NEWSLETTER
NDGS

Industrial Commission of North Dakota, North Dakota Geological Survey Vol. 21, No. 3, Fall 1994

Landslides, such as this small slump along the shores of the Jamestown Reservoir, are often found along steep valley walls of Ice Age meltwater channels. They are especially common where slopes have been undercut or oversteepened by improperly placed fill. As our State's urban areas expand, construction on and modification of slopes is increasing - hilly areas with a view are, understandably, magnets for development. Recent geologic mapping in the Jamestown area has identified many such landslides. Geologic maps themselves are important tools used for identifying these and other geologic hazards and resources. See page 6 for an article on geologic mapping in the Jamestown - Spiritwood Lake area. *Photo by Bob Biek.*

FEATURES

DEPARTMENTS

NDGS Newsletter (ISSN: 0889-3594) is published quarterly by the North Dakota Geological Survey, a division of the Industrial Commission of North Dakota. *NDGS Newsletter* is designed to reach a wide spectrum of readers interested in the geology and mineral resources of North Dakota. Single copies of *NDGS Newsletter* are distributed free upon request. Please share the *NDGS Newsletter*; we encourage its reproduction if recognition is given.

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NEWSLETTER
NDGS

FROM THE STATE GEOLOGIST

by John P. Bluemle

North Dakota's Early Oil and Gas History

I was recently asked to write a brief "history" of the North Dakota Geological Survey, an article meant to be included in the new *North Dakota Bluebook*, which the Secretary of State's office plans to publish in 1995. In view of the fact that the NDGS will also be celebrating its 100th anniversary in 1995, such a synopsis seemed appropriate. In compiling the information I needed for my Bluebook article, I also came across some information about North Dakota's early oil and gas history and the Geological Survey's role in that history. It goes back a long way and I'll comment briefly on it here.

The NDGS involvement in oil and gas development dates to 1908 when investigations were made into reports of natural gas in Bottineau County. The Survey determined that gas to be a form of low-heating value marsh gas coming from the base of the glacial drift at depths of 150 to 200 feet, and a private company was set up in 1910 to supply the gas to the community of Lansford. Shallow gas was apparently also utilized in other parts of northwestern and southeastern North Dakota even before 1910.

The 1911 State Legislature passed the state's first oil and gas conservation law, a law that prohibited natural gas production unless the wells were tied to a pipeline. The law was passed in response to complaints from farmers in the area who were disturbed by the noise resulting from the practice of promoters [apparently in the Lansford area] opening up wells for the benefit of potential investors.

The first true wildcat oil well in the state was drilled in 1915 and 1916. About that time, a North Dakota corporation known as the Des Lacs and Western Oil Company was organized in Minot. Company officials attempted to drill several wells in northwestern North Dakota. The first well, in Ward County on the Blum Farm (on the "Blum Anticline —" I am uncertain what the Blum Anticline is) was abandoned after reaching a total depth of 244.5 feet in late 1916. Interestingly enough, the Blum well was located approximately two miles from current production in the Lone Tree Field. Wells in the Lone Tree Field produce from the Sherwood (Mississippian Madison Group) at a depth of approximately 6,500 feet, so the choice of location was not really too bad, and if the well had been drilled another 6,000 feet or so, it is possible it might have been a producer.

During its early years, the NDGS received numerous inquiries about oil in North Dakota, and several investigations were conducted during the 1920's and 1930's. As a result, in 1920 State Geologist Dr. A. G. Leonard published North Dakota Geological Survey Bulletin 1, *Possibilities of Oil and Gas in North Dakota*. He concluded that the structural conditions in the Dakota Formation (Lower Cretaceous) were favorable for oil occurrence and that drilling was warranted. Of course, he had no way of knowing anything about the existence of deeper rocks in the Williston Basin, which today produce oil and gas.

The first "modern" well drilled for oil in North Dakota was drilled to 10,281 feet by the California Company in 1938. That well, though it was unsuccessful, eventually turned out to be only 1,866 feet away from a producing well drilled 18 years later, in 1956. Apparently, mud was being circulated at the time the producing zone was penetrated by the California Company well and any shows were overlooked. This 1938 well was the first well in North Dakota on which an electric log was run.

The 1941 Legislature enacted another oil and gas conservation law based on the then Model Act drawn up by the Legal Committee of the Interstate Oil Compact Commission *[see the article by Wilson Laird in the Spring, 1994 NDGS Newsletter]*. The 1941 law designated the North Dakota Industrial Commission as the state's oil regulatory authority and named the State Geologist as advisor and enforcer of the regulations. Dr. Laird, who was State Geologist at the time, was instrumental in seeking the passage of this legislation. At the time the statutes were enacted, the only oil and gas

(continued on p. 16)

SURVEY RECEIVES GRANT TO STUDY FOSSILS OF THEODORE ROOSEVELT NATIONAL PARK

by John Hoganson

The federal government is becoming increasingly aware of the importance of paleontological resources found on lands administered by federal agencies. For example, the BLM, National Park Service, and U. S. Forest Service have recently hired paleontologists to manage paleontological resources under their respective jurisdictions. This fall the U. S. Forest Service will be hiring a senior level paleontologist to develop policies and programs dealing with fossils on USFS lands. The National Park Service was recently allocated funds for paleontological investigations in several national parks, including Theodore Roosevelt National Park. The Survey received the grant for the TRNP study.

The primary objective of the study is to identify, map, and assess the significance of fossils and fossil sites within the boundaries of TRNP. This information will be used in resource management planning. Work on this 2 1/2 year project will begin this fall. Funds are available for a total of 2 1/2 months field work by myself, a field assistant and as many volunteers that I can muster. Very few paleontological studies have been conducted in TRNP, and fewer than a dozen fossil sites have been reported from within its boundaries.

Two primary rock formations are exposed in TRNP, the Bullion Creek Formation and the overlying Sentinel Butte Formation. These rocks were deposited by fluvial and lacustrine systems during the Paleocene Epoch between about 55 million and 60 million years ago. At that time, the climate of western North Dakota was subtropical to warm temperate. This environmental setting provided a mosaic of habitats for life including crocodiles, alligators, turtles, fish, mammals, clams, snails, exotic plants, etc. Even though very little information about the fossils of TRNP is available, we do know a great deal about the kinds of plants and animals that lived in the Park area during the Paleocene, mostly because of 20 years of excavations by Dr. Bruce Erickson, Science Museum of Minnesota, at the Wannagan Creek site west of the South Unit of the Park. Knowledge gained from the Wannagan Creek studies will provide base-line information for interpretation of fossils recovered from the Park during our study.

The Sentinel Butte Formation (left) and underlying Bullion Creek Formation, both Paleocene in age, are the two bedrock units exposed in Theodore Roosevelt National Park. A paleontological assessment of these units at the park is expected to yield a variety of fossils, such as the alligator jaw above.

For several years the NDGS has been an affiliate office of the Earth Science Information Center (ESIC) network. Coordinated by the U.S. Geological Survey (USGS), this nationwide ESIC network provides information about geologic, hydrologic, topographic, and landuse maps, books, and reports; aerial, satellite, and radar images and related products; earth science and map data in digital form and related applications software; and geodetic data. As an ESIC office, the NDGS can assist the public in locating those earth science materials dealing with North Dakota, as well as other states.

USGS Discontinues 15-Minute Map Series

The USGS 7.5-minute topographic quadrangle map series is the official replacement for the USGS 15-minute series. The 7.5-minute (1:24,000 scale) series, which provides greater detail than the 15-minute (1:62,500 scale) series, has now been completed for all States except Alaska. The USGS has not revised or reprinted the 15-minute maps for many years and will no longer support both the 7.5-minute and the 15-minute map series. Consequently, the 15-minute series has been officially abandoned and will no longer be available for sale by the USGS.

Fortunately for those needing 15-minute maps for portions of North Dakota, the NDGS has a limited number of these maps left for sale to the public. Once these are gone there will be no more available for sale. However, the NDGS will maintain an archive containing at least one copy of each map and make them available for viewing by the public in our Bismarck office.

The 15-minute map series was never completed for North Dakota, but an index map illustrating those areas with 15-minute map coverage is shown in Figure 1. 15-minute maps are available for many of North Dakota's

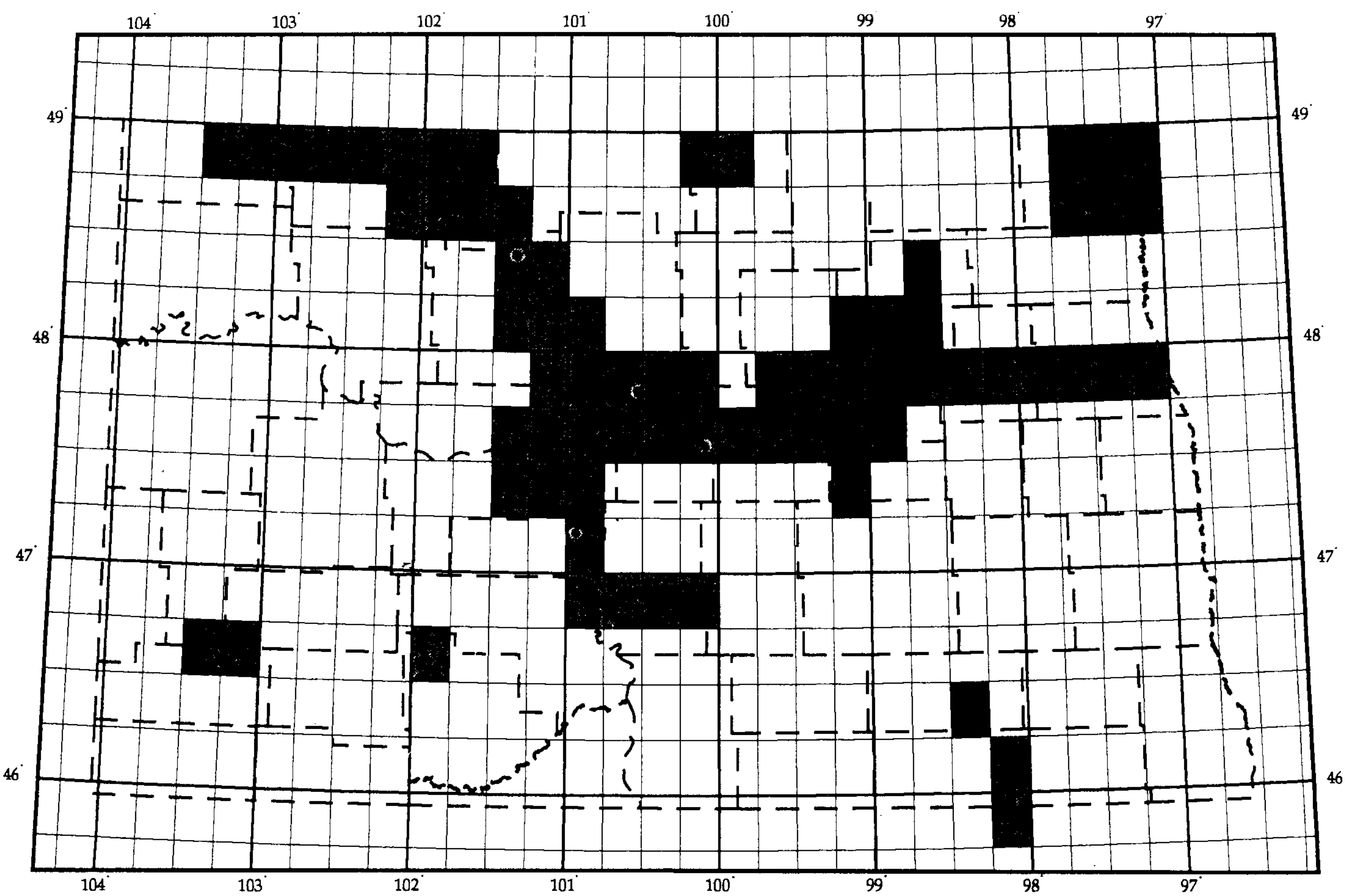


Figure 1. 15-minute map index for North Dakota. Dark areas indicate 15-minute blocks with maps available.

larger cities, as well as rural areas, and are an invaluable source of historic information about the locations of buildings, roads, streams, etc., that may no longer exist. Old maps are frequently used by people engaged in environmental studies to determine the locations of now vanished buildings, wetlands, streams, or topographic features that may now be masked by buildings, fill, or other manmade features. 15-minute maps available for North Dakota range in age from 1894 to 1962, but most were made during the 1920's through 1950's.

The NDGS is selling its remaining stock of 15-minute maps for $4 each. They are interesting and very useful maps that will soon be gone.

New Map Products

In addition to providing information about the availability of various earth science materials, the NDGS' ESIC office operates a distribution center for federally produced cartographic products. Descriptions of recently produced or reprinted maps that are available follows.

* North Dakota Land Status maps - These maps, produced in 1993 by the U.S. Dept. of the Interior - Bureau of Land Management, show those areas of the state that are public land (colored areas) versus privately held lands. These maps are single sheets, showing the entire state and including the following information in addition to land status: county boundaries, township boundaries, major roads, railroads, major water features, towns, Indian Reservations, and contour lines (200 foot interval). Public lands are separated by administering agency (different colors) and include national forest and grasslands, national parks, Bureau of Land Management lands, Corp of Engineer lands, U.S. Fish and Wildlife Service lands, and state owned lands. This map comes in two sizes: 1:500,000 scale (map size 49" X 32"), and 1:1,000,000 scale (map size 24" X 18"). Cost for these maps are: $8 for the 1:500,000 size, and $5 for the 1:1,000,000 size (plus shipping).

* Indian Land Areas - This map, produced in 1993 by the U.S. Dept. of the Interior - Bureau of Indian Affairs, shows the size and location of all Indian Reservations in the United States. The reservations are placed on a folded 1:5,000,000 scale base map (42" X 26") that also includes: latitude-longitude lines, state boundaries, Bureau of Indian Affairs administrative boundaries, interstate highways, major towns, and major water features. Cost for this map is $4 plus shipping.

To place map orders or receive additional information, contact our publications clerk or the ESIC Coordinator. Shipping costs for federally produced paper maps purchased from the NDGS are:

1 to 5 maps	$2.75
6 to 30 maps	$4.00
31 or more maps	$6.00

US GeoData

The development of geographic information systems (GIS) is a rapidly growing industry that supports natural resources studies, land management, environmental analysis, marketing, and urban and transportation planning. The increasing use of computers for storing and analyzing earth science information has greatly expanded the demand for digital cartographic and geographic (spatial) data.

The ESIC network distributes digital cartographic/geographic data files produced by the U.S. Geological Survey (USGS) as part of the National Mapping Program. Digital cartographic data files may be grouped into four basic types:

- Digital Line Graph (DLG), which is the line map information in digital form (discussed in the Fall, 1993 *NDGS Newsletter*). These data files include information on planimetric base categories, such as public-land survey, transportation, hydrography, and boundaries.

- Digital Elevation Model (discussed in the Winter, 1992 *NDGS Newsletter*), which consists of a sampled array of elevations for a number of ground positions at regularly spaced intervals.

- Land Use and Land Cover digital data, which provides information on nine major classes of land use such as urban, agricultural, or forest as well as associated map data such as political units and Federal land ownership.

- Geographic Names Information System (discussed in the Summer, 1992 *NDGS Newsletter*), which provides primary information for all known places, features, and areas in the United States identified by a proper name.

DLG Data on CD-ROM

The USGS has begun to distribute some of its intermediate (1:100,000 scale) and small (1:2,000,000) scale DLG data on CD-ROM.

The 1:2,000,000 scale DLG CD-ROM covers the entire United States in sections based on the USGS 1:2,000,000 scale sectional map (paper or analog) series. In addition to covering the same areas, the digital versions contain the same types of information as the analog versions, that is: political and administrative boundaries, major transportation routes, and major hydrography (lakes, rivers, and streams). Data is contained in three formats on a single CD-ROM, including: standard, optional, and graphic formats.

The 1:100,000 scale hydrography and transportation DLG's are rapidly being completed for the contiguous United States and Hawaii. The U.S. has been subdivided into fourteen sections (Figure 2) and CD's containing both types of coverages are being created for each of them. These CD's contain transportation and hydrography data consistent with that found on 1:100,000 scale paper maps, and as such, are the most accurate source of these data types currently available for large areas. Data is available in two formats (on separate discs), standard and optional.

To use either the 1:2,000,000 or 1:100,000 scale CD-ROM discs requires (at a minimum) a DOS-based (version 3.1 or higher) microcomputer (x86) with 512 kilobytes of free memory and a hard disk, an EGA monitor, and a CD-ROM reader with software drivers that read ISO-9660 formatted discs.

The NDGS currently stocks the 1:2,000,000 and 1:100,000 (area 10, optional format only) scale CD-ROM's as part of its map distribution effort. The price is $40 each, plus $3 shipping. The NDGS can also order any CD-ROM that it does not currently stock.

We have found both of these CD-ROM's to be extremely useful in our Automated Mapping/GIS program, and recommend them to anyone using digital spatial data for similar purposes.

(The NDGS' ESIC Coordinator is Mark R. Luther)

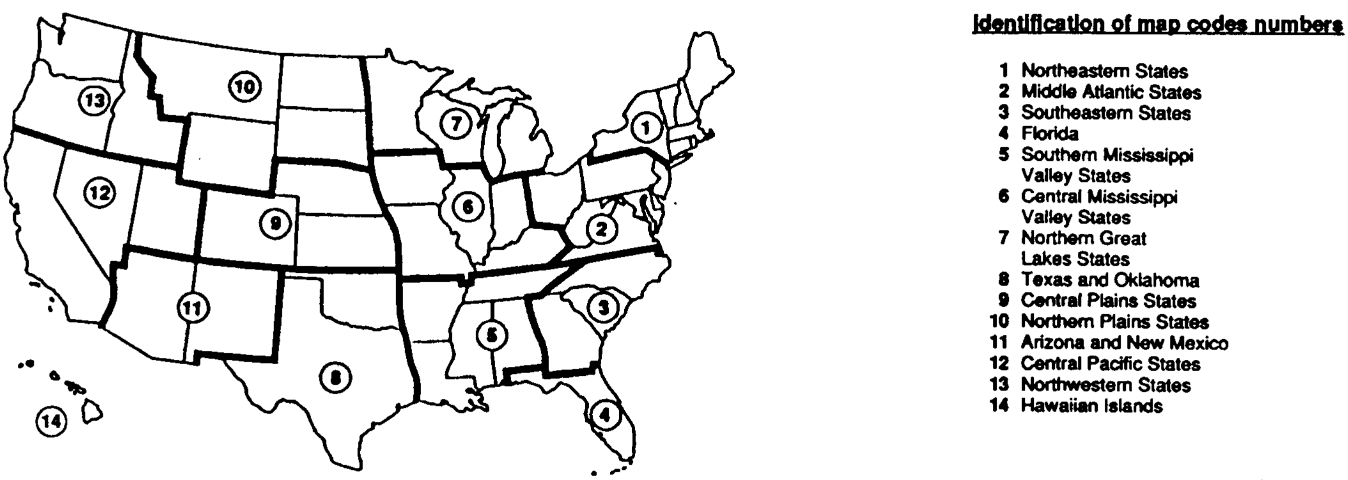


Figure 2. Regions of the United States for which 1:100,000 scale hydrography and transportation DLG's are being completed.

GEOLOGIC MAPPING IN THE JAMESTOWN AREA
Some Highlights

by Bob Biek

Geological fieldwork is a hunt for meaning. Rocks, minerals, fossils, and structures are just intermediate steps, missing links that must be identified before ignorance gives way to understanding. J. W. Harrington, Dance of the Continents.

The "meaning" referred to by J. W. Harrington is an understanding of a region's geology - an appreciation of the natural features that define its landscape, of its immense geologic history, of its inherent geologic resources and hazards. More and more geologists are confined to the office, but for those of us fortunate to work outdoors, Harrington's message rings loud and clear, and nowhere clearer than for those engaged in geologic mapping. In order to create a geologic map of an area, one must search for clues - rocks, sediments, fossils, landforms, and structures - that together provide the information necessary to create such a map.

A geologic map is the principal tool geologists use to convey information about the structure and stratigraphy of the earth's surface, the location and type of geologic hazards such as landslides and faults, and of resources such as sand and gravel, cement rock, and ore deposits. A geological map is to a geologist what the periodic table of the elements is to a chemist, a blueprint is to an architect, a master plan is to a city commissioner. It is a tool that can be used in many ways - from learning about the geologic history of an area, to providing information necessary for intelligent planning and growth - and indeed is as useful for its descriptive as well as predictive nature.

Many foresighted states have recognized that geologic maps are an essential element of city and regional planning, and have so developed programs to make such maps available. Typically, these programs are born of a string of natural disasters or poorly planned development in rapidly growing areas - Washington, with its Growth Management Act of 1990; California's Alquist-Priolo Special Studies Zones Act of 1972; and Utah's program to identify hazards associated with the Wasatch front urban corridor come immediately to mind. In each instance, and many others around the country, the goal is to incorporate earth science information into local and regional land use planning. The incentives for such efforts are avoidance of future costs inevitably found where development proceeds without adequate regard to geologic hazards, and where such development literally paves over critically needed resources such as sand and gravel, limestone, and other construction or industrial minerals.

North Dakota has no such statewide planning program, but certain areas of the State are growing rapidly. Recognizing the need for up-to-date, detailed geologic information, the NDGS recently initiated a new effort at producing detailed geologic maps of the State's major urban, recreational, and other critical areas. While the entire State has been mapped at a reconnaissance scale, and more detailed maps exist for selected areas, basic, detailed geologic maps are lacking for many of the State's fastest growing and most visited areas.

The first maps of this new effort - of the Jamestown, Bloom, and Spiritwood Lake quadrangles - are available in Open-File format, and our cartographers are currently working on preparing full-color geologic maps. The maps display four elements of the surface geology: sediment type, morphology, age, and origin. The maps emphasize sediment and rock types that directly underlie the soil horizon, and so complement existing soil maps. The mapping was made possible in part by a U. S. Geological Survey STATEMAP grant. What follows are some highlights of this region's geology; for a more complete account, please ask for NDGS Open-File Report 94-1.

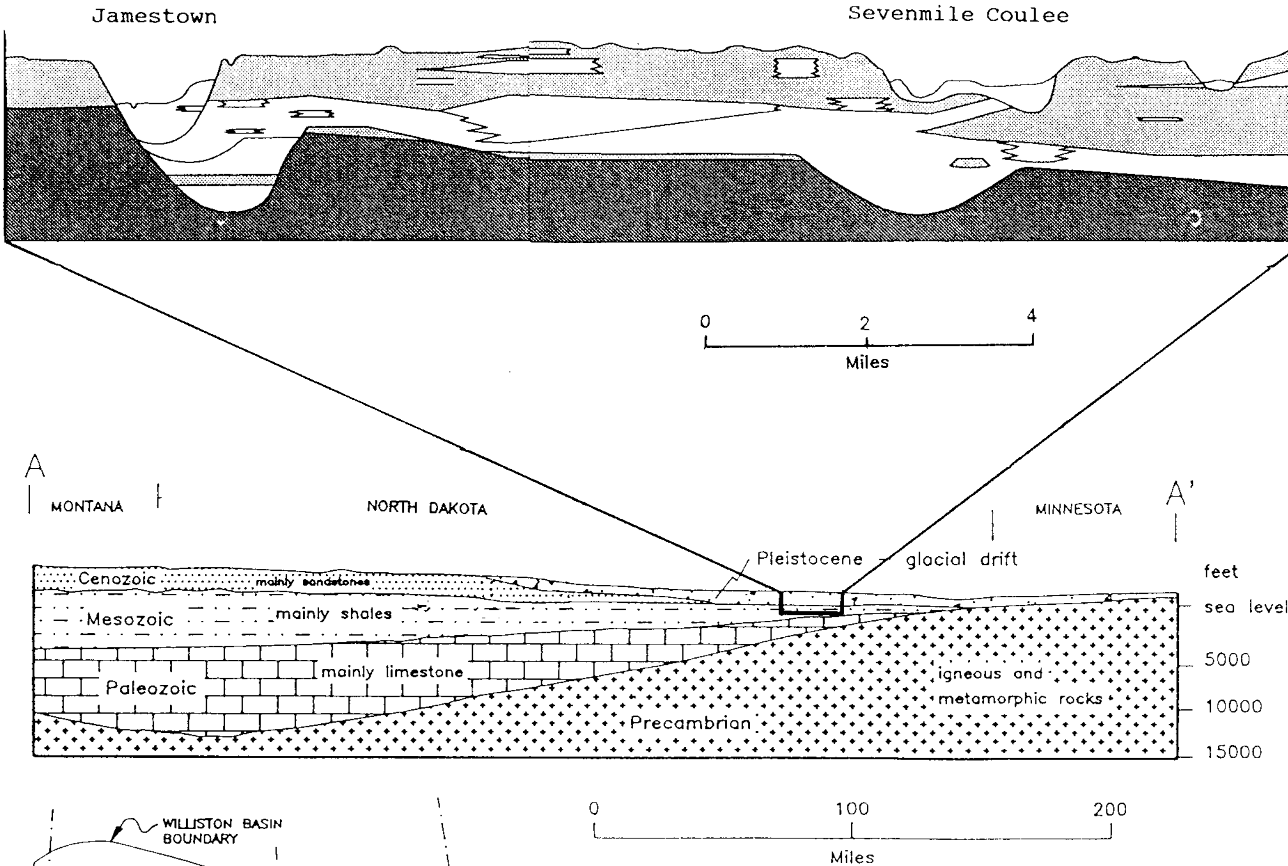
Bedrock Foundation

Jamestown, and the rest of eastern North Dakota, lies on the edge of the Williston Basin, a large bowl-shaped depression filled to the brim with sedimentary rocks (Figure 1). Underneath Jamestown this sequence of sedimentary rocks is about 3,500 feet thick; at the basin's center, in western North Dakota, it is over 14,000 feet thick. The Pierre Formation is the only bedrock unit exposed at the surface in the greater Jamestown area, and then only at the bottom of steep-walled valleys.

The Pierre Formation is a sequence of mostly gray shale that was deposited in an offshore marine environment during Cretaceous time, about 70 to 80 million years ago. It is up to 2,300 feet thick, but in the Jamestown area it is only about 500 feet thick due to deposition near the basin's margin and subsequent erosion. The Pierre Formation is divided into five members, each sufficiently distinct that they can be traced over a wide area of the northern plains. In ascending order, these are the Gammon Ferruginous, Pembina, Gregory, DeGrey, and Odanah Members. Although no detailed stratigraphic studies were undertaken, exposures in the Jamestown area seem best to fit the description of the DeGrey Member.

The Pierre Formation is exposed along the shores of the Jamestown Reservoir and Pipestem Lake, and for a short distance south of these two reservoirs; smaller exposures can be found in the Spiritwood Lake area. Some of the best and most easily accessible exposures are located in the Stutsman County Recreation Area along the northwestern side of the "island" in T140N R64W Section 13. Most bedrock exposures, however, are restricted to wave-cut banks only a few feet high, or to isolated exposures farther upslope that crop out through a colluvial cover.

The Pierre Formation here consists of light gray, fissile, flaky, noncalcareous shale. The shale is highly jointed, with black iron-manganese stains common on joint surfaces. Concretions are common and occur along selected horizons. Most are oblate in shape and about one foot in diameter. The most conspicuous feature of these concretions is their weathered rind of brown to brownish



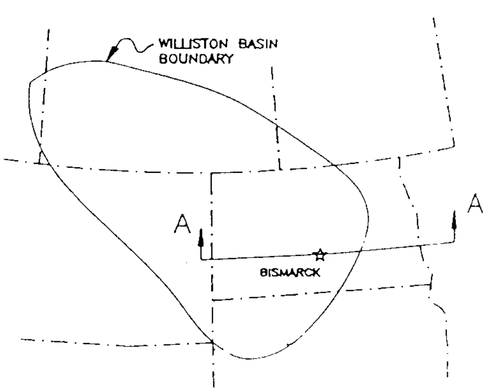


Figure 1. *Schematic cross-section through North Dakota showing how rocks of the Williston Basin thicken in the western part of the state. Enlargement shows cross-section parallel to I-94 through the Jamestown and Bloom quadrangles. Uncolored areas are mostly sand and gravel overlain by glacial sediment (light gray). Note the deeply buried channels cut into Pierre Formation bedrock (dark gray).*

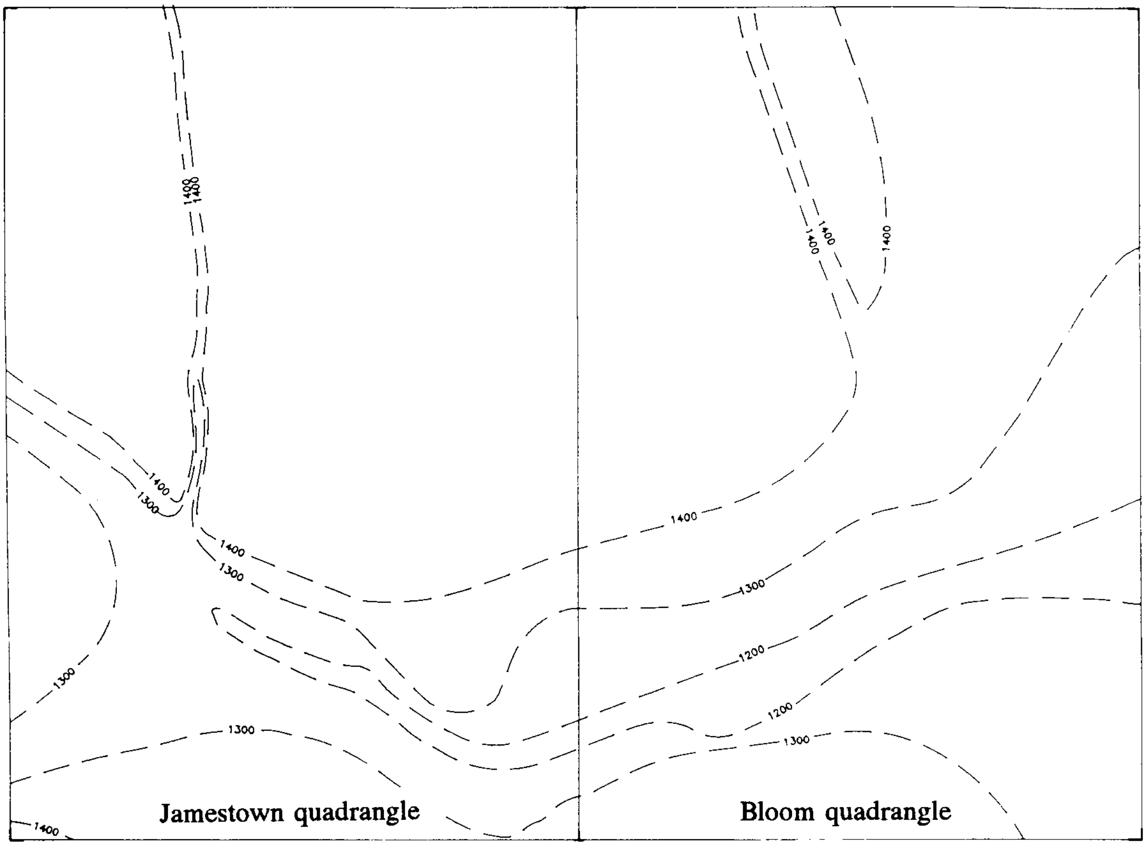
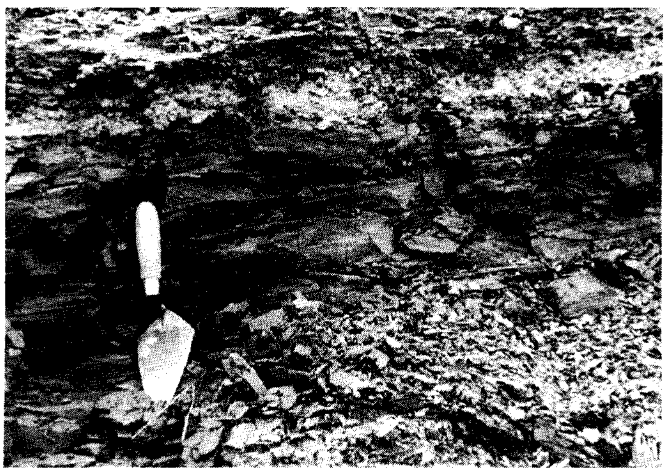


Figure 2 (below left). *Pierre Formation shale with a 2-inch-thick fuller's earth ("bentonite") bed just above the trowel handle.*

Figure 3 (left). *Topographic map of the bedrock surface in the Jamestown and Bloom quadrangles. The Stutsman diversion channel trends east through the lower portion of the two quadrangles. Note the narrow channels, now occupied by the underfit James River and Sevenmile Coulee, cut into the bedrock surface.*

black iron-manganese oxides. The interiors of the concretions are normally light gray micrite (fine-grained limestone) or a similarly colored mudstone. They are harder than the enclosing shale, but like the shale are also jointed, and so tend to form broken piles when weathered. Fragments of *Baculites* sp., an uncoiled or rocket shaped ammonite distantly related to modern squids, were found in some concretions. Elsewhere in the Pierre Formation in North Dakota, fossil shark teeth, crabs, snails, sea urchins, and ammonites have been found, as have fossils of mosasaurs and plesiosaurs, two marine reptiles.



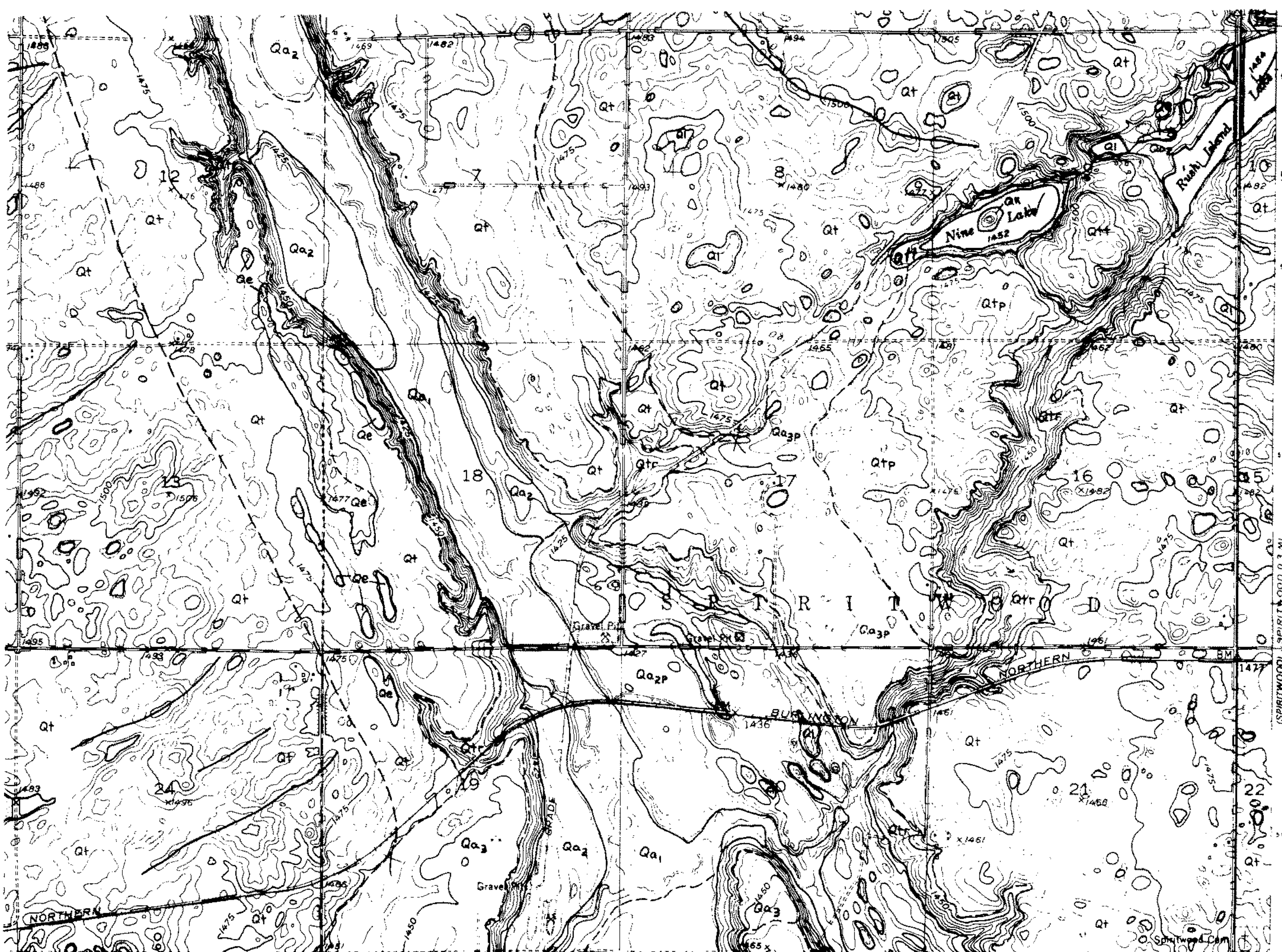
The Pierre Formation, particularly the Pembina Member, is also known for its fuller's earth beds. Fuller's earth is a non-swelling, highly absorbent clay used in the purification of mineral and vegetable oils. Two, thin, yellowish gray fuller's earth beds were found in the Jamestown area (Figure 2). The fuller's earth (often called bentonite) beds of the Pierre Formation probably resulted from the in-place alteration of volcanic ash whose source was to the west in the ancestral Rocky Mountains. Similar beds in the Pierre Formation in southern Manitoba have been mined.

Though mostly concealed by a gently undulating till plain, the surface of the Pierre Formation is anything but flat. If one were to remove all the sediments overlying the Pierre Formation in the Jamestown and Bloom quadrangles, a valley much deeper than the modern James River Valley would be revealed (Figure 3). This valley, a tributary to the still larger Spiritwood channel that underlies the eastern half of the Bloom quadrangle, formed when the ancestral Cannonball and Knife Rivers were diverted to the southeast by advancing ice. It is within these diversion channels where the region's best groundwater reserves are to be found.

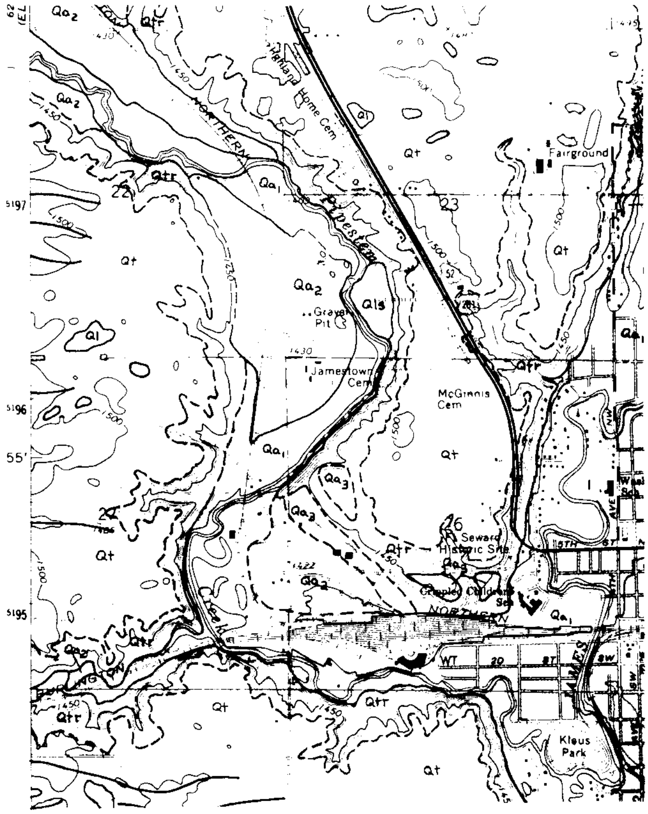
Overlying the Pierre Formation is a sequence of glacial and postglacial sediments that record a complex though incomplete history of ice advances and channel formation. Figure 4 shows the depositional environments and relative ages of these sediments in the Jamestown - Spiritwood lake area. By far the most widespread unit is undisturbed glacial sediment - till that has not been significantly modified by glacial thrusting or subsequent erosion. It consists of unsorted, unbedded, pebbly sand, silt, and clay with abundant cobbles and boulders. The following sketches serve to illustrate this and other Quaternary units. A brief summary of geologic hazards is also given.

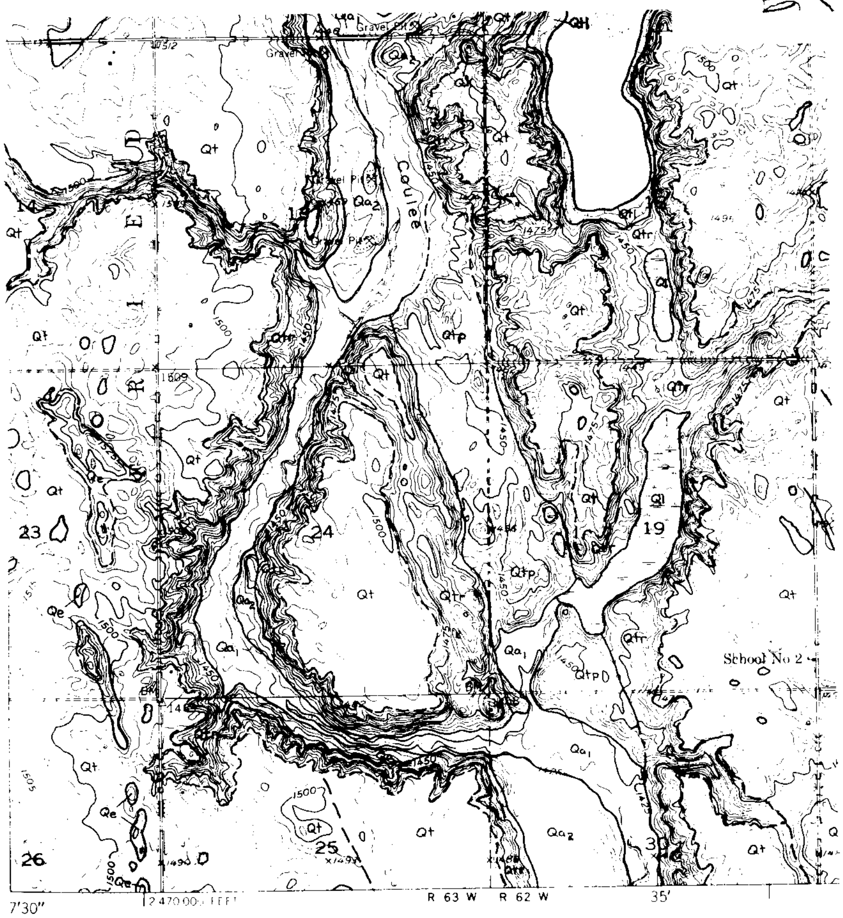
Sevenmile Coulee

Sevenmile Coulee (see map below) is thought to have formed catastrophically as a result of sudden, rapid drainage of one or more upstream pro-glacial lakes. Such outbursts typically form relatively straight, steep-walled channels, often with a well-defined outer zone. It was the outer zone (shown here by a dashed line parallel to the main channel) that contained flow before the main channel was eroded. This outer zone has been scoured flat compared to adjacent areas; narrow, northeast-trending ridges (washboard moraines) have been truncated and closed depressions or potholes, commmon outside the zone, have been obliterated. A discontinuous veneer of sand and gravel is found throughout the outer zone.



Southeast of Rush Island Lake, till of the Kensal end moraine partially obstructs a pre-existing meltwater channel. Rush Island Lake lies in a depression formed when the hill immediately to its southwest (mapped as ice-thrust till, Qtt) was thrust into place; the two form a classic hill-hole pair as described by State Geologist John Bluemle (see *NDGS Newsletter*, v. 19, no. 2, Winter 1992). That the thrust feature is associated with a partially overridden channel and an esker (the small hills of sand and gravel immediately northeast of the lake, Qe), suggests that high pore water pressures may have facilitated thrusting. Nearby Nine Lake may have formed in the depression left by a melting block of ice. The hill at the center of Nine Lake (a kame, Qk) is composed of poorly sorted sand and gravel, and likely formed when sediments melting out of the ice collected in a central depression. South of Nine Lake, a veneer of Kensal till (Qtp) overlies older fluvial deposits. The original extent and shape of the buried channel is still apparent, hence the subscript "p" for "palimpsest," meaning to partly conceal.





Obstructed Channel

In the Spiritwood Lake quadrangle, the most recent ice advance (the Kensal advance, about 11,000 years old) came from the northeast and blocked a portion of Sevenmile Coulee (see illustration at left). Glacial sediment (till) from the Kensal advance now partially conceals the original channel and has been mapped as Qtp, palimpsest glacial sediment. As meltwater was forced around the ice dam, it scoured the till plain immediately west of the blocked channel (mapped as Qtr, river-eroded till), but eventually abandoned that route and eroded a narrow, steep-walled channel farther west. The narrow, rocky, uncultivated ridge just west of the coulee is part of an esker (Qe) that trends for at least 8 miles through the Bloom quadrangle. Eskers are sand and gravel deposits formed by rivers flowing on, within, or under glacial ice.

Terraces and Landslides

Like Sevenmile Coulee, the steep-walled valley now occupied by Pipestem Creek (see illustration at left) is thought to have formed by one or more great floods of glacial meltwater at the close of the Ice Age. Terraces within this channel (mapped as Qa_2) have provided much of the sand and gravel for construction projects in the Jamestown area. Higher level terraces (Qa_3) are also found in this valley. The valley walls themselves have been mapped as river-eroded till (Qtr), as a veneer of river, colluvial, and slopewash sediment is commonly present. In the southwestern corner of Section 23, a large landslide (Qls) is present. It formed at the outside bend of a meander (possibly in response to erosion at the river's edge and consequent undermining of the adjacent slope) and blocked and diverted Pipestem Creek. Old aerial photographs show that it once had a hummocky surface typical of landslides, although it has now been extensively reshaped by excavation and placement of fill. Many smaller landslides formed during the summer of 1993 were also mapped along the Pipestem Creek and James River valley walls.

The sketches above outline the geology of three areas - one each in the Jamestown, Bloom, and Spiritwood Lake quadrangles - and show some of the sediments and landforms that make them interesting. It is these features - the sediments, rocks, landforms, and the relationships among them - that a geologist strives to understand and portray on a geologic map. Such maps are useful not only for the insight they provide into the geologic history of an area, useful that is to satisfy a geologist's insatiable curiosity. Geologic maps also show information that directly impacts society, such as the location and type of geologic hazards and mineral resources, and so should form a fundamental layer in any land use management or planning document.

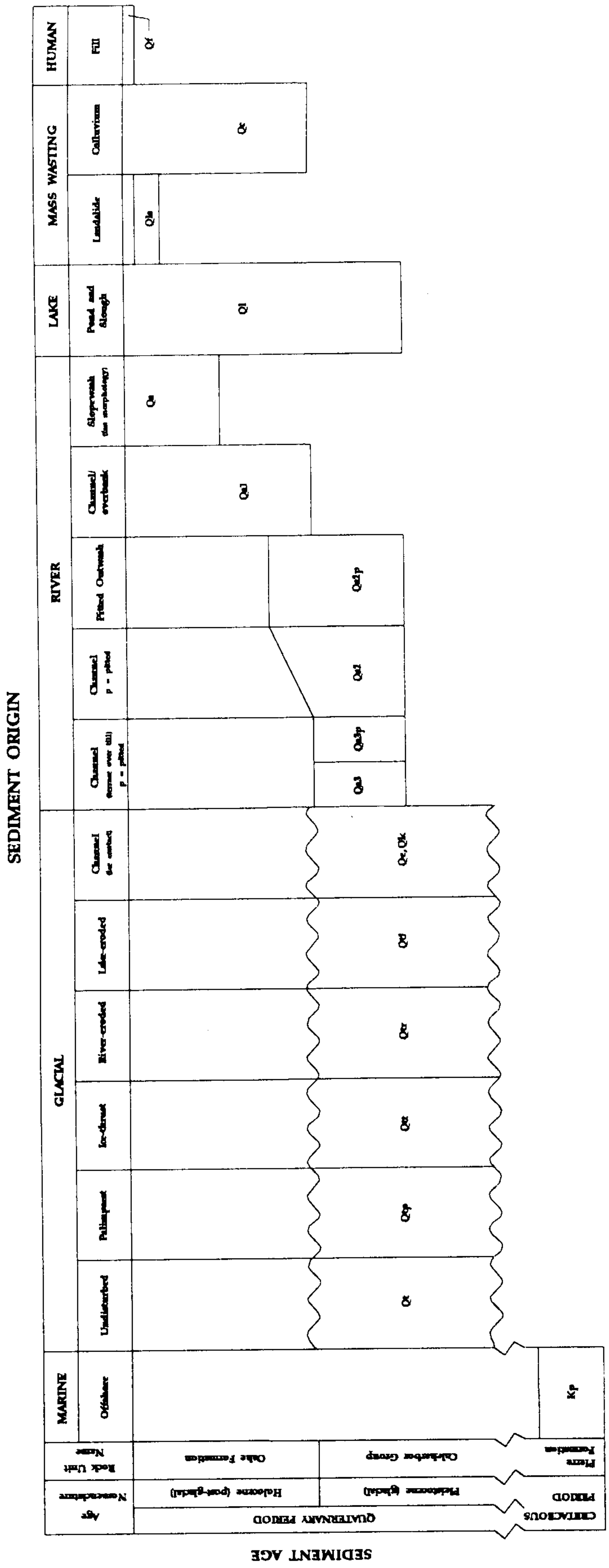


Figure 4. *Correlation diagram of map units in the Jamestown, Bloom, and Spiritwood Lake quadrangles.*

Geologic Hazards in the Jamestown Area

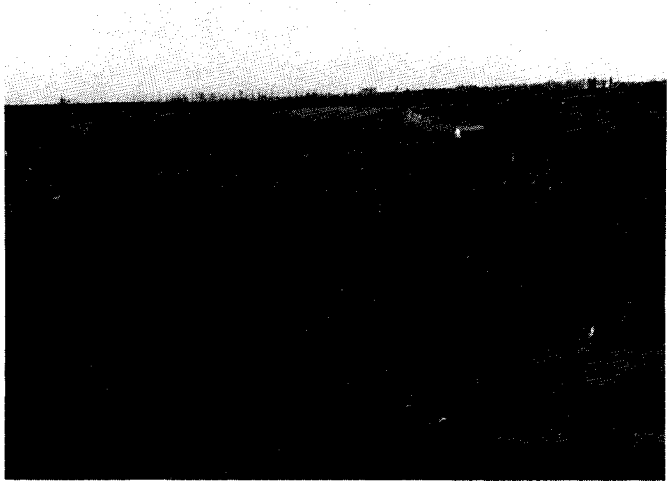
Geologic hazards in the greater Jamestown area are generally confined to landslides, shoreline erosion, flooding, and abandoned sand and gravel pits; it is not known whether radon is a problem. A 1993 EPA report indicates that areas overlying shale of the Pierre Formation, and glacial deposits derived from this shale, are highly susceptible to indoor radon problems. The shale content of tills in this area ranges from uniformly low to very high and the distribution of these units may be useful in evaluating the potential for radon problems (see OFR 94-1 for a generalized map of till distribution). Swelling soils and reactive aggregates in concrete (rocks and minerals that react with Portland cement and cause cracking and accelerated aging of concrete structures) are also widespread problems throughout the Great Plains.

Landslides alone caused significant damage in the Jamestown area during the summer of 1993. Most were relatively small slumps that occurred where slopes were undercut or steepened by improperly placed fill. Because much new construction in the greater Jamestown area is taking place on and near steep valley walls, the potential for additional landslide damage is increasing. Property damage can also result from soil creep, a process wherein the soil horizon creeps slowly downhill under the influence of gravity. Soil creep is apparent as shallow, concentric scars on valley walls, and is especially common where the Pierre Formation bedrock is close to the surface. Geologic maps can and should be used to delineate zones susceptible to landslides, and provide the basis for formulating regulations to govern development in such areas.

Abandoned sand and gravel pits represent a potential hazard not so much from their often steep sides, but from the fact that they are often used as dumps for bulky or other waste. Sand and gravel pits are often associated with important groundwater supplies, and any waste placed in such pits may affect groundwater quality.

The principal concern with shoreline erosion, aside from reservoir siltation and loss of shoreline property, is that it undercuts adjacent slopes, creating conditions favorable for landslides. Several landslides along the shores of the Jamestown Reservoir can be linked to shoreline erosion, (see cover photo).

Undercutting and oversteepening of slopes is an important factor in the development of many landslides.



These shallow concentric scars result from soil creep and indicate an unstable soil horizon.

Abandoned sand and gravel pits often become sites for bulky waste disposal, a poor end use given proximity to groundwater supplies.

Recent GIS Activities

by Rod Bassler

Geographic
Information
Systems
Center

Our geographic information system activities continue to expand and grow with every month that passes. Projects have varied widely, ranging from in-house mapping, to our own database development, to inter-agency data processing and manipulation. Our UNIX workstations are at times working around the clock and space on the computers can be quite precious at times, but we are gradually getting our Arc/INFO databases built up to the point where we can now move much faster on projects. (The GIS center has 2 UNIX based Data General Aviion workstations running ESRI's Arc/INFO GIS software. In addition, the lab also has a 66 MHz personal computer with PC Arc/INFO attached to our Altek digitizer.)

Geologic Mapping

We are nearing the completion of the conversion of our 1:500000 scale state geologic map to an electronic form. Most of the linework has been input into our Arc/INFO GIS, and all that remains are quality control checks of linework and attributing before a new map can be compiled. This map should be completed sometime this fall.

Another series of geologic maps are concurrently in production. These maps of the Jamestown, Bloom, and Spiritwood Lake quadrangles have been compiled at a scale of 1:24000 and cover approximately 160 square miles of the Jamestown vicinity. The geologic information for these quadrangles has been electronically input into Arc/INFO and is ready for compilation into final maps. The first map from the series, the Jamestown quadrangle, has been completed, and is in the final stages of review. This quad was completed first due to the availability of 1:24000 scale base map data and makes a very nice contribution to our growing collection of GIS maps. We are not so fortunate in the case of the Bloom and Spiritwood Lake quads. The base data for these maps are not available at the 1:24000 scale from the USGS and we are exploring other ways to create the digital base information that we need.

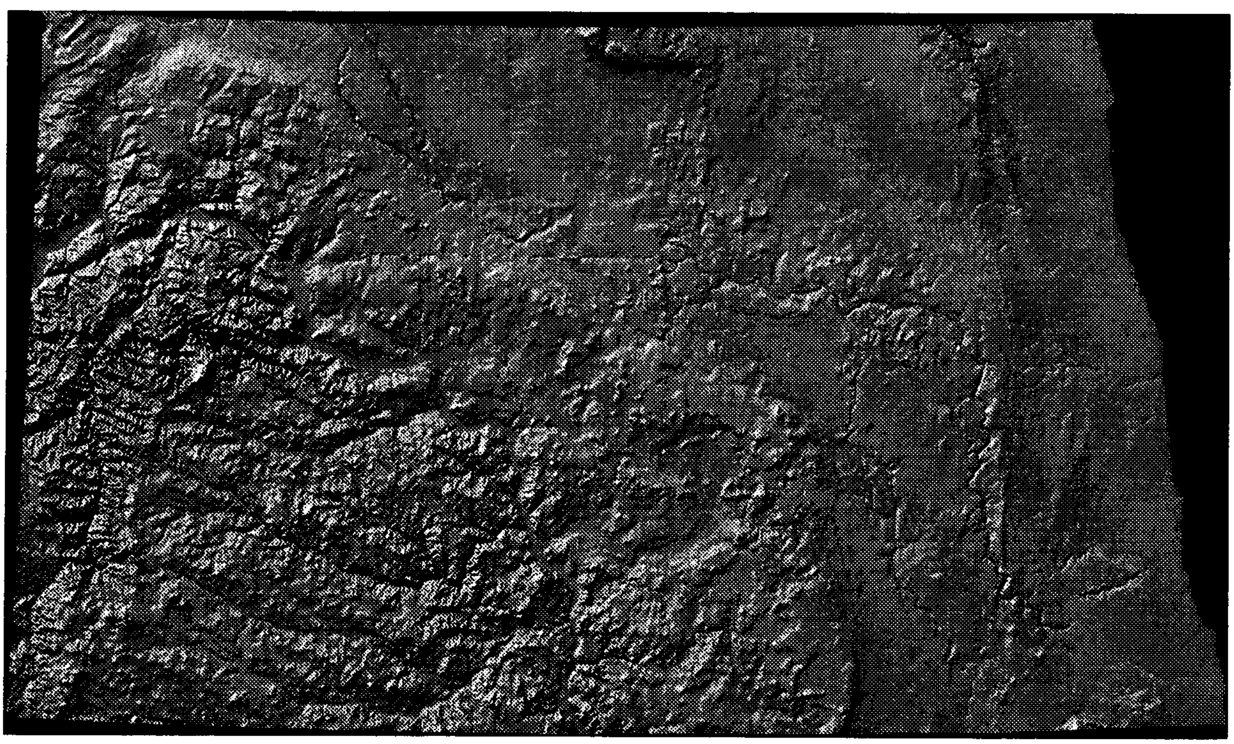
DLG Development for the State

As any cartographer knows, a good quality map requires close attention to detail and many different forms of data for even the simplest of representations. One of the most difficult aspects of cartography can be the collection of the base information that most people take for granted on maps, such as roads or hydrology. The Survey is a depository for all United States Geological Survey (USGS) electronic data, but until recently, we had very little of this information compiled into Arc/INFO coverages and therefore they were not immediately available for map production or GIS modeling. In order to benefit from this excellent source of data, we have undertaken the task of converting the USGS's Digital Line Graph (DLG) database to Arc/INFO GIS coverages for the state at a scale of 1:100000. The procedures for conversion of the hundreds of data files are long and tedious if applied on a file by file basis, but most of the computer processing has been automated and is being run continuously during the workday.

The data available at this scale completely covers North Dakota and is quite appropriate for many of the mapping tasks that we tackle here at the Survey. The DLGs are highly detailed and allow us to put cartographic products together in much less time than was previously needed. The DLG's that we have already converted to Arc/INFO coverages include roads, railroads, and miscellaneous transportation (including pipelines, power lines, airports, etc.). All of these coverages have been cleaned and are attributed with all available USGS attributes. We are currently working on the hydrology coverage and will probably complete it by the end of August.

Once these data sets are completed we can easily mix and match the features that we would like to portray on a map. The roads coverage can be easily manipulated to display primary highways in one particular line type or color, while the secondary roads or trails can be displayed in another line type or color. In another case, only interstate highways might be shown. The hydrology coverage will have the same capabilities. Attributes distinguishing perennial versus intermittent streams will allow us to use different line styles to portray each, or possibly exclude one or the other from the map.

Because these DLG Arc/INFO coverages have been fully attributed and input into our system, we can clip out the areas that we need to use on any particular mapping or modeling project. Even without the hydrology for the state completed, we are seeing the value of having these data sets available as we have already produced maps in less than half the time it would have normally taken. We are also avoiding the possibility of having to reprocess the same raw DLG files for future projects, as once we are completed with this DLG conversion, we will only need to copy the required base data from the master coverages. All of the DLGs are being processed using standard cartographic and GIS procedures and will eventually reside on our computers in a permanent electronic GIS library.



Preliminary version of a digital shaded relief portrayal of North Dakota.

Shaded Relief of North Dakota

The GIS center is also working on a shaded relief portrayal of the state of North Dakota which should be completed late this fall. Although the map resembles a satellite picture of the state, it is actually a computer model of the state's terrain. The model was created using our Arc/INFO software and Defense Mapping Agency Digital Elevation Models or DEMs (complete description in Winter, 1992 *NDGS Newsletter*). A DEM is a grid of points that have an elevation tagged to each point as an attribute. These data are available for the whole state at a scale of 1:250000. The digital elevation model for North Dakota amounts to roughly 34 million data points, one point at every 3 arc-seconds (or about 200 ft). Once we had this data input into our system, we created the shaded relief portrayal using Arc/INFO. This software displays the surface topography by simulating the Sun's rays to create shadowing effects, thus creating a pseudo three dimensional effect. The resultant map shows a stark, albeit intriguing surface that accentuates most of North Dakota's physiographic features.

The most appealing application that will eventually come from the development of this DEM data is a series of maps that can be overlaid on the shaded relief map. Geology or soils maps could be draped over the map to aid in future mapping or to provide a regional perspective. Many glacial features, too large to be seen from the ground or from the air, but too insignificant to be seen from a satellite, could be highlighted or exaggerated and might help in the study of specific sites.

The draping of themes over our surface model is the simplest of scenarios for future maps. Since DEMs are models of surface terrain, we can use them for modeling stream basins, predicting water inundation for new reservoirs, or for estimates of volumetric measurements such as what would be used for a cut and fill operation The modeling capabilities of our GIS are greatly enhanced by having this DEM data.

Inter-Agency Cooperative Efforts

In addition to our in-house mapping and modeling projects, we are also working cooperatively with several other agencies to collect, manipulate, and display various data that are ideally suited to GIS operations. They not only include standard geologic mapping projects, but also grasshopper studies, wetland delineation studies, and most recently, mapping of potential corn plant sites.

The North Dakota Department of Agricultural recently asked us to quickly produce maps indicating the locations of cities that are currently vying for a new multi-million dollar corn processing plant to be located in the upper midwest. The GIS center was asked to provide maps showing a one-hundred mile radius around each of the North Dakota, South Dakota, and Minnesota cities that are competing for the plant. Major highways, railroads, various cities, and affected counties were also included on the maps. Completion of the maps took roughly one week. This included the collection of the raw source data, compilation into draft maps, editorial review, and final production of four different maps.

Another ongoing project involves an effort to map the geology of a large portion of the upper Red River Valley in both North Dakota and Minnesota. In a cooperative effort with the Minnesota Geological Survey, we are currently compiling a quaternary geologic map at a scale of 1:250000 and should have it completed some time this fall. The first draft has been completed and we are currently waiting for editorial review by NDGS and MGS scientists for the final decisions that need to be made.

The most time consuming task that we are currently working with is modification of National Wetlands Inventory coverages for all of the area east and north of the Missouri River. This project is a joint effort between the U.S. Fish and Wildlife Service and the NDGS to modify the NWI data sets by simplifying the wetland classification system from the Cowardin Classification to the Stewart and Kantrud Classification. The project itself is being sponsored by the U.S. Environmental Protection Agency and is scheduled for completion this fall.

We have a full agenda for our small staff in the GIS center. As the demand for digital cartographic data and products continues to grow, hopefully we will continue to expand our resources in terms of staff, computing capabilities, and data storage, in order to accommodate this growth. Our current capabilities are taxed, however we will continue to work with other agencies in ways that will increase efficiency, reduce costs, and benefit the state.

The Citizens' Guide to Geologic Hazards

A guide to understanding geologic hazards — including asbestos, radon, swelling soils, earthquakes, volcanoes, landslides, subsidence, floods and coastal hazards

Prepared by
The American Institute of Professional Geologists

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Order from A.I.P.G. 7828 Vance Drive, Suite 103, Arvada, CO 80003, Phone (303) 431-0831. Sets of 35 mm slides of photos and line drawings of hazards depicted in this book are available.

If you have ever wondered about the actual dangers of landslides, floods, radon, earthquakes, and other geologic hazards that are mentioned but not very well explained in the news, then this book is for you. The book was written and lavishly illustrated for non-scientists, especially planners, contractors, homeowners, elected officials, insurance underwriters, lenders and financiers, realtors, science teachers, and students. Many losses due to geologic hazards are preventable if present knowledge is applied by the public. This book provides an excellent and indeed captivating introduction to those hazards.

Through over 100 color photographs and illustrations, the reader is taken on a comprehensive tour of the hazards presented by earthquakes, volcanoes, landslides, subsidence, floods, coastal hazards, reactive minerals, and into an understanding of the controversies that surround the issues of radon gas and asbestos hazards. The reader is also introduced to geologists and their roles in preventing losses from geologic hazards, and finally to specific sources of help in the appendices. Each chapter is followed by an extensive list of references and videotapes.

<u>The Citizen's Guide to Geologic Hazards</u> was commissioned by the American Institute of Professional Geologists to give readers knowledge that will save lives and dollars. It can be ordered from the AIPG, 7828 Vance Drive, Suite 103, Arvada, CO 80003 (tel. 303-431-0831).

From the State Geologist, Cont.

activity in the state was a small gas field in the southwestern North Dakota.

Oil was finally discovered in Amerada Petroleum Corporation's No. 1 Clarence Iverson well in Williams County in 1951. One pint of free oil was recovered from the test tool in the Devonian Duperow Formation, although the well was later completed as a producer in the Silurian Interlake Formation. Amerada then drilled a 75-mile string of successes on the Nesson Anticline. The North Dakota Geological Survey saw a great increase in activities following the discovery of oil. Our first petroleum engineer was hired in 1953, the first core library was authorized shortly thereafter, and a sizeable increase in funding allowed the hiring of 15 additional staff. Branch offices to handle oil-well inspections were established in Bismarck and Williston.

There's a lot more to the history of the oil and gas industry in North Dakota, and that history becomes much more involved and detailed after the 1951 discovery, so I'll end this essay here. Although the North Dakota Geological Survey is no longer responsible for the direct regulation of oil and gas exploration and production, our geologists continue to advance the knowledge of North Dakota petroleum geology through programs in the subsurface studies of the Williston Basin.

NEW PUBLICATIONS

Biek, Robert F., 1994, *Geology of the Jamestown, Bloom, and Spiritwood Lake quadrangles, Stutsman County, North Dakota*: NDGS Open-File Report 94-1, 6 plates, 1:24,000, 62 p., $5.00.

Outside Publications/Presentations

Biek, Robert F., 1994, *Till Stratigraphy of the Jamestown - Spiritwood Lake area, Stutsman County, North Dakota*: American Quaternary Association, Program and Abstracts of the 13th biennial meeting, p. 62.

Burke, Randolph B., 1994, *Mississippian subaerial exposure surfaces within the Sherwood subinterval, Mission Canyon Formation, Lucky Mound Field, North Dakota*: AAPG 1994 Annual Convention, Official Program, vol. 3, p.112.

Burke, Randolph B., *Comparative analysis of Waulsortian carbonate buildups in core and outcrop from the Williston Basin*: Presentation to the SEPM Carbonate Research Group, 1994 Annual Meeting, Denver, June 14, 1994.

Heck, Thomas J., and LeFever, J. A., 1994, *Basin center gas in the Williston Basin*: AAPG 1994 Annual Convention, Official Program, vol. 3, p. 168.

Price, Leigh C., and LeFever, Julie, 1994, *Dysfunctionalism in the Williston Basin: the Bakken/mid-Madison petroleum system*: Bulletin of Canadian Petroleum Geology, vol. 42., no. 2, p. 187-218.

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