RAGBRAI Geo-pedia

Sioux Quartzite is a hard, pink rock that was originally sand on an ocean-front beach about 1.7 billion years ago. It is exposed in extreme northwest Iowa, as shown on cover photo of Gitchie Manitou State Preserve in Lyon County. Numerous northwest Iowa buildings are constructed with the pink stone, including the Romanesque-style Pierce mansion in Sioux City, built in the early 1890s (now the Sioux City Museum, photo below). The quartzite is still mined in Minnesota and South Dakota for railroad ballast and aggregate in concrete and asphalt. This is why many northwest Iowa roads have a distinctive pink hue. Sioux Quartzite can also be seen as scattered boulders in northwest Iowa.

Loess (rhymes with bus) is a glacial deposit where glacial activities have ground the rocks to a very fine powder. After drying, these deposits are highly susceptible to wind erosion, and downwind deposits may become hundreds of feet deep. The Loess Hills of Iowa and the Loess Plateau in China are examples of thick loess deposits.

The USGS streamflow gaging network is an online, real-time network for stream stage information. Over 140 of these gages are in Iowa alone. The USGS stream gages work by recording stream stage data and transmitting it to nearby USGS offices. This information is then uploaded to the web to be viewed online. You can see the river stages by visiting the USGS website on the back of this brochure.

Links

US Geological Survey – Iowa Surface Water Data
http://waterdata.usgs.gov/ia/nwis/sw

National Streamflow Information Program
http://water.usgs.gov/nsip/

Quaternary Geology of the Storm Lake Area
www.igsb.uiowa.edu/gsipubs/pdf/GB78.pdf

Glacial Sedimentation along the Algona Moraine
www.igsb.uiowa.edu/gsipubs/pdf/GB36.pdf

Geology of Iowa Websites
www.igsb.uiowa.edu/gsipubs/pdf/GB34.pdf
www.igsb.uiowa.edu/gsbpubs/pdf/ofm-2005-3.pdf

Cretaceous Stratigraphy and Sedimentation in Northwest Iowa
www.igsb.uiowa.edu/gsbpubs/pdf/GB-04.pdf

Iowa State Agricultural Overview - 2005
www.nass.usda.gov/Statistics_by_State/Ag_Overview/AgOverview_IA.pdf

Veterinary Medicines in the Environment
http://toxics.usgs.gov/highlights/vet_meds.html

Books about Iowa's Land

Iowa's Geological Past
by Wayne Anderson, University of Iowa Press, 1998

Landforms of Iowa
by Jean C. Prior, University of Iowa Press, 1991

RAGBRAI 2007

Learn about the Land

Day 1

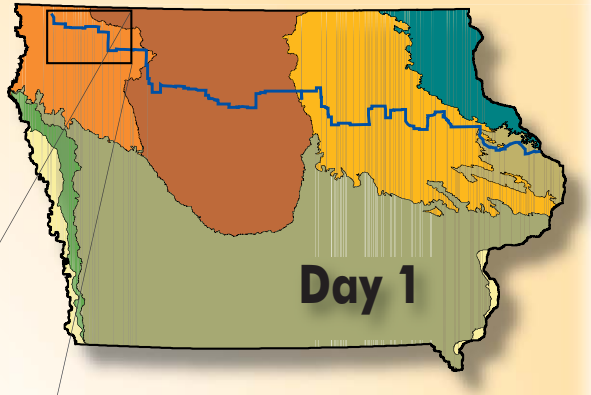
Sunday, July 22

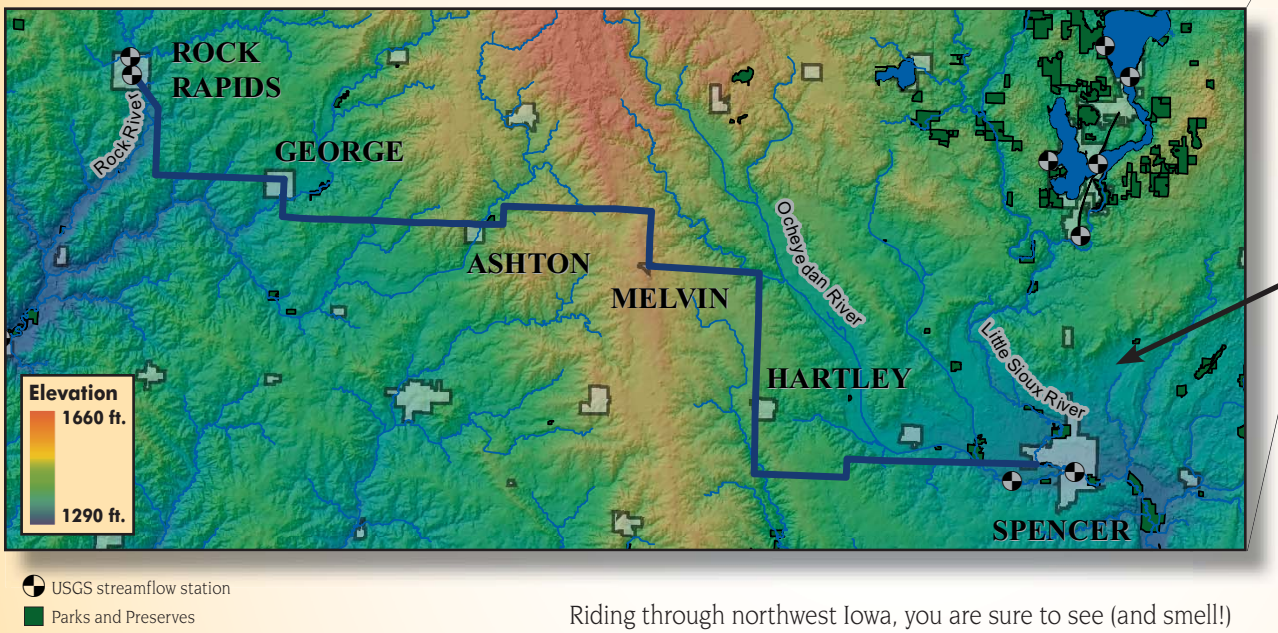
Iowa DNR – Geological Survey
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319)-335-1575
www.igsb.uiowa.edu

US Geological Survey
Iowa Water Science Center
400 S. Clinton St.
Iowa City, IA 52240
(319) 337-4191
http://ia.water.usgs.gov

RAGBRAI 2007 starts out on the gently rolling landscape called the **Northwest Iowa Plains**, one of Iowa's seven major landform regions. The western part of this region is composed of deposits from numerous glacial advances between 500,000-2.2 million years ago. These clay and pebble deposits are mantled with much younger wind-blown silt known as **loess,** deposited between 12,000-30,000 years ago. East of Everly, you will drop into the broad valley(s) occupied by the Ocheyedan River and Little Sioux River, which originally developed along the margins of the Des Moines Lobe ice sheet as outwash streams.

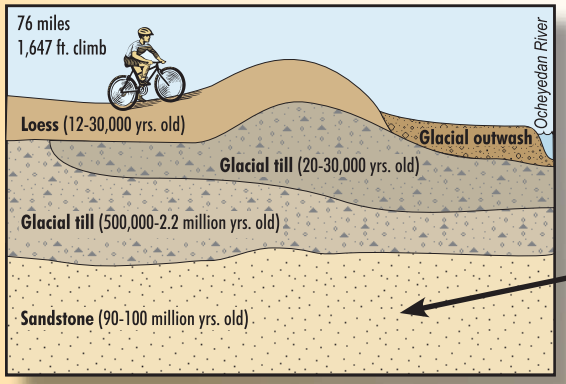
The Iowa map to the right shows RAGBRAI*'s route for* 2007. *Also shown are the* ***Landform Regions of Iowa****. This year* RAGBRAI *will be traveling through four of Iowa's seven Landform Regions.*





Although you probably won't notice it, today as you ride into Spencer you'll weigh a little less than at the start of your journey. This is due to a deep structure known as the **Spencer Pluton.** The Spencer Pluton is a large mass of igneous rocks about 50 miles in diameter that intruded into the upper crust about 1.4 billion years ago and lies beneath what are now Dickinson, Clay, Emmet, and Palo Alto counties. The pluton is known primarily from its gravity and magnetic signatures, along with 7,850 feet of exploration core recovered during the early 1960s (currently in the Iowa Geological Survey's Rock Library). Although the pluton is dominantly granite, drill cores obtained from an area of a strong magnetic anomaly encountered iron-rich norite rocks northeast of Spencer. The Spencer Pluton's magnetic anomaly is so strong that area roads surveyed by compass diverge from the usual N-S and E-W trends.

Riding through northwest Iowa, you are sure to see (and smell!) numerous **confined animal feeding operations.** Within the first few miles, you will pass several open feedlots with hundreds of beef cattle milling about. At first you might be tempted to shout "Moo!" at them, but after the 5th or 6th lot you pass, your voice will be tired and you'll probably be craving a hamburger. Along the way there will also be several animal confinement buildings that look like large sheds. Each one can hold up to 1,200 hogs!



Cross-section showing the layers and ages of geologic materials underlying the ground for day one of RAGBRAI.

Northwest Iowa is predominantly underlain by **Cretaceous** age bedrock. Cretaceous rocks in Iowa were deposited between about 90–100 million years ago by a shallow sea that moved into Iowa from the west, with rivers that flowed from the east. The Cretaceous sea eventually covered the entire state, but the shales deposited in it have been eroded away everywhere except the western edge of the state where they were thickest. Today, the most extensive Cretaceous bedrock unit in Iowa is the Dakota Formation. The lower Dakota sequence is dominated by sandstone and provides drinking and irrigation water for much of northwest Iowa. This is called the Dakota aquifer.

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RAGBRAI Geo-pedia

Fens are special wetlands fed by groundwater instead of surface water. Very sensitive to disturbance, fens are among the rarest landscapes in Iowa; only 200 intact sites are known to exist (Silver Lake Fen in Dickinson County, photo left). A large proportion of Iowa's rare and threatened floral and faunal species exist only on these sites. If you think you might own a fen, or would like to find out more about fens, contact your private lands biologist at www.iowadnr.com/wildlife/files/plbios.html.

Oolite is a distinctive limestone type made up of small (<2 mm) spherical particles (resembling fish egg "oocytes") with thin concentric layers of limestone formed in warm shallow seas. In Iowa, Mississippian-aged oolite originally were deposited near the shore of a vast tropical seaway that covered a large middle region of the North American continent. During this time period, 'Iowa' occupied a position in the southern tropics.

A statewide **groundwater monitoring well network** is being developed to evaluate the quality of Iowa's groundwater. These wells are monitored for natural water quality and for evidence of human contamination. For information on groundwater monitoring, go to 'Fact Sheets' at wqm.igsb.uiowa.edu

Links

EPA Fen Facts
www.epa.gov/owow/wetlands/types/fen.html

Iowa Fen Fact Sheet
www.igsb.uiowa.edu/gsbpubs/pdf/WFS-2007-02.pdf

Iowa Groundwater Quality Fact Sheet
www.igsb.uiowa.edu/gsbpubs/pdf/wfs-2004-03.pdf

USGS Ground Water Information Pages
http://water.usgs.gov/ogw/

National Water-Quality Assessment (NAWQA) Program
http://water.usgs.gov/nawqa/

Groundwater Quality Response to Closure of Agricultural Drainage Wells in Floyd County, Iowa
www.igsb.uiowa.edu/gsbpubs/pdf/TIS-40.pdf

Bathymetric Contour Maps of Lakes Surveyed in Iowa in 2004
http://pubs.usgs.gov/sim/2006/2949/

Books about Iowa's Land

Iowa's Geological Past
by Wayne Anderson, University of Iowa Press, 1998

Landforms of Iowa
by Jean C. Prior, University of Iowa Press, 1991

RAGBRAI 2007

Learn about the Land

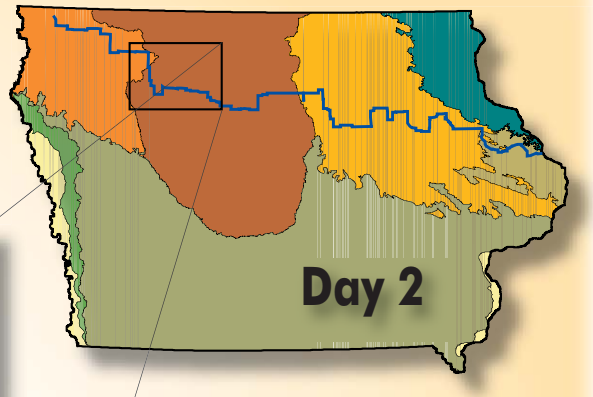
Monday, July 23

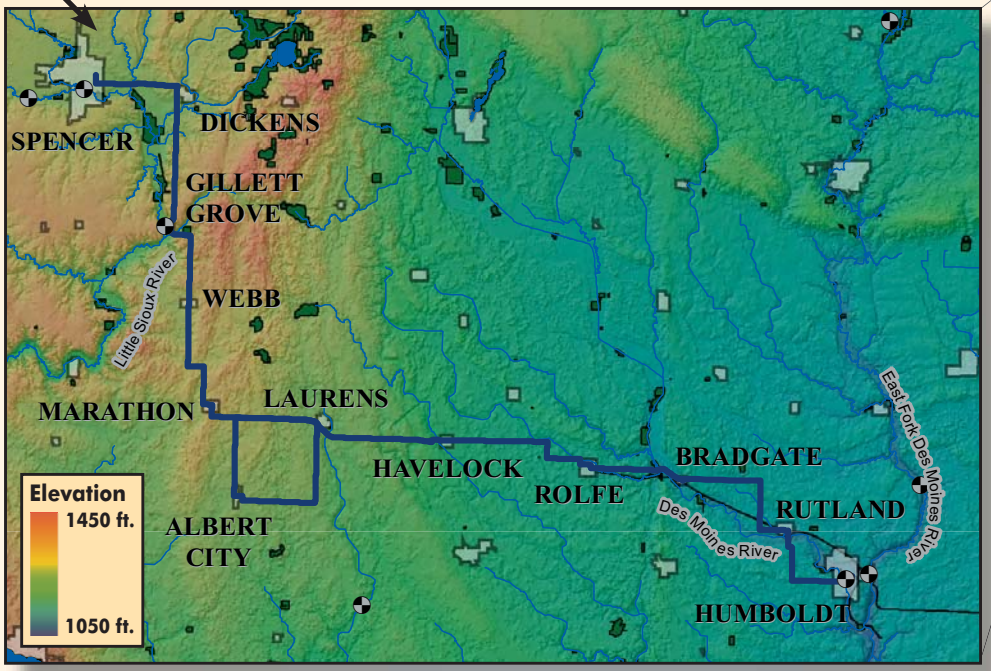
Day 2

Iowa DNR – Geological Survey
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319)-335-1575
www.igsb.uiowa.edu

US Geological Survey
Iowa Water Science Center
400 S. Clinton St.
Iowa City, IA 52240
(319) 337-4191
http://ia.water.usgs.gov

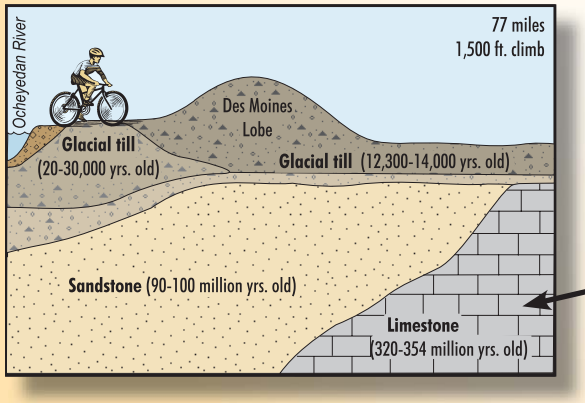
Today, as you head eastward on B24, you are traveling on a broad glacial outwash terrace. If you look to the north and east, you should notice that the landscape is very flat, even for Iowa. What you are riding your bike on is actually the abandoned lake plain of **"Glacial Lake Spencer."** The extent of this former glacial lake is fairly well defined, and covered the area around Spencer and east to the town of Dickens. This lake is believed to have formed about 14,500 years ago by the Des Moines Lobe, and may have existed for 1,000 years before its final catastrophic drainage down the Little Sioux River valley. Geologic cores taken from the area show lake sediments are at least 30 feet thick.





Those hardy souls who would like to see something truly unique on RAGBRAI might consider a 25-mile round trip to view the **Grotto of Redemption** near West Bend – self-proclaimed "the largest grotto in the world" (detail shown on cover photo). The grotto structures have an estimated rock value of over $4.3 million. Father Paul Dobberstein started constructing the grotto in 1912. It is composed of nine city-block sized grottos, each portraying a scene of Christ and His work.

Many of Iowa's rich agricultural soils, particularly those in north-central Iowa, are poorly drained and retain excess water that can drown crops. In these areas, fields are often artificially drained by tiles or **agricultural drainage wells** (ADWs). ADWs are drilled shafts that funnel water down to the underlying bedrock. Nearly all of the ADWs in Iowa were constructed between 1900 and 1950. Since that time it has been discovered that ADWs threaten groundwater quality in Iowa as contaminants such as nitrate, pesticides, bacteria, and sediment can be delivered to someone's drinking well. Since 1987, efforts have been made to develop alternative drainage options to ADWs.



Cross-section showing the layers and ages of geologic materials underlying the ground for day two of RAGBRAI.

As you bike east out of Gillette Grove on M54, to your left will be a special area called **Fen Valley.** This area is comprised of thick deposits of peat (up to 10 feet) overlying sand and gravel. The porous sand and gravel constantly supply the peat with groundwater. These unique wetland conditions allow for sixty distinctive plant species in this area, eleven categorized in Iowa as 'very rare.' Iowa's fens are typically found in northern Iowa, and are very small, usually less than 2 acres.

Between the cities Rutland and Humboldt, you will cross the northwestern-most exposures of limestone in Iowa. The Mississippian-aged (345 million years old) bedrock is characterized by several types of limestone, most notably **oolite**. You can view these limestone exposures near the dam in Rutland, at Rose Mill County Park, and at numerous limestone quarries in the area. Features in the Rutland-Humboldt area limestones indicate that initial deposition was in coastal mudflats, similar to environments seen today in areas like the Bahamas and the Persian Gulf.

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RAGBRAI Geo-pedia

Varves are contrasting thin beds representing seasonal sedimentation in a lake deep enough for thermal stratification and turnover occur.

Hummocky topography is topography consisting of randomly arranged knobs (hummocks) that are separated and defined by intervening low-lying areas (photo right).

Moraine is a general term for debris of all sorts originally transported by glaciers that have melted away. There are many categories of moraines, including lateral, medial, interlobate, and terminal. In Iowa, the Des Moines Lobe has many distinct moraines left by separate advances and retreats of the ice.

Kettle Lakes are depressions created by partially-buried glacial ice blocks as they melted. The depressions that filled with water became kettle lakes. The cover photo shows Freda Haffner Kettlehole State Preserve in Dickinson County.

Limestone is a sedimentary rock composed of calcite ($CaCO_3$). The primary source of this calcite is marine organisms. These organisms secrete shells that settle out of the water column and are deposited on ocean floors. Pure limestone would be white; however, clay and other impurities in the limestone usually give it a tan, off-white color.

Dolomite is also known as "magnesian limestone" and is a calcium-magnesium carbonate rock similar to limestone, a rock made of calcium carbonate.

Links

Iowa Outdoors
www.iowaoutdoors.org

Iowa Department of Natural Resources
www.iowadnr.com

South Fork Iowa River Water Quality Study
http://pubs.usgs.gov/fs/2005/3064/

The Great Ice Age
http://pubs.usgs.gov/gip/ice_age/

Schoolyard Geology
http://education.usgs.gov/schoolyard/index.html

Surficial Geologic Map of the Des Moines Lobe of Iowa – Phase 4: Humboldt County
www.igsb.uiowa.edu/gsbpubs/pdf/ofm-2002-3_txt.pdf

Depositional Environments of Glacial Sediments and Landforms on the Des Moines Lobe
www.igsb.uiowa.edu/gsbpubs/pdf/GB-06.pdf

Hogs, Bogs, & Logs: Quaternary Deposits and Environmental Geology of the Des Moines Lobe
www.igsb.uiowa.edu/gsbpubs/pdf/GB-18.pdf

Books about Iowa's Land

Iowa's Geological Past
by Wayne Anderson, University of Iowa Press, 1998

Landforms of Iowa
by Jean C. Prior, University of Iowa Press, 1991

RAGBRAI 2007

Learn about the Land

Day 3

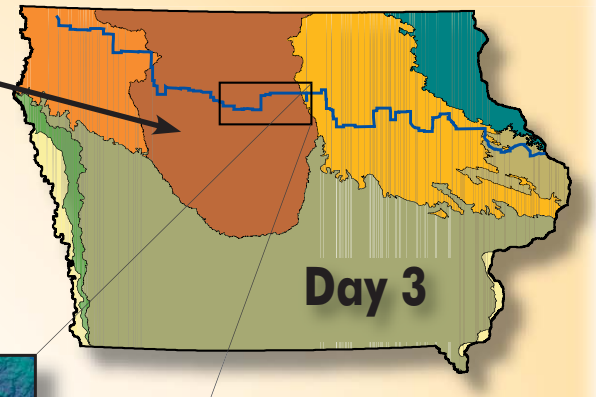
Tuesday, July 24

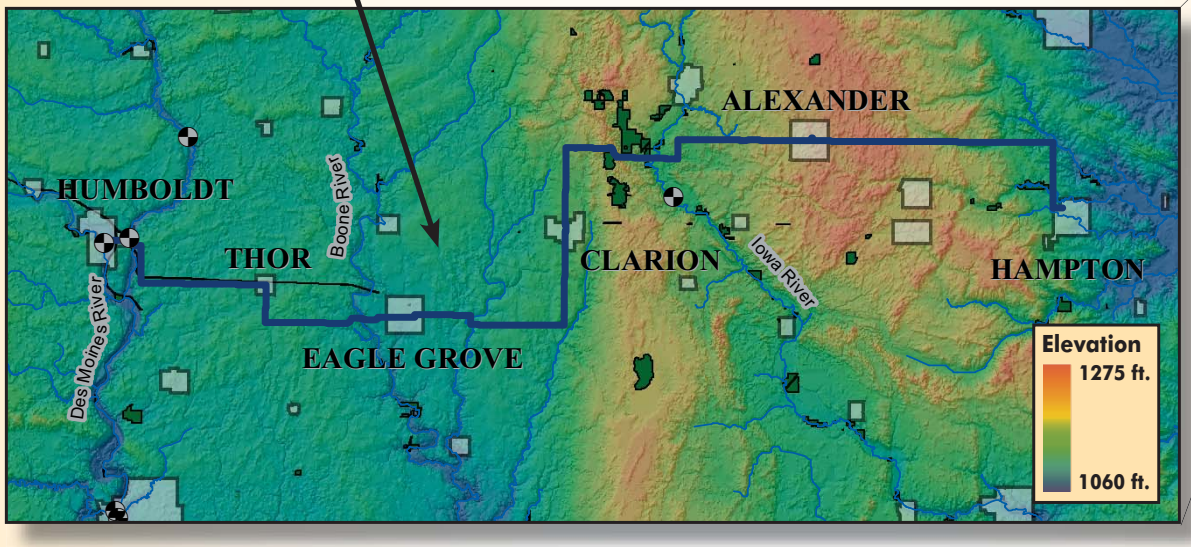
Iowa DNR – Geological Survey
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319)-335-1575
www.igsb.uiowa.edu

US Geological Survey
Iowa Water Science Center
400 S. Clinton St.
Iowa City, IA 52240
(319) 337-4191
http://ia.water.usgs.gov

On your ride from Humboldt to Eagle Grove, you will ride over a relatively low relief plain. On the west side of Eagle Grove, you will descend approximately 30 to 40 feet into the Boone River Valley. Later, several miles east of Eagle Grove, past Eagle Creek, you will enjoy the level abandoned lake bed of **Glacial Lake Wright.** This former lake developed on the backside of the Altamont Moraine as the Des Moines Lobe glacier stagnated and melted about 13,500 years ago. The lake was very shallow and covered an area several counties in size. It was probably short-lived and has no varved sediments. The ride continues across this plain until you near Clarion.

For most of Day 3 you will be crossing the **Des Moines Lobe Landform Region,** the area of Iowa last touched by glaciers. During today's ride, you will encounter the Boone River and the Iowa River valleys. Both of these river valleys formed as glacial meltwater, or "outwash," drained the final surge of the Des Moines Lobe ice.



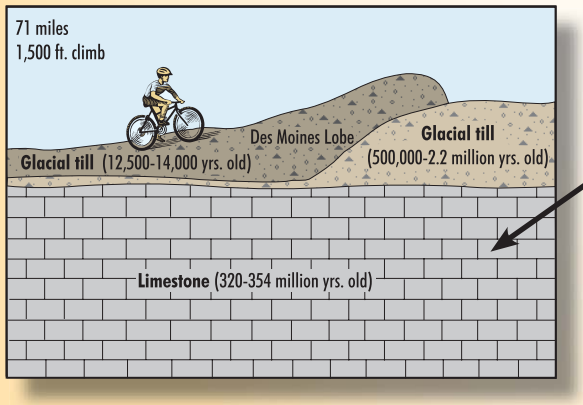


USGS streamflow station

Parks and Preserves

Once Buffalo Creek is crossed before the town of Hampton, RAGBRAI will depart the Des Moines Lobe landform region and enter a landscape region of older glacial-age materials known as the Iowan Erosion Surface. Riding south into Hampton, you may see the signs to Beed's Lake Park, or some of you may be camping there. It is the remnant of what was once another **ice-marginal lake.**

Heading out of Clarion, RAGBRAI returns onto the plain of Glacial Lake Wright after crossing White Fox Creek, just west of Lake Cornelia. **Lake Cornelia** is a kettle lake that formed as a large block of ice was separated from the main glacial body. This area exhibits good hummocky topography, typical of glacial moraines, and has considerably more relief than the till plain and lake plain you have been riding over today.



Cross-section showing the layers and ages of geologic materials underlying the ground for day three of RAGBRAI.

Day 3 of RAGBRAI will include scattered bedrock exposures that include strata of latest **Devonian** and early **Mississippian** age (deposited about 355-365 million years ago). This bedrock can be seen along streams, roadcuts, and old quarries. The succession of strata in the area includes Devonian rocks of the Sheffield Shale and Aplington Dolomite and Mississippian strata of the Prospect Hill Siltstone, Chapin Limestone, and Maynes Creek Formation. These bedrock units were all originally deposited in shallow tropical seas that once covered the interior of North America.

The overlying **Maynes Creek Formation** is the most prominent bedrock unit in the Hampton area, characterized by beds of dolomite and minor limestone with abundant nodules of chert (commonly called "flint"). The Maynes Creek Formation derives its name from exposures along Maynes Creek a few miles south of Hampton.

Printed on recycled paper.

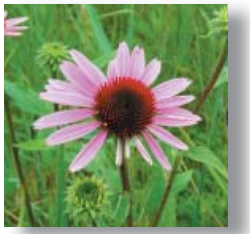
RAGBRAI Mini Prairie-Pedia

Throughout RAGBRAI you will notice some 'wild' areas, with diverse wildlife and flowers. These tiny remnants and reconstructions represent what once was a vast, statewide prairie. Today, it is estimated that less than 0.1% of our original prairie exists.

Black-eyed Susan
Rudbeckia hirta

Yarrow
Achillea millefolium

Rattlesnake Master
Eryngium yuccafolium



Purple Coneflower
Echinacea purpurea

Prairie Blazingstar
Liatris pycnostachya

Compassplant
Silphium laciniatum

Culver's Root
Veronicastrum virginicum

Coreopsis
Coreopsis lanceolata

Cover photo: Butterfly Milkweed *Asclepias tuberosa*

Links

Cedar Hills Sand Prairie
www.nature.org/wherewework/northamerica/states/iowa/preserves/art2227.html

Prairie Plant Index
www.illinoiswildflowers.info/prairie/plant_index.htm

Iowa EcoType Project
www.uni.edu/ecotype/

Landscape Features of Iowa
www.igsb.uiowa.edu/Browse/landscap/landscap.htm

Landform Regions of Iowa
www.igsb.uiowa.edu/Browse/landform.htm

USGS Cedar River Project
http://ia.water.usgs.gov/projects/crp/index.html

WaterWatch (realtime streamflow conditions)
http://water.usgs.gov/waterwatch

Water Quality Information Pages
http://water.usgs.gov/owq/

Books about Iowa's Land

Iowa's Geological Past
by Wayne Anderson, University of Iowa Press, 1998

Landforms of Iowa
by Jean C. Prior, University of Iowa Press, 1991

RAGBRAI 2007

Learn about the Land

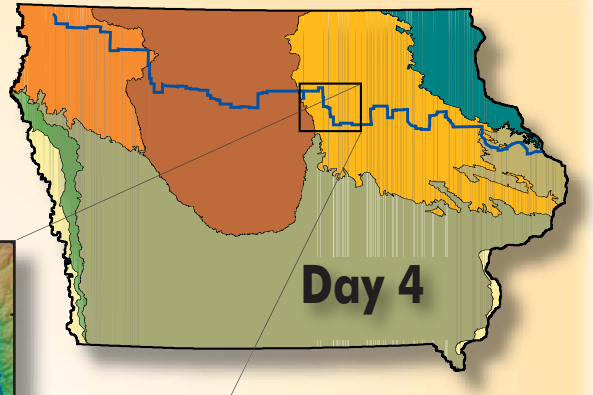
Wednesday, July 25

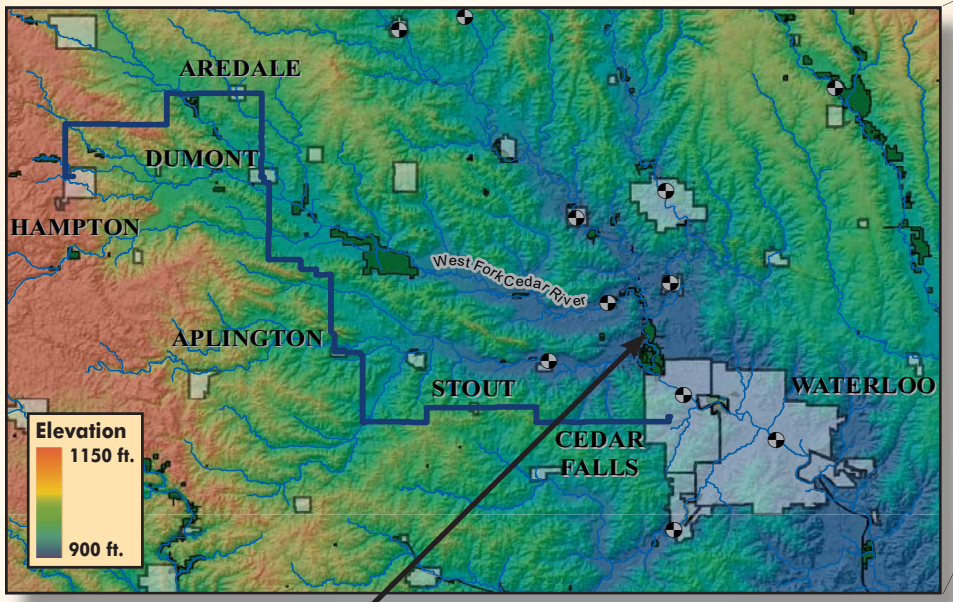
Day 4

Iowa DNR – Geological Survey
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319)-335-1575
www.igsb.uiowa.edu

US Geological Survey
Iowa Water Science Center
400 S. Clinton St.
Iowa City, IA 52240
(319) 337-4191
http://ia.water.usgs.gov

The Iowan Surface Landform Region dominates the landscape on days four through six of RAGBRAI. From 500,000 to 2.2 million years ago, the Iowan Surface was covered with glaciers numerous times. The deposits left by these glaciers were substantially eroded during the coldest part of the last glacial period from 16,500-21,000 years ago. This created the gently rolling topography and low relief of the land that we see today. There may be a thin loess (wind-blown silt) cover on some areas. Characteristics of the Iowan Surface include stone lines, glacial erratics (large boulders carried by glaciers), and paha. Numerous glacial erratics are found throughout the area and may be observed in fields along the route.





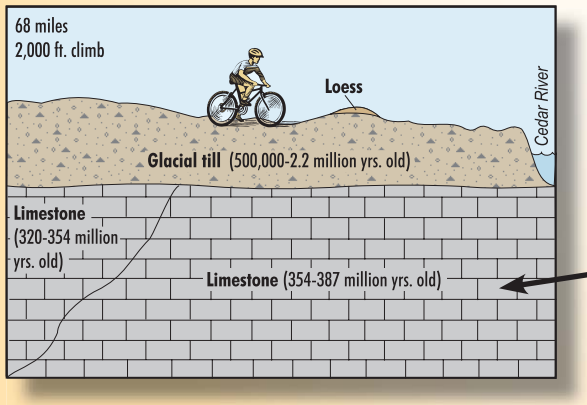
USGS streamflow station

Parks and Preserves

Iowa has not always been corn and soybeans. At one time, large, diverse prairies covered the Iowa landscape. The **Iowa Ecotype Project** is a collaborative effort by many agencies to restore some of these indigenous prairies in Iowa. Natural prairie seeds are selectively chosen, bred, and sold for restoring the native prairie foliage and grasses throughout Iowa. Seeds from the Iowa Ecotype Project have been used for restoring an estimated 12,000 acres of roadside prairie in the past 10 years.

Paha are characteristic features of the Iowan Surface. Paha, a Dakota Sioux word meaning hill or ridge, are erosional remnants left behind following the erosional stripping of the Iowan Surface. Paha are till ridges that have a thick loess mantle. Six to seven miles outside of Hampton, RAGBRAI riders should notice an elongated northwest to southeast trending ridgeline. This is the first paha that you will see, and you actually will pass through a gap in the ridge. During the middle of the day, you should notice several paha north of Aplington and will get to ride over one just two miles north of town.

The Cedar Hills Sand Prairie, located ten miles northwest of Cedar Falls, contains a sand prairie, a sedge meadow, and even a small fen. It has been managed by the University of Northern Iowa Biological Preserves since 1969. The preserve sits atop a broad sandy divide between the Cedar River and Beaver Creek, and is one of a series of aeolian (wind-formed) sandy ridges found along the Cedar River valley. Within the preserve, dry sand prairie occupies the upland ridge and sedge meadow occupies the large swale. A small fen is found on seepy, peaty soil in a portion of the sedge meadow. More than 360 native species of grasses and forbs have been identified here.



Cross-section showing the layers and ages of geologic materials underlying the ground for day four of RAGBRAI.

Most of the bedrock you'll see today is of Middle and Late **Devonian** age (360-385 million years old). You can see old quarries and other rock exposures about 2 to 7 miles south of Dumont. These limestone and dolomite strata contain numerous fossils, especially corals and brachiopods. North of Aplington, you can find the reference section of the Aplington Dolomite. These beds also contain fossils, and an interesting brachiopod assemblage has been found near Aplington. The Aplington Dolomite and a thin shale locally above it comprise the youngest Devonian strata in northern Iowa.

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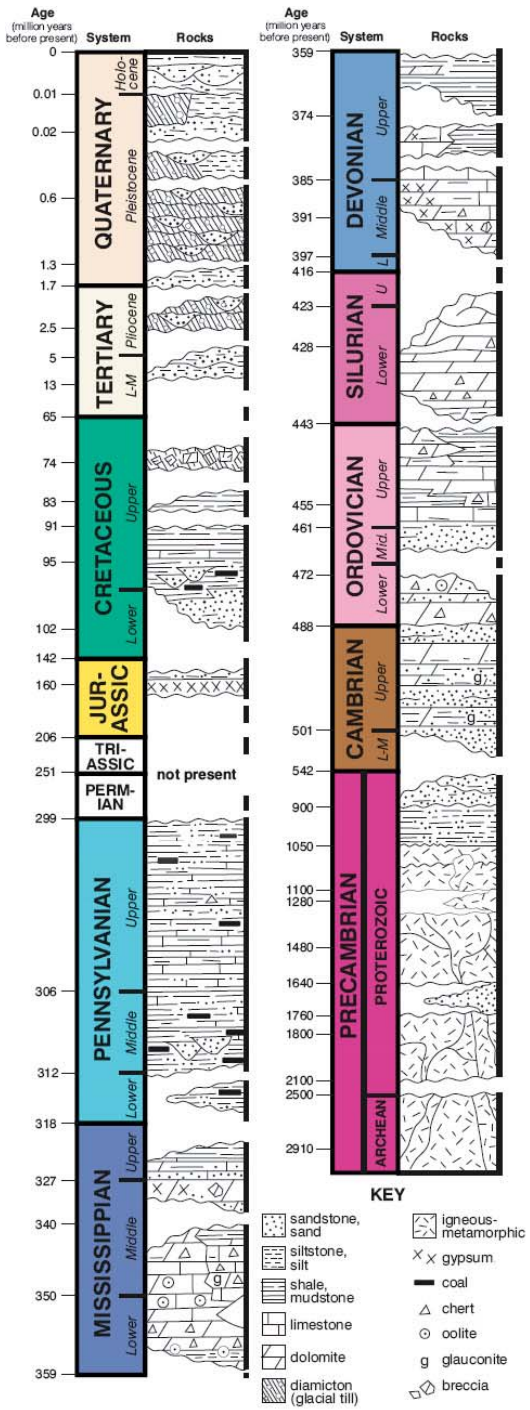
Stratigraphic Column of Iowa



Links

Silurian Stratigraphy and Carbonate Mound Facies of Eastern Iowa
www.igsb.uiowa.edu/gsbpubs/pdf/GB-11.pdf

General and Environmental Geology of Cedar Falls/Waterloo and Surrounding Area
www.igsb.uiowa.edu/gsbpubs/pdf/GB-22.pdf

The Stratigraphy, Paleontology Depositional and Diagenetic History of the Middle-Upper Devonian Cedar Valley Group of Central and Eastern Iowa
www.igsb.uiowa.edu/gsbpubs/pdf/GB-16.pdf

Bedrock Aquifers of Iowa
www.igsb.uiowa.edu/inforsch/bedrock.htm

Using LiDAR to Scan Iowa from Aircraft
www.igsb.uiowa.edu/gsbpubs/pdf/RIFS-2006-1.pdf

River and Stream Health in Iowa
www.igsb.uiowa.edu/gsbpubs/pdf/WFS-2001-07.pdf

Books about Iowa's Land

Iowa's Geological Past
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Landforms of Iowa
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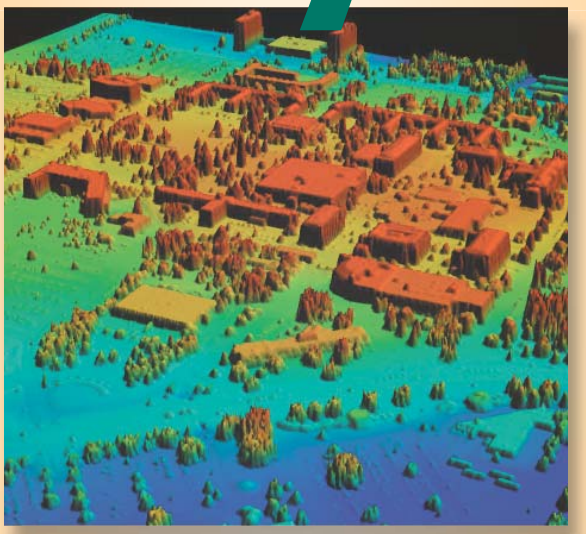
RAGBRAI 2007

Learn about the Land

Thursday, July 26

Day 5



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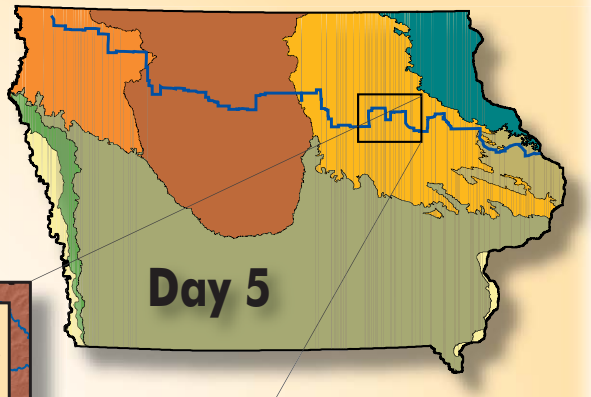
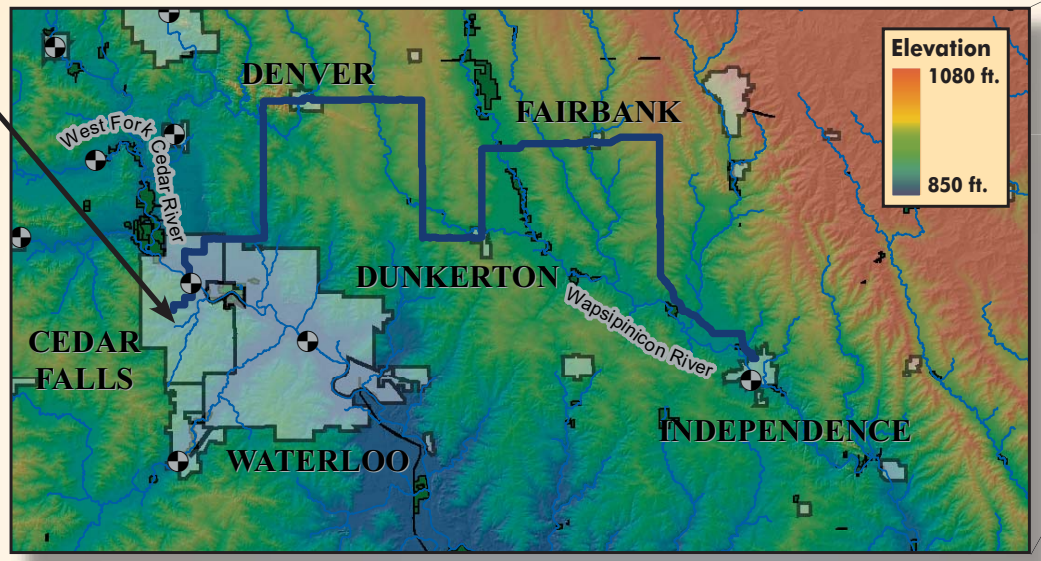
US Geological Survey
Iowa Water Science Center
400 S. Clinton St.
Iowa City, IA 52240
(319) 337-4191
http://ia.water.usgs.gov

Today's bike route begins in the **Cedar River** watershed. The Cedar River watershed extends from the headwaters in southern Minnesota to Columbus Junction, Iowa, where it joins the Iowa River and subsequently flows into the Mississippi River. The total drainage area of the Cedar River is 7,815 mi^2, with 87% of it in Iowa. The watershed accounts for about 20% of the total land area in Iowa. George Wyth State Park lies along the Cedar River and includes many excellent bike and hiking trails, fishing spots, and boating opportunities.

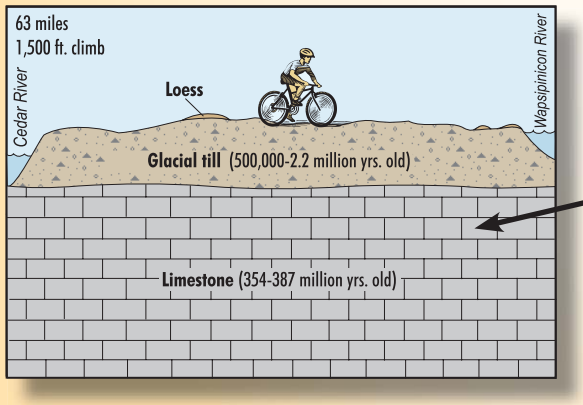


Dry Run Creek is the site of an urban water quality improvement project. Alterations to a stream as a result of urban growth can increase water flow in the stream. These higher stream flows reduce habitat for aquatic life and may carry pollutants such as bacteria, sediment, or oil and grease from parking lots and streets. In 2005, the Black Hawk Soil and Water Conservation District initiated urban conservation practices. The DNR has been monitoring the stream to document water quality improvements resulting from these practices.



USGS streamflow station
Parks and Preserves

The image of the UNI Campus on the front cover was generated by a technology known as **Light Detection and Ranging (LiDAR).** LiDAR data is captured by scanning the earth with lasers to generate highly accurate elevations. The information from the laser beams is then interpolated with Geographic Information Systems (GIS) software to create 3-D elevation models. Currently the State of Iowa has contracted for state-wide coverage of LiDAR through a cooperative effort among many agencies. These flights began in January 2007 and are expected to be complete by the fall of 2008. This information will be made available on the web at no cost and will prove invaluable for infrastructure planning and engineering, education and research, risk assessments, and permitting processes. Plus it makes for great images.



Cross-section showing the layers and ages of geologic materials underlying the ground for day five of RAGBRAI.

Limestone quarries around Independence reveal **Devonian** strata of the Wapsipinicon and Cedar Valley groups (390-395 million years old). Wapsipinicon limestone and dolomite strata were deposited in a saline embayment of the Devonian seaway and in hypersaline waters unsuitable for most marine life. Fossils are generally absent from these beds. By contrast, the overlying limestones of the Cedar Valley Group have abundant fossils, reflecting the geographic expansion of the tropical interior seaway with better circulated waters. Cedar Valley Group rocks are exposed throughout the valley of the Cedar River (for which it is named) and underlie all but the northeast and northwest corners of Iowa. The Cedar Valley Group is quarried extensively for aggregate and serves as one of eastern Iowa's most important rock aquifers.

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RAGBRAI Geo-pedia

Fossils in Iowa

Trilobites display a three-lobed, segmented skeleton, often with distinct eyes. They belong to an extinct group of bottom-dwelling, hard-shelled arthropods that scavenged the ancient sea floor. Whole specimens are highly prized by collectors (photo above right).

Crinoids. Often called "sea lilies," crinoids (photo right) are actually related to the modern starfish. Most crinoids live in shallow seas, but some have been found as deep as 6000 meters below the surface.

Brachiopods are among the most common fossils found in Iowa. Looking somewhat like mollusks of today, brachiopods (photo right) lived inside the protective cover of two hinged shells, attached to the floor of the warm, shallow seas that once covered Iowa.

Nautiloids are a subclass of marine mollusks that possess an external shell (cover photo). They flourished during the early Paleozoic era, including the Silurian age. During that time they were the main predatory animals, and had an astonishing variety of shell shapes and forms. Some 2,500 species of fossil nautiloids have been identified, but only a few species are around today.

Links

Backbone State Park
www.iowadnr.com/parks/state_park_list/backbone.html

The Natural History of Backbone State Park
www.igsb.uiowa.edu/gsipubs/pdf/GB61.pdf

Delaware County Backbone Park Attractions
www.delawarecountyia.com/backbone001.html

Living in Karst
www.igsb.uiowa.edu/gsbpubs/pdf/gb-25.pdf

Information on Karst
www.caves.org/grotto/iowa/karst.htm

Silurian Stratigraphy and Carbonate Mound Facies of Eastern Iowa, Field Guidebook to Silurian Exposures in Jones and Linn Counties
www.igsb.uiowa.edu/gsbpubs/pdf/GB-11.pdf

Fossils of Iowa
www.igsb.uiowa.edu/gsbpubs/pdf/EM-26.pdf

USGS Lake Delhi study
http://ia.water.usgs.gov/pubs/reports/WRIR_03-4085.pdf

Books about Iowa's Land

Iowa's Geological Past
by Wayne Anderson, University of Iowa Press, 1998

Landforms of Iowa
by Jean C. Prior, University of Iowa Press, 1991

RAGBRAI 2007

Learn about the Land

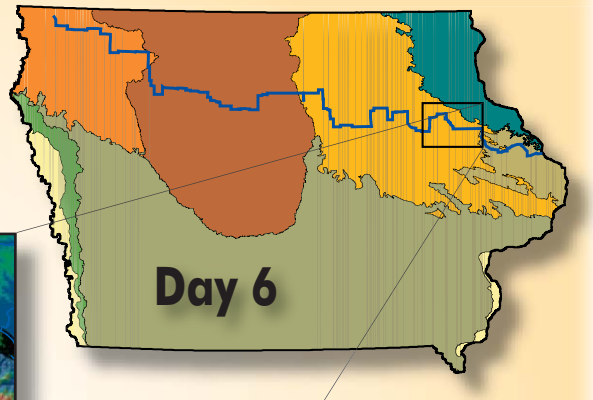
Day 6

Friday, July 27

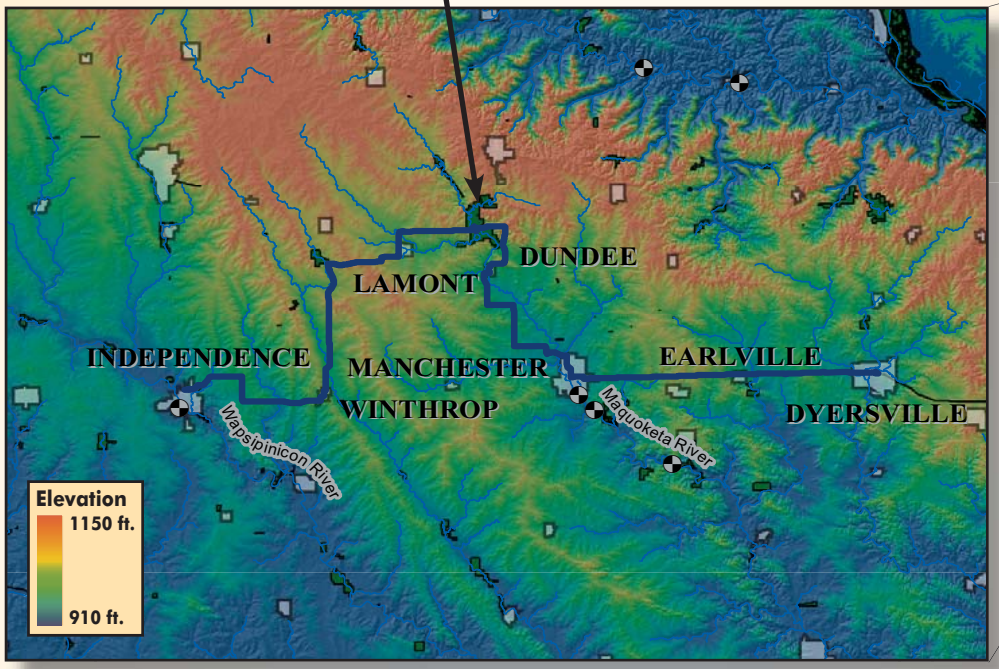
Iowa DNR – Geological Survey
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319)-335-1575
www.igsb.uiowa.edu

US Geological Survey
Iowa Water Science Center
400 S. Clinton St.
Iowa City, IA 52240
(319) 337-4191
http://ia.water.usgs.gov

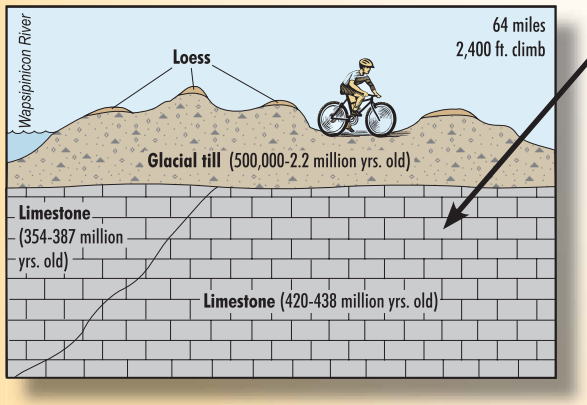
If you feel like cooling off naturally today, you can hunker down for a while in **Backbone Cave,** located in Backbone State Park. Always cool in summer, the cave has one main passage that gradually gets slimmer before tapering off after 210 feet. Be careful if you're claustrophobic! There also is a small side passage about 2/3 of the way back. While relaxing in the cave, you can ponder the eons of time and geologic processes that made the cave what it is today.



When limestone is close to the land surface, as it is in northeastern Iowa, there is typically interesting landscape features like caves and sinkholes. These features typify **Karst terrain.** A 'karst' landscape is shaped by the dissolving of limestone or dolomite by water. The dissolving bedrock forms fractures and crevices where water easily moves through the subsurface. These processes formed many of the great cave structures throughout the world, including Maquoketa caves, and Richmond Spring.



A high and narrow ridge of rock, once termed the "Devil's Backbone," towers prominently above the Maquoketa River north of Dundee in Delaware County. This ridge provided the namesake for Iowa's very first state park, **Backbone State Park.** Backbone State Park was dedicated in 1920 to preserve the natural beauty of this special area for the enjoyment of future generations.



Cross-section showing the layers and ages of geologic materials underlying the ground for day six of RAGBRAI.

The bedrock found in Backbone State Park, including the "Devil's Backbone," is of **Silurian** age and primarily composed of dolomite. The bedrock was originally deposited as lime in a shallow, tropical seaway that covered much of the continental interior from 430-440 million years ago. Fossil corals, sponges, brachiopods, nautiloids, trilobites, and crinoids found in these strata indicate that this area was biologically diverse at the time of deposition. The Silurian rocks at Backbone lay buried beneath younger rocks and sediments for millions of years before erosion ultimately exposed them at the surface. In particular, the waxing and waning of continental ice sheets across Iowa over the last 2 million years was accompanied by a complex record of erosion and sedimentation on the Iowa landscape.

Most Silurian strata seen along the RAGBRAI route on Day 6 belong to the **Hopkinton Formation,** a rock interval exposed at numerous localities in eastern Iowa and originally named after typical exposures near the town of Hopkinton in Delaware County. Old quarries and roadside rock ledges are seen along today's route to the west of Lamont, as well as in the Dundee, Manchester, and Dyersville areas, and, of course, Backbone State Park.

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RAGBRAI Geo-quiz

1. Fens are a type of _____.
a. wetland b. fossil c. fish belly

2. 374 million years ago, 'Iowa' was a _____.
a. desert b. forest c. shallow sea

3. During the past 2 million years, Iowa's landscape has been mostly shaped by_____.
a.volcanism b. glaciation c. pluton intrusion

4. Which fossil would you not expect to find in Backbone State Park bedrock?
a. corals b. trilobite thorax c. teradactyl egg

5. What is the last area of Iowa touched by glaciers?
a. Northwest Iowa Plains b. Des Moines Lobe
c. Iowan Surface

6. The Des Moines Lobe was deposited _____ ago.
a. 12,000-14,000 yrs. b. 30,000-33,000 yrs.
c. 90-100 million yrs.

7. Till is associated with_____.
a. ancient seas b. plutons c. glacial deposits

8. LiDAR is used for finding _____.
a. elevation b. foliage c. buried treasure

9. Backbone State Park was dedicated in _____.
a. 1977 b. 1892 c. 1920

10. _____ are found in karst terrain.
a. batholiths b. sinkholes c. geodes

Answers: 1.a, 2.c, 3.b, 4.c, 5.b, 6.a, 7.c, 8. a, 9.c, 10.b

Links

Testing of Bottled Water Sold in Iowa
www.uhl.uiowa.edu/newsroom/research/bottledWater.xml

Large Floods in the U.S. – Where They Happen and Why
http://pubs.usgs.gov/circ/2003/circ1245/

The National Map
http://nationalmap.gov/

USGS Science Education
http://education.usgs.gov/

Water Science for Schools
http://ga.water.usgs.gov/edu/gwartesian.html

Facets of the Ordovician Geology of the Upper Mississippi Valley Region
www.igsb.uiowa.edu/gsbpubs/pdf/gb-24.pdf

The Bedrock Beauty of Whitewater Canyon
www.inhf.org/winter06-whitewater-geology.htm

New Perspective on the Paleozoic History of the Upper Mississippi Valley
www.igsb.uiowa.edu/gsbpubs/pdf/GB-08.pdf

Books about Iowa's Land

Iowa's Geological Past
by Wayne Anderson, University of Iowa Press, 1998

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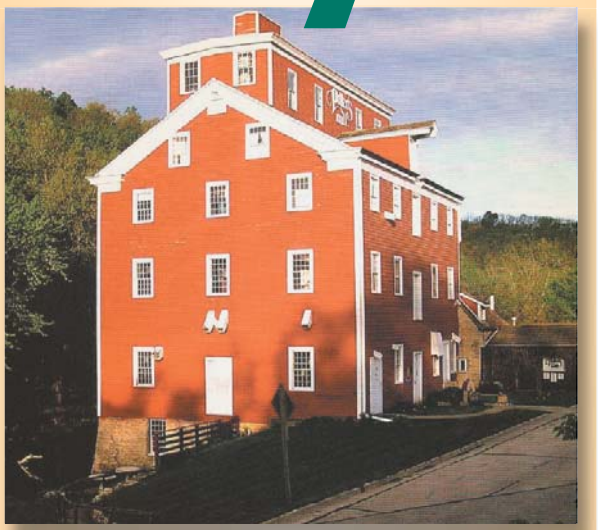
by Jean C. Prior, University of Iowa Press, 1991

RAGBRAI 2007

Learn about the Land

Day 7

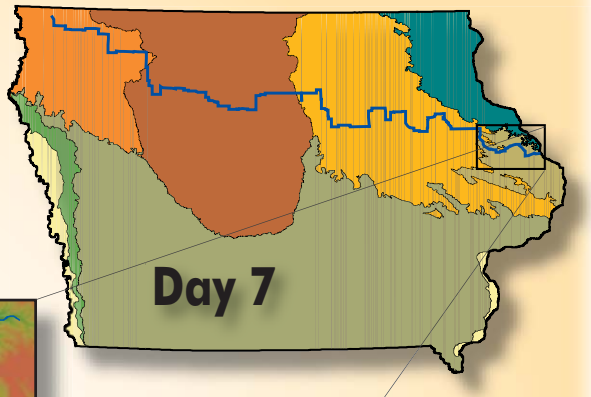
Saturday, July 28



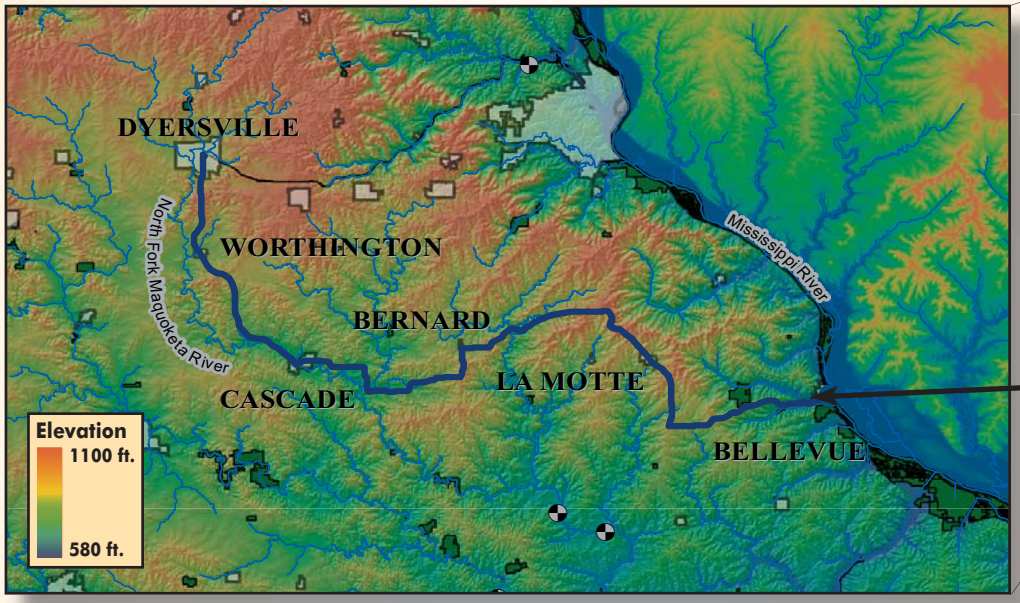
Iowa DNR – Geological Survey
109 Trowbridge Hall
Iowa City, IA 52242-1319
(319)-335-1575
www.igsb.uiowa.edu

US Geological Survey
Iowa Water Science Center
400 S. Clinton St.
Iowa City, IA 52240
(319) 337-4191
http://ia.water.usgs.gov

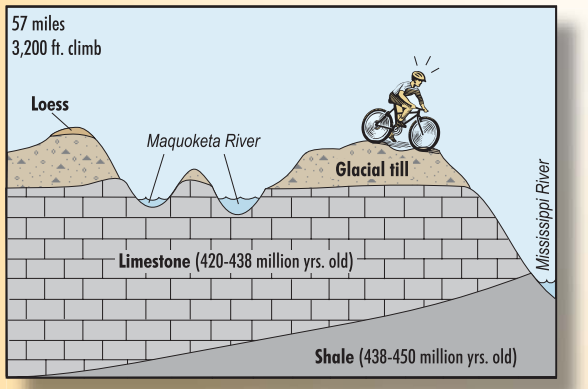
During spring and summer 1993, **record flooding** inundated much of the upper Mississippi River Basin. Record or near-record flood discharge measurements were recorded across the entire upper Midwest. At that time the magnitude of the damages – in terms of property, disrupted business, and personal trauma – was unmatched by any other flood disaster in United States history. The Mississippi and the Missouri rivers were closed to navigation before, during, and after the flooding. Cities were destroyed, and millions of acres of productive farmland remained under water for weeks during the growing season, all resulting in billions of dollars in damages. Over 420 counties in the nine-state area were declared Federal disaster areas. Dubuque was the host city for the end of RAGBRAI in 1993 and was rained out.



The route will pass close to **Whitewater Canyon** about four miles west of Cascade along the Dubuque-Jones County line. This deep and narrow rock gorge is cut into Silurian bedrock of the Hopkinton and basal Scotch Grove formations. Its scenic beauty and natural environment will be preserved for future generations, as a portion of it has been purchased recently and made public through the efforts of the Dubuque County Conservation Board and the Iowa Natural Heritage Foundation.



Right before you enter Bellevue, you'll notice a drastic decrease in elevation, this is called the **Silurian Escarpment.** Shown in the background of the front photo of Potter's Mill, the Silurian Escarpment is a steep, northeast facing cliff that follows an irregular line from central Fayette County to southeastern Jackson County. This prominent line of cliffs separates the landform regions of the glacial till dominated Iowan Surface (west) and rock-dominated Paleozoic Plateau (east). As RAGBRAI begins the descent into the town of Elgin you should notice a significantly steeper grade for about an eighth of a mile. There the land surface drops about 100 feet through the escarpment onto the rounded slopes of the more easily erodible Maquoketa Shale. Similar Silurian rocks form the Blue Mounds in Wisconsin and the Niagara Escarpment in New York, where the resistant limestone ledge forms Niagara Falls.



Cross-section showing the layers and ages of geologic materials underlying the ground for day seven of RAGBRAI.

Water flows naturally (without pumping) from many wells drilled in the Mississippi River Valley, and several of these '**flowing wells**' were drilled in Bellevue. Some of these wells flow at a rate of 200–500 gallons per minute, more than enough for your typical home. When an aquifer is confined (sealed on the top and bottom by impermeable rocks), a water in a well drilled into the aquifer will rise to the level of the highest elevation of the saturated portion of the aquifer (called its "head"). If this head is higher than the top of the aquifer formation, the well is called "artesian." If this head is higher than the land surface, water will naturally flow from the well and it is called a flowing well.

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