa. This repetitive rising and falling of sea level is the product of the growth and melting of a huge mass of continental glacial ice that developed on the ancient continent of Gondwana, which lay at the south pole at the time (Fig. 4). The water to build the glacial ice mass derived from evaporation of sea water, so as the glaciers grew, the sea level dropped. The extent of the

Pennsylvanian glaciation was comparable to the maximum extent of the Pleistocene glacial grow. As the Pennsylvanian ice expanded and melted, sea level rose and fell 200-300 feet. Each transgressive-regressive cycle lasted between 230,000 and 400,000 years. The sea level rise advanced hundreds of miles on to the low-lying interior of North America.

Pennsylvanian Cherokee Group

The Cherokee Group is the basal Pennsylvanian unit over most of Iowa (Fig. 5). It lies with a major disconformable contact above various Mississippian formations in south-central Iowa. The strata of the Cherokee Group are characterized by extremely complex lateral and vertical facies (*characteristic lithic features*) relationships, which have always presented serious correlation and nomenclature problems. In ascending order, the Cherokee Group in the vicinity of Red Rock Dam is divided into the Kilbourn, Kalo, Floris, and Swede Hollow Formations (Fig. 6) representing distinct depositional regimes. Cherokee strata comprise a succession of shale-dominated, cola bearing cyclothem with locally thick sandstones. A few contain thin limestones associated with minor and intermediate scale cyclothem, with only known major

cyclothem (Verdigris-Ardmore) being traceable from Oklahoma to Indiana, and present in the Saylorville spillway. The Cherokee contains most of the coal resources of the Midcontinent area. In south-central Iowa, the Cherokee Group reaches about 500 feet in thickness; while in the Forest City Basin of the Iowa/Missouri/Nebraska border region, it thickens to about 800 feet. In the past, various informal divisions have been used to separate the Upper and Lower Cherokee, primarily distinguishing the somewhat more regular and persistent strata of the Upper Cherokee and its dominantly marine lithologies from the Cherokee irregular, discontinuous strata of the Lower and its dominantly fluviodeltaic lithologies. The lack of laterally continuous beds in the Lower Cherokee has resulted in a proliferation of informal names

applied to coals and other distinctive lithologies. Previously, coal bed names in Iowa were either derived locally, usually from the mining operations, or extended from the nomenclature of strata in neighboring states. Unfortunately, in the past, most of the names assigned to coals had only local significance. Other names have been proposed in many unpublished theses; but, certain coal names have been used extensively in the literature discussing Cherokee Group Coals. Certain names applied to mined beds however, are not necessarily consistent with stratigraphic interpretations. Some coal seams may not have been named, while others may have more than one name. Conversely, a single name may apply to different seams.

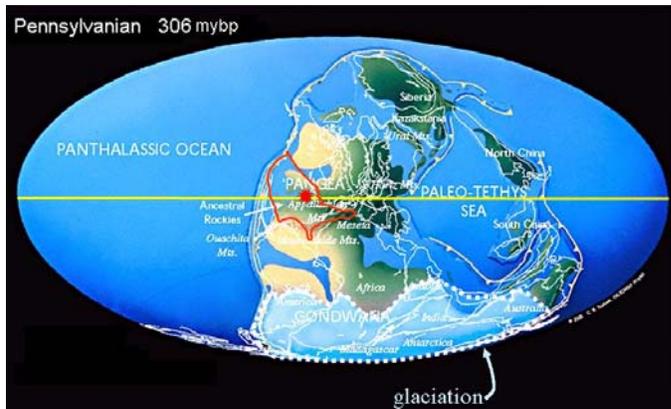


Figure 4. Map of Pennsylvanian Paleogeography showing location of United States. Asterisk shows location of Iowa. Modified from map series by Ron Blakey, Northern Arizona University.

Kilbourn formation

The Kilbourn formation represents the initial Pennsylvanian deposition on the land surface developed on argillaceous (clayey or shaley) and arenaceous (sandy) Mississippian Carbonates. Stream incision on these carbonates had produced a surface of considerable relief and irregularity. Kilbourn deposition was the result of subsidence in the Forest City Basin, in combination with several marine transgressions and regressions. The deposition predominately took place in the incised paleo-valleys during the relative rises in sea level, while pedogenesis (soil formation) and erosion continued on the interfluves (area between adjacent streams). As many as seven depositional cycles are encountered in the subsurface of south-central Iowa, dominated by non-marine sandstones, shales, siltstones, mudstones, and coals. Thin marine limestones and shales (including phosphatic black shales) were deposited in the distal (landward) ends of estuaries during maximum transgression. Most of the sediments are thin and discontinuous, but they eventually filled the paleo-valleys and nearly leveled topographic relief. The prominent coals have been correlated to the Tarter, Reynoldsburg Coals of the Illinois Basin on the basis of palynology (study of pollen), but they have not been named in Iowa.

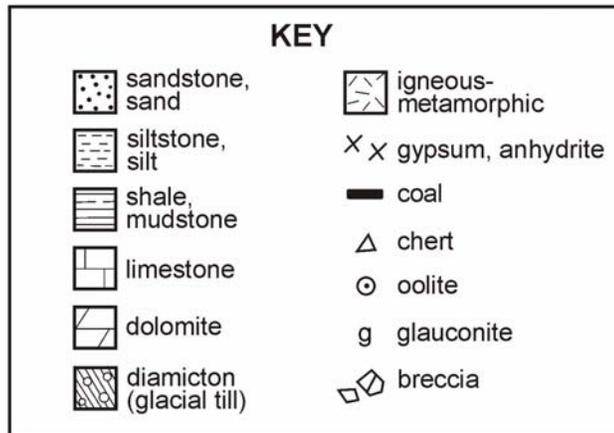
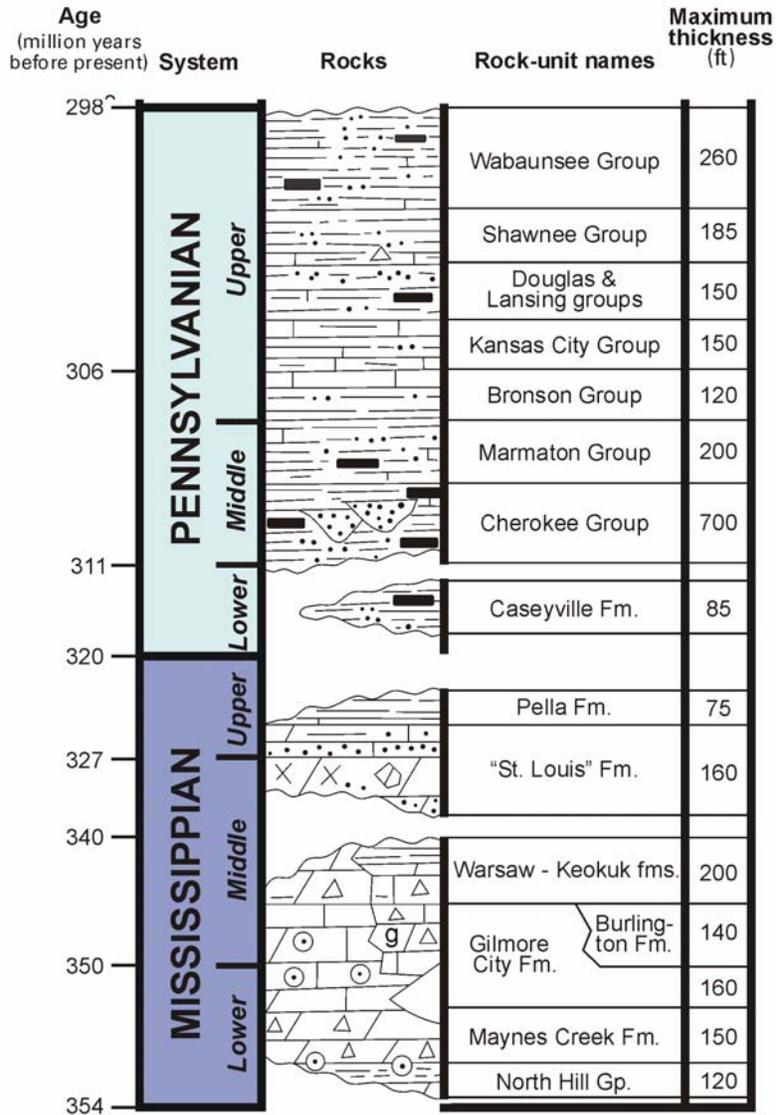


Figure 5. Pennsylvanian and Mississippian Stratigraphic Column of Iowa (Iowa Geological Survey)

Kalo Formation

The Kalo Formation includes strata from the base of the Blackoak Coal to the base of the Laddsdale coal in the overlying Floris Formation. Two major coals, the lower Blackoak and the upper Cliffland, are the only two named Members of the Kalo Formation in Iowa. Because of the leveling of the Mississippian erosional surface by Kilbourn deposition, the first widespread episodes of coal deposition occurred in Iowa. The Atokan-Desmoinesian boundary is placed between the lower Blackoak and upper Cliffland coals. The top of the Atokan is recognized by the final regular appearance of the palynomorph Dictyo-

triletes bireticulatus, which occurs in the Blackoak Coal, but not in the Cliffland Coal in Iowa. This is in agreement with the boundary placement suggested in Illinois. Further support for this boundary is suggested by the fact that the conodont genera Idiognathoides and Declinognathodus (both considered restricted to the Atokan of the midcontinent) do not range above the Blackoak Coal. Based on palynology, the Blackoak Coal correlates to the Pope Creek Coal of Illinois, and the Cliffland Coal correlates to the Rock Island (No. 1) Coal of Illinois.

Cherokee Group

Swede Hollow Formation

Mulky Coal

Bevier Coal

Wheeler Coal

Ardmore Limestone

Oakley Shale

Whitebreast Coal

Floris Formation

Carruthers Coal

Laddsdale Coal

Spoon Formation

Kalo Formation

Cliffland Coal

Blackoak Coal

Kilbourn Formation

Floris Formation

The Floris Formation includes strata from the base of the lower Laddsdale Coal to the base of the Whitebreast Coal at the top of the formation. The lower part of the Floris is characterized by the Laddsdale Coal Member. Most coals recently being mined in Iowa at the present time are in the Laddsdale Member. The Laddsdale is part of an extremely complex sedimentary unit consisting of up to five or six coal beds of varying thickness and separated by unnamed shale and marine sediments. The type section appears to represent the most complex development of the Laddsdale Member. It consists of five coal seams from one inch to 34 inches thick over a total thickness of 30 feet. The individual coal beds in the Laddsdale are lensoidal and generally cannot be traced with reliability, except in areas of closely spaced exposures or by drill holes. Although these coals may sometimes achieve thicknesses of 72 inches or more in a few localities, their discontinuous nature demands careful exploration work. The Laddsdale has been surface mined in Marion and Lucas counties. The associated strata are predominantly non-marine shales and siltstones, which may coarsen upward into sandstone. In some instances a fossiliferous marine shale or limestone may occur. Thus, these coals may represent from one to six depositional cycles over a period of time in which there was little change in the flora. As with the Blackoak and Cliffland Coals, they are palynologically distinct from other Cherokee Coals, but individual coals cannot be distinguished

Figure 6. Cherokee Group Stratigraphy (Iowa Geological Survey)

from each other. Above the Laddsdale are one or more palynologically distinct unnamed coals. Lenticular marine limestones are often associated with these coals. At this point, the relationship of the coals and the marine unit to each other in this interval is poorly understood. Higher up is another palynologically distinct coal, the Carruthers. In contrast to the lower Floris Coals, it is relatively persistent over a wide area. A fossiliferous marine shale and/or limestone usually directly overlie the Coal. A thin, persistent,

phosphatic black shale with a distinct conodont fauna lies two to ten feet above it. The Carruthers correlates with the Greenbush and De Koven Coals of Illinois. A persistent coal smut and lenticular marine sequence that lies several feet above the Carruthers Coal near the top of the Floris Formation, is thought to correlate with the Abingdon Coal of Illinois. In general, the Floris represents a transition from non-marine fluvial and deltaic processes to more marine processes. Major incised valleys and their associated thick sandstone fills, probably occurred before deposition of the Carruthers Coal. These early Floris sequences of sandstone, 140 or more feet thick, cut downward into the underlying Kalo and Kilbourn Formations, and occasionally into the Mississippian. One exception to this is the 50 foot thick informally named "Hanging Rock Sandstone" in southwestern Dallas County that occurs just below the paleosol (underclay) beneath the overlying Whitebreast Coal.

Swede Hollow Formation

The Swede Hollow Formation is the uppermost formation with the Cherokee Group, and includes strata from the base of the Whitebreast Coal Member to the top of the Mulky Coal Member. The lower Members of the Swede Hollow Formation are part of the first major marine cycle in the midcontinent Pennsylvanian. This cycle spans the interval from the top of the paleosol below the Whitebreast Coal, including the Oakley Shale, and Ardmore Limestone, to the top of the paleosol below the Wheeler Coal in Iowa. The Verdigris Limestone is a lithostratigraphic unit comprising the Oakley Shale overlain by the Ardmore Limestone. The Verdigris extends across the entire midcontinent and can easily be recognized on geophysical logs, cores, outcrops and well cuttings. Therefore, it is an important unit for mapping purposes. The Wheeler Coal represents a minor cycle in south-central Iowa. The Bevier Coal represents another minor marine cycle and extends upward to the top of the paleosol below the Mulky Coal. A lenticular limestone or dark fossiliferous shale with an abundant conodont fauna occurs above the coal in the area. In southwestern Dallas County, unnamed, thick sandstone occurs in the upper Swede Hollow Formation. In places it cuts out the entire Verdigris cycle, but its exact relationship to the Wheeler and Bevier coals is unknown.

Mississippian Strata

In the vicinity of the dam, the contact between Pennsylvanian and Mississippian rocks averages at the elevation of the valley floor. Within a half-mile, however, Mississippian rock may be found 40 feet higher and Pennsylvanian rock 30 feet lower. The Mississippian rocks alternate between limestones and sandstones to a depth of about 70 feet below the flood plain. They form distinct units that persist throughout the site. In some areas at the base of these rocks, deposits of gypsum and anhydrite up to 17 feet thick have been found. Both gypsum and anhydrite belong to an interesting group of minerals called evaporates, which are sedimentary deposits composed of salts precipitated from seawater. Evaporites form in shallow or near shore marine and lake environments, where evaporation has produced an unusually high concentration of dissolved salts and where there is little or no circulation of fresh water. The precipitation of sediment from these hyper-saline brines is associated with hot and relatively dry climatic conditions. Iowa's paleogeography at several times in the state's geologic past duplicated these environments of deposition and resulted in major accumulations of evaporate minerals. As a result, several geologic units in Iowa underlying sedimentary rock sequence host economically significant deposits known as gypsum. Recent partial removal of this material by solution, and subsequent collapse of the overlying beds, has resulted in a horizon of unconsolidated or poorly consolidated detrital material. Beneath the gypsiferous horizon to an additional depth of at least 70 feet, are hard, massive dolomitic shales, interbedded within strata of softer black shales, some of which are laterally persistent.

"St. Louis" Formation

The highest Mississippian strata in the dam area belong to a poorly-defined interval that has historically been included within the so-called "St. Louis" and Pella Formation (Fig. 5) of Meramecian age. Although the term "St. Louis" has been widely used in Iowa to label strata above the Augusta Group, these

strata show significant lithologic dissimilarities (especially the abundance of sandstone and sandy carbonates) with strata of the typical St. Louis Formation in Missouri. In addition, it is now known that the upper part of the “St. Louis” interval in the southeast Iowa does not biostratigraphically correlate with the type section of the St. Louis Formation. It is probably equivalent to part of the younger St. Genevieve Limestone. Pending further investigations, the “St. Louis” Formation will serve as an informal and provisional label.

The “St. Louis” of south-central Iowa is characterized by inter-bedded dolomite (commonly sandy), sandstone, limestone, green-gray shale, and gypsum/anhydrite. Sandstone units reach thicknesses to 40 feet, but are usually thinner. The interval is locally brecciated (broken), especially in the lower part, forming a complex mixture of lithologies. Lower strata of the “St. Louis” Formation in areas of south-central Iowa locally contain evaporate intervals of gypsum and anhydrite, which reach thicknesses of up to 60 feet in Monroe County, and 40 feet in Marion County. The “St. Louis” interval reaches a maximum thickness of about 125 feet in areas where thick gypsum-anhydrite units are present.

Pella Formation

The Pella Formation, named for exposures near that city, comprises the highest (youngest) Mississippian interval in southern Iowa, and is characterized by fossiliferous calcareous shale and limestone. Where the Formation is thickest, it locally contains scattered sandstone inter-beds in the upper part, and can reach a maximum thickness of 50 feet; but, is thin to absent across much of the area due to significant pre-Pennsylvanian erosion, and is absent in the dam area. The top of the Mississippian unit is an erosional surface that represents millions of years. The lower Middle Pennsylvanian Cherokee Croup unconformably (with a time gap) overlies the “St. Louis” or Pella Formations.

Field Trip Stops

The geologic sections that will be visited lie in the area of the Red Rock Visitor Center located at the south end of the Red Rock Dam. Figure 7 shows the topography in the area of the Visitor Center. Black dots on Figure 7 identify the locations of cores drilled during dam construction. These cores were used to construct the cross section displayed as Figure 8.

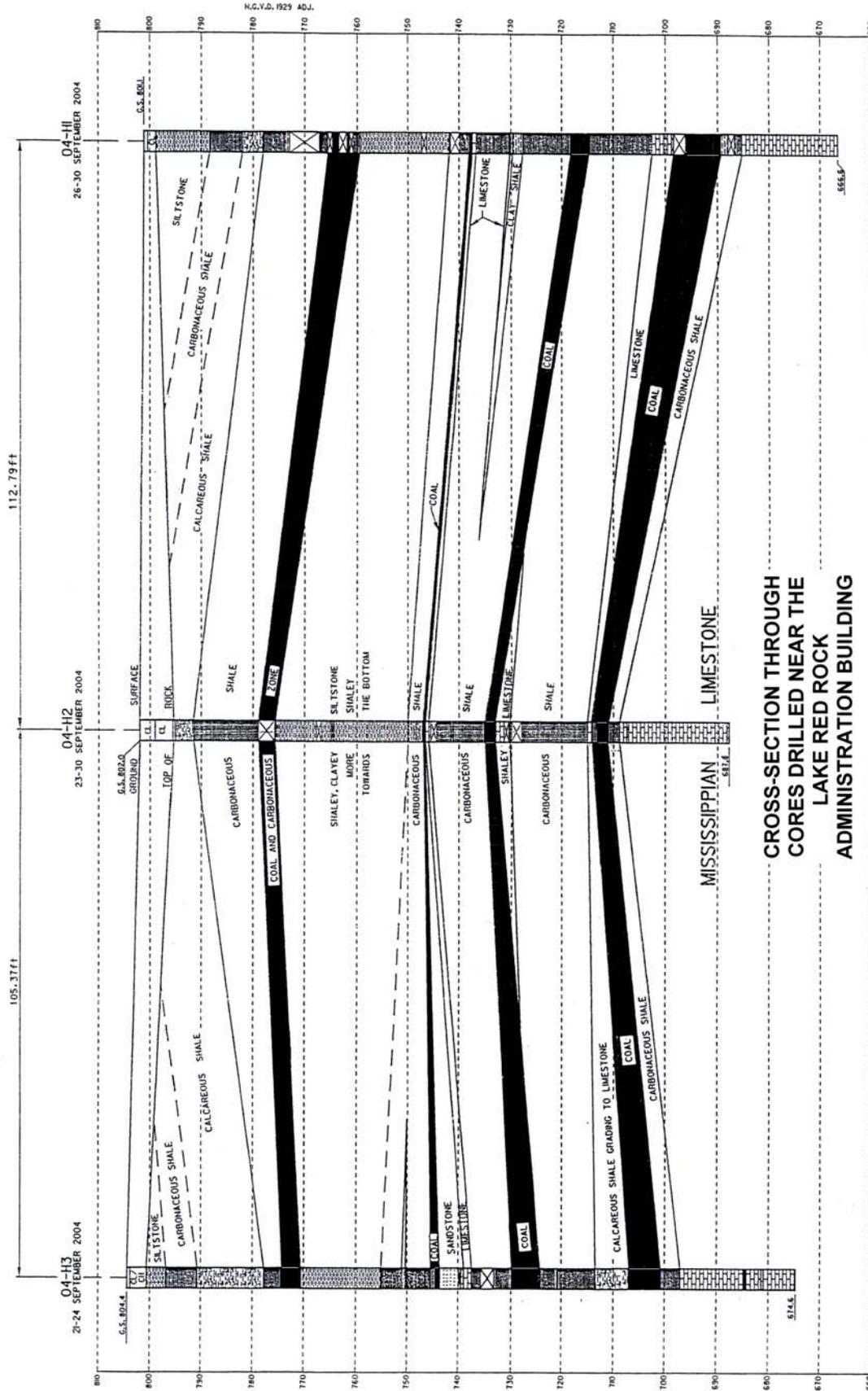
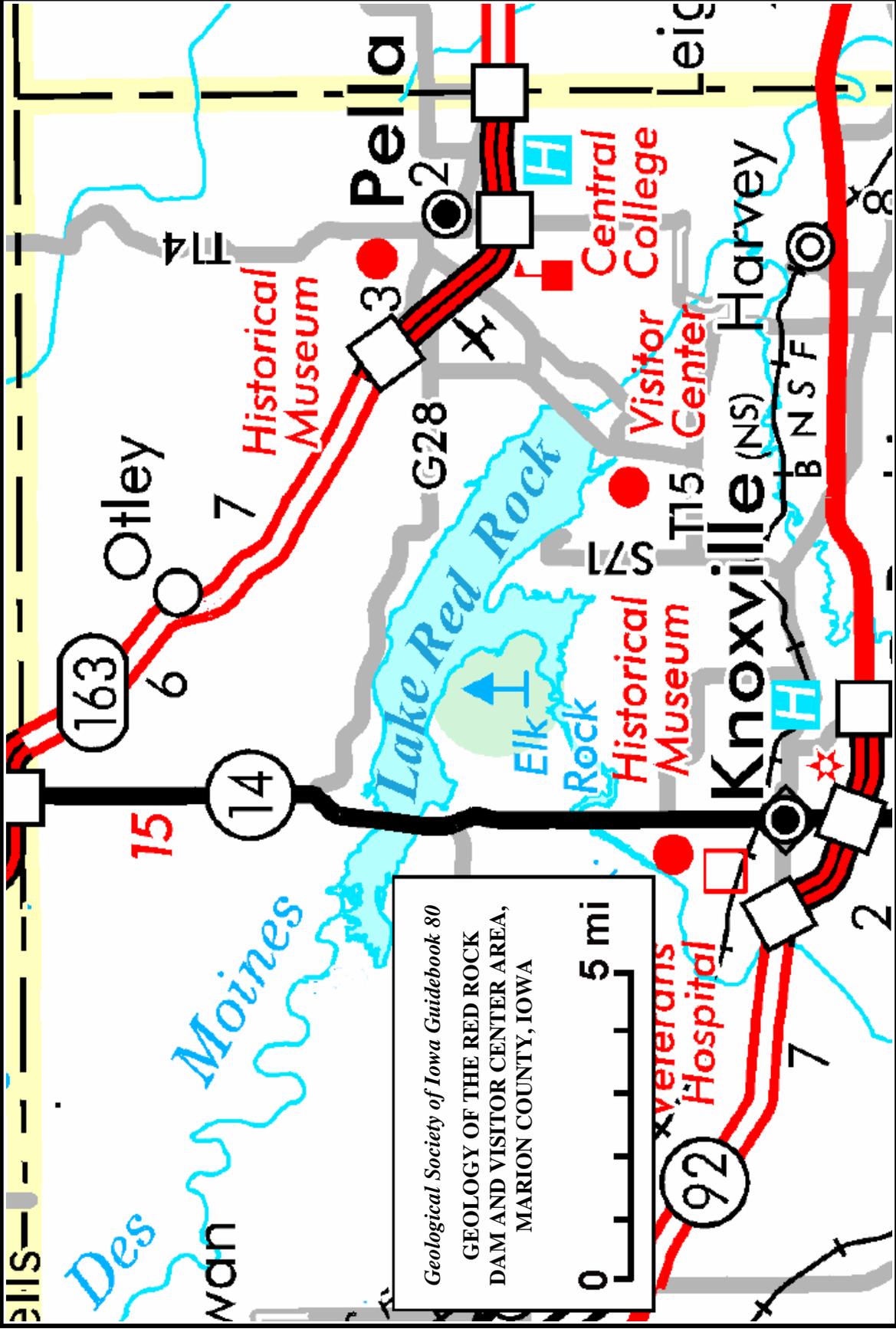


Figure 8. Cross-section of geologic units near the Red Rock Visitor Center.
 (locations of cores used for cross-section can be found on Figure 7)
 Modified from U.S. Army Corps of Engineers handout.



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