NEWSLETTER

D G S

Industrial Commission of North Dakota, North Dakota Geological Survey Vol. 21, No. 1, Spring 1994

The fantastically sculpted, horizontal layers of rock that comprise the North Dakota badlands belong primarily to a unit geologists call the Fort Union Group. These sedimentary rocks were deposited by ancient rivers flowing away from the rising Rocky Mountains, between 55 to 60 million years ago (during the Paleocene Epoch). The presence of lignite coal, fossilized tree stumps and leaves, and the fossils of crocodiles, turtles, and fresh water clams and snails indicate that the Paleocene climate was subtropical to warm temperate, decidedly warmer and wetter than the climate of today. The geology and natural history of the North Dakota badlands, as seen at Theodore Roosevelt National Park, is brought to light in a revised and expanded roadlog guidebook recently published by the Theodore Roosevelt Nature and History Association (see page 13). *Photo by Ed Murphy.*

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.

Your comments - and contributed articles, photographs, meeting announcements, and news items - are welcome. Correspondence, subscription requests, and address changes should be addressed to Editor, *NDGS Newsletter*, North Dakota Geological Survey, 600 E. Boulevard Ave., Bismarck, ND 58505-0840; (Tel. 701-224-4109).

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NEWSLETTER

NDGS

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WILLIAM A. McCLELLAN, Asst. State Geologist
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FROM THE STATE GEOLOGIST

by John P. Bluemle

Geologic Mapping and Economic Development in North Dakota

The staff of the North Dakota Geological Survey has, over the years, mapped the geology of the State in increasing detail. We have completed two phases of geologic mapping and just recently begun a third, much more detailed, phase. The first phase extended from the Survey's beginning in 1895 until about 1958. During most of that span, the NDGS staff consisted of one or two geologists who used existing field technology to map the surface geology of the entire State, nowhere in any great detail. That initial mapping, even though it was little more than a reconnaissance, resulted in the early discovery and development of clay, coal, and other resources and, in 1952, the discovery of oil.

Beginning in 1959, and continuing until 1992, the North Dakota Geological Survey, operating with a staff of between 10 and 15 geologists, worked at mapping the State in moderate detail, as part of a joint, N.D. Geological Survey / State Water Commission / U.S. Geological Survey county mapping program. As a result of this program, we increased our knowledge of the geology of the State many-fold, locating and evaluating additional resources and also identifying many of the environmental problems we are facing today. The mapping we did between 1959 and 1992 resulted in a geologic map of every county in the State of North Dakota. In addition, as part of this ongoing study, the State Water Commission compiled aquifer maps for every county in the State. Even though the county geologic maps reflect much greater detail than previously, they are still "reconnaissance" work, less detailed than planners, developers, and other users need in their work.

We have recently undertaken a new mapping program, one that will eventually result in our mapping much of the State in far greater detail (1:24,000 or 2.64 inches to a mile) than before. The immediate impetus for this program is the new National Mapping Program, passed by the U.S. Congress of 1992. At this scale, we will be able to identify new mineral deposits and define known deposits in much greater detail than is possible on our existing (1:125,000 scale or 0.50 inches to a mile) maps. State geological surveys are required to match, on an equal basis, federal funds awarded as part of the National Mapping Program. Last year we were awarded $23,998 through the program. Nationwide, 37 of 54 proposals were funded; the average state award was $31,974. As our initial effort under this program, NDGS geologist Robert Biek last summer mapped three 7.5 minute quadrangles, about 160 square miles, in the Jamestown area (the Jamestown, Bloom, and Spiritwood Lake quadrangles). These maps should be available by mid-summer. This year we have applied for mapping program funds to map in the Dickinson area. At least initially, our intent is to focus our mapping efforts on the State's major urban and recreational areas, as well as areas overlying important shallow aquifers.

North Dakota has a great potential for a variety of kinds of mineral resource production. However, we do not currently have an economic materials geologist on our staff. The last time we published a general appraisal of the known economic minerals in North Dakota was over 20 years ago (Landis, 1973). An important part of our detailed mapping program has got to be geared to dealing with a number of economic-minerals issues, which must be evaluated and/or re-evaluated in light of modern technology and economics. If we had an economic geologist, he or she would work closely with our surface mapping geologists and petroleum geologists to identify and develop potential economic mineral resources.

Just a few examples: over the years, exploration by private companies has occurred several times in eastern North Dakota for lead-zinc deposits. A number of cores have been taken in the eastern part of the State and in Minnesota, but we have never been able to evaluate the potential ourselves. A reconnaissance geochemical survey would be useful in evaluating the potential for lead-zinc production in the State. We also need to investigate the occurrence of iron and associated minerals known to occur in northeastern North Dakota. Magnetic, geochemical, and other surveys would help to determine the economic potential of these mineral resources. North Dakota even

has a potential to produce some exotic materials, such as diamonds; we need to evaluate this potential in detail.

Various kinds of economic studies should be undertaken. We need to make a major effort to sample and evaluate the surface sediment geochemistry. That, coupled with a coring and core analysis program to examine the Cretaceous, Jurassic, Ordovician, and Precambrian rocks, would define, or at least provide a framework for later detailed studies of the non-oil mineral potential of the State.

We also need to map the State's aggregate deposits (gravel and sand) in much greater detail. These materials are critical to the construction industry (Langer and Glanzman, 1993). Detailed knowledge of their occurrence would have additional benefits in the areas of environmental issues and hydrology (avoidance of groundwater contamination, etc.).

The United States Geological Survey did an economic analysis last year to determine the benefit-cost ratio of obtaining geologic map information (Bernknopf, et al., 1993). They noted that financial decisions that rely in part on geologic map information include issues related to environmental preservation, hazard mitigation, and mineral extraction. They went on to evaluate the value of geologic mapping in Loudoun County, Virginia, concentrating on only two specific issues: landfill siting and highway construction (they did not consider mineral extraction). The cost of producing a highly detailed geologic map of that county was $1.16 million. The gross benefit, just for two applications (siting a landfill and constructing a highway) amounted to a minimum of $2.44 million to a maximum of $4.66 million. Thus, the benefit-cost ratio, just for these two applications, was something between 2.1:1 and 4.0:1. As I said, no value was placed on new mineral value or on any other issue.

The economic return to the State of North Dakota, from an intensive geologic evaluation of our mineral resources alone, would be highly significant in terms of tax revenues and new jobs. A couple of years ago, I tried to calculate the value returned to the State for the money it spends on the Geological Survey. Although I soon learned it was virtually impossible to precisely determine benefit-cost ratios, it is safe to say that, for every dollar spent on the NDGS since its inception in 1895, the State has seen a return of at least 30 dollars. Most of the identifiable value has, over the past 30 years, been in additional petroleum discovered and/or produced, but other resources that are not now produced may also be economic.

Detailed geologic mapping will provide a wealth of data about the environment and give us the information we need to avoid a variety of environmental problems. An improved geologic map data base for North Dakota will result in enormous savings if properly applied to land-management decisions. I don't know whether all applications of improved geologic map information will yield positive net benefits. I do know though, that in regions that exhibit economic growth, improved geologic maps will be increasingly important for making decisions that relate to the revitalization of the Nation's infrastructure, for avoiding irreversible environmental impacts, and for mitigating effects of natural hazards.

I believe that our central natural resource concerns are providing adequate energy, mineral, and water supplies, developing the ability to dispose of wastes in an environmentally sound and effective way, and understanding earth processes in such a way as to reduce the impact of natural hazards. The fundamental solution to these central concerns is geological. More specifically, the solution lies in an ever more sophisticated delineation of the earth's surface through geologic mapping (Fisher, 1993). Geologic maps remain the context for most geologic analyses. North Dakota is wealthy in mineral resources; geologic mapping is necessary to locate and develop those resources in an economically, yet environmentally sound way. If ever there was a time for projects and programs to stimulate economic development, to create jobs, and to protect the environment, now is that time.

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Second Williston Basin Horizontal-Drilling Workshop
April 25-26, 1994
Minot, North Dakota

In the last Newsletter we announced the Second Williston Basin Horizontal-Drilling Workshop in Minot, ND on April 25-26, which we are cosponsoring with Saskatchewan Energy and Mines. The meeting will have one day of geology talks and poster discussion sections and another on engineering topics. The talks will cover subjects on both sides of the border, and displays will include cores, information sources, drilling techniques, reservoir evaluations, equipment, etc. Scheduled talks include:

North Dakota topics:

Lodgepole Waulsortian mounds; Reserves and potential of Madison horizons; Red River potential in Bowman Co.; Horizontal drilling in the Tyler sands of Stark Co.

Saskatchewan fields:

Manor Spearfish/Alida pool; Optimizing costs and limiting formation damage in the Weyburn Midale pool; Additional tba pool study.

Engineering:

Short radius re-entry drilling; Problem solving in re-entry drilling; Rosebank Alida pool case study results; 3D reservoir modeling of pore geometry and its application; Drilling opportunities in Manitoba.

The meeting is intended to be informal to maximize the opportunity to meet people and share information and experience. For more information contact Bill McClellan at 701-224-4109 or Ken Stalwick at 306-787-2571. ----- *Bill McClellan*

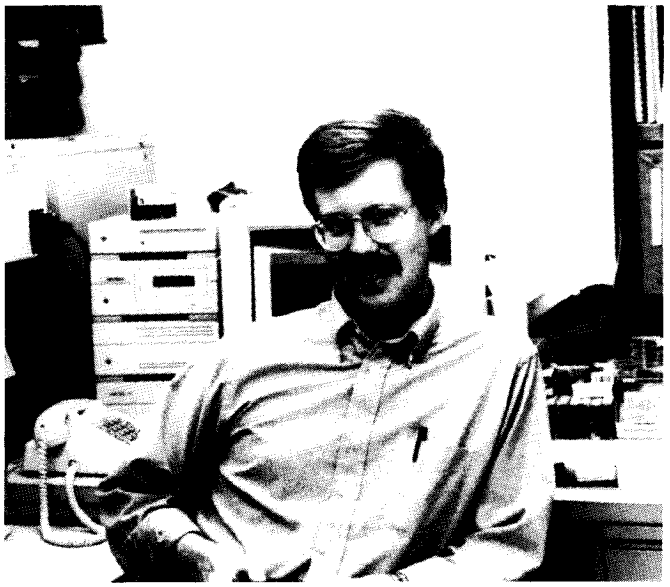
Conoco Lodgepole Cores

The first Lodgepole cores from the Conoco wells in Dickinson field are now off tight hole status and available for study in our Bismarck lab facility. There has been considerable interest in just what kind of depositional environment is present in the reservoir rocks of this prolific new field. If you don't have an opportunity to see them at the lab some of the cores will be on display at the horizontal-drilling workshop in Minot. They are very interesting cores.
----- *Bill McClellan*

Library Materials Donated to NDGS

Harris Brown & Klemer, Inc., the Bismarck-based geological consulting firm, recently donated a substantial collection of geological literature to the North Dakota Geological Survey library. Much of the literature deals with petroleum, coal, and other mineral resources of the Dakotas and Montana. The collection contains over 130 U.S. Geological Survey and U.S. Bureau of Mines publications, about 60 Canadian publications, and a large number of publications from the State Geological Surveys of South Dakota, Montana, and other states. Many geological textbooks were also donated. These materials constitute a significant addition to the library here at the NDGS. The Canadian publications will be especially valuable to researchers studying regional Devonian and Mississippian stratigraphy. We thank Harris Brown & Klemer for their generous contribution.

GIS Specialist Hired



Rod Bassler recently joined the North Dakota Geological Survey and is hard at work in our Geographic Information System (GIS) lab. As the Survey's GIS Analyst, Rod will be responsible for the day-to-day operation of our lab, building on progress made in the program to date. His duties will include automated mapping/map production, organization of digital data sets, continuation of ongoing GIS projects, cooperation with other agencies in a technical advisory role, and in-house GIS training.

Rod was born and raised in the village of Almond, Wisconsin, and received his B.S. degree in Geography from the University of Wisconsin-Stevens Point, where he had a dual emphasis in Cartography and Physical Geography and a minor in Earth Science. While there, he was the Cartographic Assistant to the Department of Geography/Geology and was involved with map production and management of the cartographic lab.

Rod comes to us from the University of Kansas where he is pursuing a Master's degree in Geography with an emphasis in Automated Cartography and GIS. While at the University of Kansas, Rod had a research assistantship with the Kansas Geological Survey where he began as a cartographer and GIS analyst with the Geohydrology Section. For the past two years, he worked for the Kansas Survey as a GIS consultant/database manager on a 5-year, multi-agency project on the Dakota Aquifer of western Kansas. Rod intends to finish his thesis sometime in the next six months.

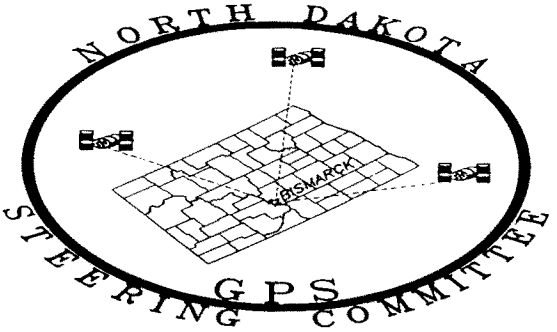
NORTH DAKOTA GEOLOGICAL SURVEY

CENTENNIAL LOGO CONTEST

In 1995, the North Dakota Geological Survey will celebrate its 100th anniversary. We are at work on a series of special publications to commorate the event, and will also plan other activities.

In order to commorate this historic occasion, the North Dakota Geological Survey is conducting a logo contest. The logo will be used on promotional material and publications. Rules of the contest are as follows:

Eligibility:	All persons are eligible to enter this contest, except members of the judging committee.
Prize:	Recognition for your effort!
Logo Entry Deadline:	May 2, 1994.
Logo Restrictions:	Logo can be up to 3 colors, must fit within a 4" x 4" area, and be designed for possible reduction and reproduction in black and white. The design must be submitted on 8½" x 11" paper, but does not need to be camera ready. All entries will become the property of the North Dakota Geological Survey.
Submit entries to (or for more information, contact):	John P. Bluemle, State Geologist North Dakota Geological Survey 600 E. Boulevard Avenue Bismarck, ND 58505-0840 (701) 224-4109



MEMORANDUM

TO: Parties interested in accessing the Global Positioning System (GPS) community-base station (CBS) located in Bismarck, ND.

FROM: Mark R. Luther, Chairman, North Dakota GPS Steering Committee

DATE: February 22, 1994

SUBJECT: Obtaining Bismarck GPS-CBS Data

A number of North Dakota state agencies*, one federal agency**, and Bismarck State College have cooperated to install a Global Positioning System (GPS) community-base station (CBS) at Bismarck State College. The Bismarck GPS-CBS consists of a Trimble 4000 System SSE geodetic-grade receiver, geodetic antenna, a 486 PC running OS/2, a modem, and Trimble Universal Reference Station (URS) software.

The GPS-CBS collects data from all visible satellites, and stores data in three formats: raw data files, DAT files, and SSF files. We also anticipate making RINEX files available later this spring. Separate files are created for each hour of operation. Current hours of operation are 7AM - 7PM Central time, although they can be extended with prior notification. Data will be kept on-line for two weeks, after which it will be archived on tape. Archived data will be kept for three months before being erased.

GPS-CBS **on-line** data can be obtained by two methods: by modem or by 3.5" diskette. Modem access is given to those who pay a yearly fee of $1350 per calendar year, and use a modem with a minimum transfer rate of 9600 baud. After payment of the yearly fee, users are given an account and password and can then obtain data 24 hours-a-day through the bulletin board capability of the URS software. For those preferring to obtain **on-line** GPS-CBS data on diskette, a fee of $15/day (1-12 hours on the same day), plus $3 shipping/handling will be assessed. All users requiring data **archived** on tape will receive that data on 3.5" diskette, and will be assessed a fee of $30/day (1-12 hours on the same day), plus $3 shipping/handling.

To receive Bismarck GPS-CBS data by either modem or diskette, contact: Mark Luther, North Dakota Geological Survey, 600 East Boulevard, Bismarck, ND 58505-0840 (Phone 701-224-4109). Payment of fees should be made by check or P.O. payable to the North Dakota Geological Survey.

While every attempt will be made to collect and store quality data during scheduled hours, neither the GPS Steering Committee nor the North Dakota Geological Survey assumes any responsibility or liability for the availability or quality of GPS-CBS data.

* ND Dept of Agriculture, NDIC ND Geological Survey, NDIC Oil and Gas Division, ND Dept of Health & Consolidated Labs, ND Dept of Transportation, ND State Water Commission

**US Geological Survey - WRD

Omars in North Dakota

By Bob Biek

While examining exposures of glacial sediment along the shores of Lake Sakakawea this past September (as part of our Quaternary Mapping Workshop fieldtrip), geologists from the Minnesota and South Dakota Geological Surveys pointed out a distinctive glacial erratic they knew by the name "omar." This particular type of erratic is a dark gray, fine-grained sandstone (graywacke) with characteristic calcareous concretions (Figure 1). As we walked along the windy, rocky shoreline, we saw several of them.

The curious thing about omars is that they *may* be derived from a particular formation exposed in the Belcher Islands of southeastern Hudson Bay. I was intrigued, but like every good mystery, the story is more complex than the first clues suggest. Indeed, the interpretation of omars - what the Canadians know as "dark erratics" - has been the subject of considerable controversy.

An erratic is a rock that differs in lithology from the bedrock underlying it. The glaciated portion of North Dakota is strewn with erratics from the Canadian shield and plains, and they alone are one of most compelling indications of long-vanished ice sheets. The glaciers brought a varied suite of igneous, metamorphic, and sedimentary rocks that would not otherwise be found in North Dakota - granite, schist, gneiss, greenstone, limestone, dolostone and many other rock types. Farmers know them all too well, having laborously piled them in the corners of their fields, or buried them, or used them for fences and foundations - anything to get rid of them.

Only a few rock types, however, are sufficiently distinct to enable one to trace them back to their source. Flint (1971), DiLabio (1989), Dyke et al. (1989), and Klassen (1989) list several types of erratics that have been traced back to their source hundreds of miles away. Erratics have also been used as exploration tools in the search for ore deposits. Copper mines were opened in Finland after tracing copper-bearing erratics back to their source, and Quebec gold mines were founded after an analysis of gold-bearing erratics in Maine. Such tracking of erratics is but one aspect of the broader science of sediment and provenance analysis that researchers use to determine the history and source area of glacial and other sediment.

The study of these and other erratics has been useful for reconstructing ice flow patterns and ice-sheet geometries, but such use of erratics is not without its problems. As Dyke et al. (1989, p. 179) note, "The main diffi-

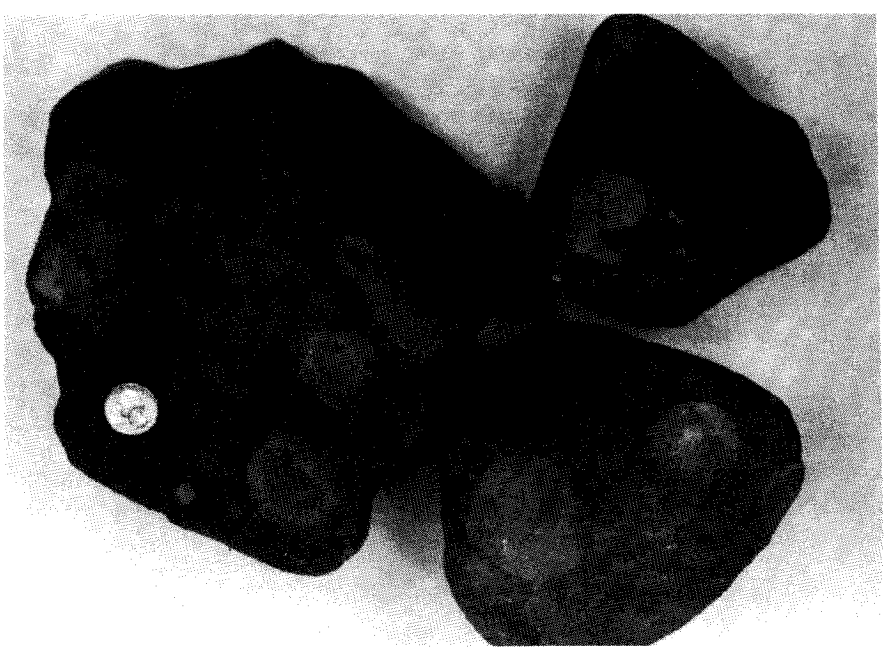


Figure 1. Typical "omars" with characteristic light-colored calcareous concretions. Because the concretions are more suceptible to weathering than the fine-grained sandstone host, they often appear as shallow pits in the rock's surface. The term "omar" is short for Omarolluk, the formation in southeastern Hudson Bay from which these stones may have been derived (see page 8).

NORTH DAKOTA GEOLOGICAL SURVEY

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John P. Bluemle
State Geologist
William A. McClellan
Asst. State Geologist

Dear Fellow Geoscientists:

In an effort to keep one another apprised of current geologic projects, and to stimulate interaction among geologic researchers in North Dakota, the North Dakota Geological Survey is requesting your cooperation in completing the form below. The form requests information about areas in North Dakota — and nearby areas of adjoining States and Provinces — being studied by geoscientists in your university or agency during 1993 and 1994.

All geoscientists should complete the form — industry, academic, and government professionals, as well as students. **Please circulate this form among your staff and/or colleagues for the required information and return by May 18, 1994.** Photocopies are acceptable. Additional copies of this form can be obtained at no charge.

Responses will be published in the *NDGS Newsletter*; special searches of the data base can be made by type of study, county, and researcher at no charge. The NDGS will solicit and publish this information on an annual basis as a summary of "Geologic Projects in North Dakota."

Please detach and return the completed form to:

North Dakota Geological Survey
600 E. Boulevard Avenue
Bismarck, ND 58505-0840

Attn: Robert F. Biek

Thanks for your cooperation,

John P. Bluemle
State Geologist

Please detach and return completed form

Investigator(s): _____

Organization(s): _____

Address: _____
City State Zip

County(ies) (refer to county codes): _____

Location of Study: _____

Type of Study (refer to study codes): _____

Title/Subject: _____

Scale of Geologic Mapping, if applicable: _____

Date of Inception: _____ Date of Completion: _____

Location of Information (i.e., University thesis; state or technical agency open-file report or publication; other publication; company, confidential - where, release date and provisions):

_____

May the NDGS have a copy of the completed report and/or map for our library: _____ Yes _____ No

County Codes

Adams	AD
Barnes	BA
Benson	BE
Billings	BI
Bottineau	BO
Bowman	BW
Burke	BU
Burleigh	BL
Cass	CA
Cavalier	CV
Dickey	DI
Divide	DV
Dunn	DU
Eddy	ED
Emmons	EM
Foster	FO
Golden Valley	GV
Grand Forks	GF
Grant	GR
Griggs	GG
Hettinger	HE
Kidder	KI
LaMoure	LM
Logan	LO
McHenry	MH
McIntosh	MI
McKenzie	MK
McLean	ML
Mercer	ME
Morton	MO
Mountrail	MR
Nelson	NE
Oliver	OL
Pembina	PE
Pierce	PI
Ramsey	RA
Ransom	RN
Renville	RE
Rickland	RI
Rolette	RO
Sargent	SA
Sheridan	SH
Sioux	SI
Slope	SL
Stark	SK
Steele	ST
Stutsman	SM
Towner	TO
Traill	TR
Walsh	WA
Ward	WD
Wells	WE
Williams	WI
Statewide	SW
Minnesota	MN
Montana	MT
South Dakota	SD
Manitoba	MB
Saskatchewan	SK

Type of Study Codes

Economic Geology:	
a. General	EC
b. Coal	CG
c. Nonfuel minerals	NF
d. Petroleum	PG
Engineering Geology	EG
Environmental Geology	EV
Geochemistry	GC
Geochronology	GR
Geologic Hazards	GH
Geologic Mapping	GM
Geomorphology	GO
Geophysics	GP
Hydrogeology	HG
Mineralogy	MN
Paleomagnetism	PM
Paleontology	PA
Palynology/Paleobotany	PY
Petrology	PT
Quaternary Geology	QG
Sedimentology	SD
Soils	SO
Stratigraphy	ST
Structural Geology/Tectonics	SG

culties arise where erratics may be recycled from older glacial deposits, where transport may have been accomplished by ice flow in more than one direction during a single glaciation, and where erratics might come from still unmapped rock formations." Omars present a classic example of these difficulties.

While "dark erratics" (omars) are most abundant in northwestern Ontario along the southwest coast of Hudson Bay (Dyke, et al., 1989, p. 185), omars have also been discovered in northern and southwestern Manitoba, central Saskatchewan, as far west as southern Alberta, and as far south as Leamington, Ontario (Dredge and Cowan, 1989). Dyke, et al. (1989) indicated that omars occur in North Dakota as well.

The controversy over omars is two-fold: 1) do they all come from one source, the Belcher Islands of southeastern Hudson Bay? and 2) if so, what constraints does that impose on ice sheet configurations? Based in part on the distribution of omars, conflicting models of ice-sheet development have been proposed for the Hudson Bay area. Some researchers believe that the wide distribution of omars requires sustained flow of ice across Hudson Bay from a center in Labrador throughout most of the last glacial stage. If this were the case, it would preclude an ice divide over the southern portion of Hudson Bay.

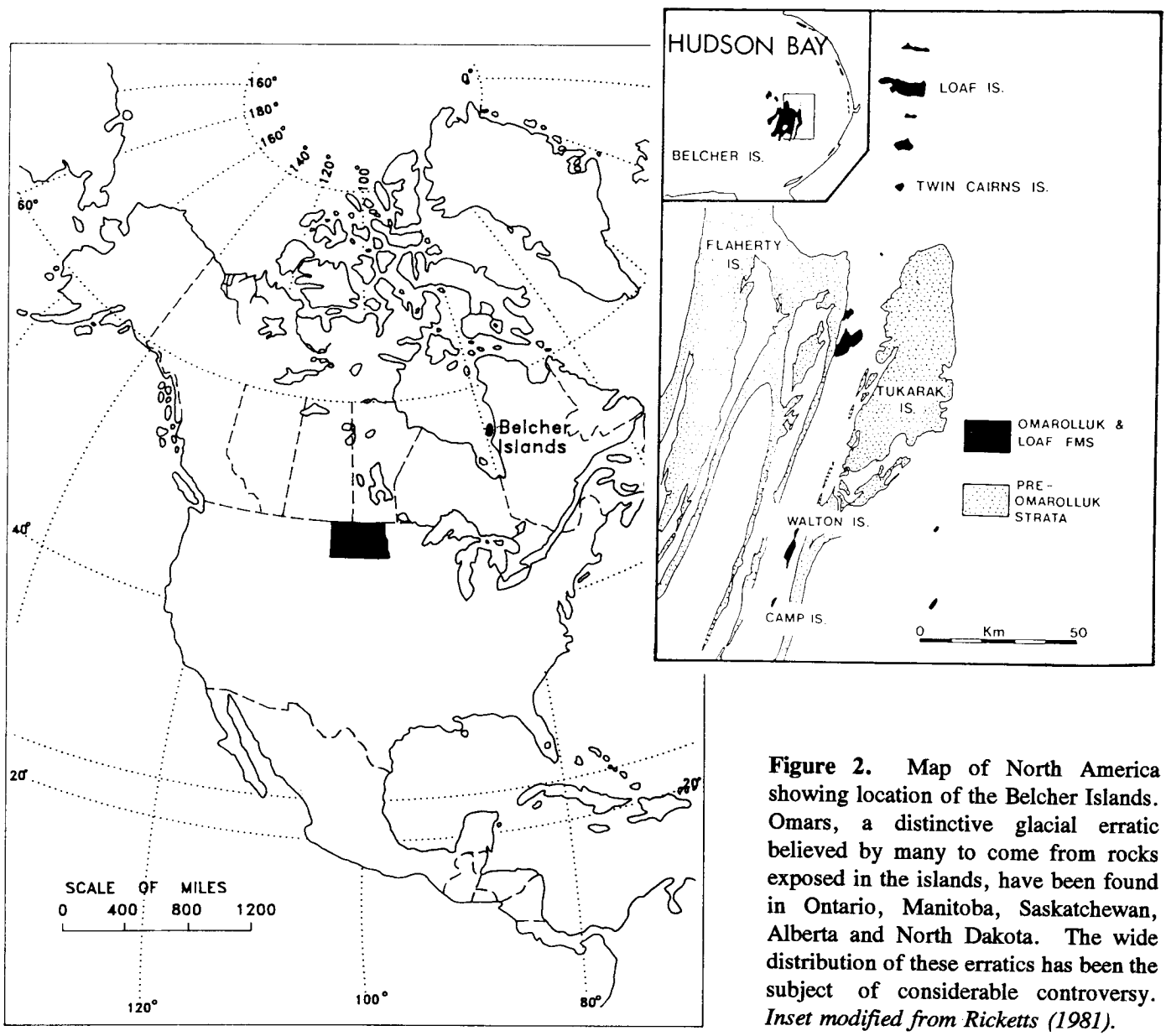

Figure 2. Map of North America showing location of the Belcher Islands. Omars, a distinctive glacial erratic believed by many to come from rocks exposed in the islands, have been found in Ontario, Manitoba, Saskatchewan, Alberta and North Dakota. The wide distribution of these erratics has been the subject of considerable controversy. *Inset modified from Ricketts (1981).*

Dredge and Cowan (1989) put forward three convincing arguements why the distribution of these graywackes cannot be used to argue against a Hudson Ice Divide, and in doing so nicely illustrate the omar problem. Their findings are summarized below:

1. There may be alternative source areas for the dark erratics, particularly those found to the north and west. Graywacke is exposed in northern Manitoba and is particularly abundant as erratics south of these exposures. In addition, unrecognized source areas may be present under Hudson Bay.

2. The dark erratics are likely polycyclic, since they occur in pre-Wisconsinian and all Wisconsinian tills of eastern origin. Stated alternately, either the dark erratics were recycled into younger tills or the source rocks were re-eroded during each glacial event. Both could be true, but polycyclicity is favored because the dark erratics are sometimes associated with other erratics of non-eastern provenance.

3. The distinctive concretionary graywackes may have initially been transported to the west by Labrador Ice and then redispersed by Hudson Ice as the Hudson Ice Divide developed.

Recently I returned to the wavecut exposures near Riverdale, with the intent of determining from which till or tills the omars were derived (the omars, and other erratics, weather out of the tills and form a shoreline lag deposit). Along about 2,000 feet of rocky shoreline, I saw about a dozen mostly cobble-size concretionary graywackes, and many more pebble-size graywackes lacking concretions. I did not see any concretionary graywackes in the till itself. Two pre-Wisconsinian tills (Medicine Hill Fm., aka "Deadman" till, and Horseshoe Valley Fm., aka "Mercer" till) and one Early Wisconsinian till (Snow School Fm., aka "Napoleon" till) are exposed along the shoreline, and it is obvious that the omars come from one or more of the tills. Just which is uncertain.

Given the information at hand, we cannot say for certain that the omars found near Riverdale came from the Belcher Islands of southeastern Hudson Bay. Other source areas may exist, perhaps in northern Manitoba. We also cannot say that they didn't.

The Omarolluk Formation

The following information is summarized from Ricketts (1981) and Ricketts and Donaldson (1981).

The Omarolluk Formation is exposed in the Belcher Islands of southeastern Hudson Bay. It is a 1.76 billion-year-old sedimentary sequence characterized by extremely regular, laterally extensive, tabularly bedded graywackes (poorly sorted sandstone with abundant feldspar grains and rock fragments) and shales. These rocks form a classic turbidite sequence, layer upon layer of sediments that were deposited by undersea density currents. The Omarolluk Formation represents a prograding submarine fan environment deposited in a setting similar to the modern day Nile Cone or Bengal Fan. These sediments were subject to only simple folding and low-grade metamorphism during the Hudsonian Orogeny, and so internal structures are well preserved.

Calcite concretions are common in the Omarolluk turbidite beds. They take on a variety of shapes depending on the sedimentary structures and permeability differences of the beds, ranging from highly irregular concretions that mimic convoluted bedding, to more nearly spherical concretions that formed in massive graywacke beds where growth was unconstrained by primary sedimentary structures or fabrics. Convergence of laminae outside the concretions suggests that growth of the concretions took place in relatively unconsolidated sediment.

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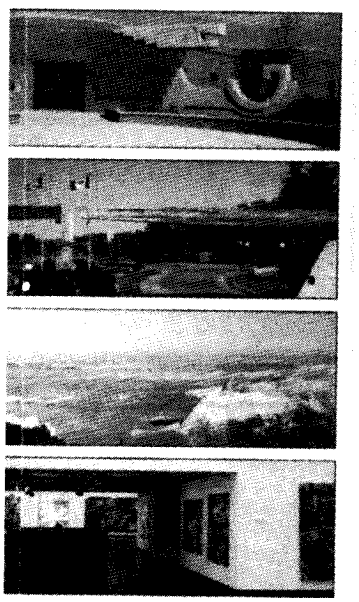
EARTH SCIENCE EDUCATION

by Bob Biek

The State Historical Society of North Dakota and the North Dakota Humanities Council recently published the *Directory of North Dakota Museums*, the first of its kind in the State. Subtitled "A Comprehensive Listing of Museums, including Art, History, Science, Tribal, and Children's Museums; Nature and Interpretative Centers; Park Museums and Historic Site Museums; Wildlife Refuges and Zoos; and Art Galleries," the directory is an important reference for those wishing to learn more about the natural and human history of North Dakota. At least 36 of these museums contain geological or paleontological exhibits.

The directory contains 175 entries organized alphabetically by city and is accompanied by an index of museum types (History, Art, Science, Tribal, or Miscellaneous). For each entry, the address and telephone number, authority/owner, season and hours, accessibility, admission, museum type and principal features are given. The 63-page directory measures 4" x 10.5", a convenient size to keep in the car, purse, or briefcase for ready reference.

The directory costs $4.00 and is available from the State Historical Society of North Dakota, North Dakota Heritage Center, 612 East Boulevard Avenue, Bismarck, ND 58505-0830 (Tel. 701-224-2666). (ND residents add 5% sales tax, Bismarck residents 6%. Shipping is $2.00 for 1-2 items, $3.50 for 3-5 items, and $5.00 for 6-8 items. Make checks payable to State Historical Society of North Dakota. Visa and Mastercard are also accepted). The directory is also available from the Museum Stores at the Fort Totten, Gingras Trading Post, Fort Buford, Chateau De Mores, and Fort Abercrombie State Historic Sites from mid-May to Mid-September.



Directory of North Dakota Museums

HOW THE OIL AND GAS CONSERVATION LAW CAME ABOUT

by

Wilson M. Laird, State Geologist Emeritus

[Note: Wilson Laird wrote this article in May of 1981. He sent it to me several months ago and I thought it would be appropriate for the NDGS Newsletter — John Bluemle.]

"If they're for it I'm against it," said Representative Billy Crockett, from Wales, Cavalier County when I answered a question about who favored an oil and gas conservation bill. I had said that probably all the oil and gas companies operating in the State at the time were for that legislation. So saying, Billy got up, waved his arms and left the room. The place was the Legislative House Committee on State Affairs chaired by Lafe Twitchell of Fargo. The time was about February 1941, and the subject was the oil and gas conservation bill I had asked George Saumur of Grand Forks to sponsor.

The background of this interesting exchange of views probably is known to only a few people still living, but it played an important part in the oil and gas development in North Dakota. During the fall of 1940, a small oil play had been going on in western North Dakota. It began with the drilling of the California Kamp #1 Well in Williams County in the fall of 1938. This well unfortunately was a dry hole, but it is interesting to note that it was located in a spot that today is only about a half mile from production on the Nesson Anticline in the Capa Field.

In the fall of 1940, oil industry individuals working with the oil laws of the State recognized that what laws we had were woefully inadequate and impossible to administer. Therefore, it was suggested that my predecessor, Dr. Frank Foley, investigate what could be done about getting better legislation on the books should there ever be a time when there would be production in North Dakota. Accordingly, he contacted the Interstate Oil Compact Commission headquartered in Oklahoma City and obtained a copy of their model act for an adequate oil and gas conservation statute.

Conferences were arranged with Governor John Moses, who suggested that, instead of an additional state agency to regulate something not then in existence and because there were already too many state agencies, the regulation of the oil and gas industry should be placed in the hands of the State Industrial Commission, which already handled the State Mill and Elevator and the Bank of North Dakota. Inasmuch as the Commission had no full-time staff capable of handling a technical matter like oil and gas regulation, it was decided that the State Geologist located at the University in Grand Forks would be the administrator of the act for the Commission. The State Geologist would thus be designated Supervisor of Oil and Gas.

Accordingly, a bill was drawn and introduced into the 1941 Legislative Session. House bill 210 was sponsored by Representatives George Saumer from Grand Forks, Walter Bubel from Center (Oliver County), Theodore O. Rohde of Van Hook (Mountrail County), and Senator Lars. K. Morland from Scranton (Bowman County). After its first reading, the bill was referred to the State Affairs Committee, which was chaired by Lafe Twitchell of Fargo. Mr. Twitchell was an old timer in the Legislature and didn't suffer fools gladly, and I am sure he thought that anyone sponsoring and supporting such a bill was little short of being demented. In fact, he told George Saumur that he couldn't see why in hell anyone wanted to introduce a bill of that kind as there wasn't any oil in North Dakota now, and that there wasn't going to be any in the future. It is true that no oil was being produced in the State at that time, but some relatively shallow gas was being produced on the Cedar Creek Anticline from a few wells owned by the Montana Dakota Utilities Co. in the southwesternmost part of Bowman County. The Cedar Creek later proved to be a prolific oil and gas producer in both North Dakota and Montana.

To get back to the hearing of the State Affairs Committee at which I was appearing as the prime witness for this bill. It should be noted that I was only 26 years old at the time and had been in the State for only about 5 months. I had become State Geologist because of the resignation of Dr. Foley, my predecessor, who went with the United States Geological Survey. To say that I was a stranger to legislative processes, as well as a stranger to the State and to the people in it, would be a gross understatement.

I was questioned about the need for this bill and what it would mean to the State, whether it would involve any additional funds to administer and generally how it would work. I explained that there was a geological chance for oil and gas to occur in commercial quantities in North Dakota. I also pointed out that the present laws were a hopeless mess and that, without the proposed legislation, there would essentially be no State control whatever if oil was discovered. I told them what had happened in other states, notably Texas when oil was discovered in the East Texas Field in the early thirties, and what chaos had resulted. I summarized my remarks with the hope that the Legislature would be foresighted and pass the bill.

After I was finished, the questions again started, and it was at that time that Billy Crockett made his famous statement. Famous, at least to me, as I thought that the whole matter had gone down the drain. I therefore left the hearing, my tail between my legs, and headed for the Grand Pacific Hotel where I packed my bag and prepared to depart on the evening train back to Grand Forks.

As I was checking out, George Saumur met me in the lobby and asked me where I was going. I told him that I felt I had failed and that I was going back to Grand Forks. He asked me to stay, and said that he would see if Mr. Twitchell would give me another hearing. I checked back in and stayed until the next day when I saw George again at breakfast time.

George told me that he had gone to Lafe Twitchell's room the previous evening and said to him, "You treated my boy kind of rough this afternoon." To which Lafe had replied, "Why does the damn fool think we should have that sort of legislation anyway?" George reasoned with him for some time, and the end effect was that Mr. Twitchell told him to have me up at the hearing again the next day.

I was there, needless to say, and answered more questions. The atmosphere was decidedly more friendly than the previous day. After that, I went home and left the matter in George Saumur's capable hands.

After the second hearing, George circulated around the House, and when the bill came to a vote there was no opposition to the measure whatsoever. I believe it passed without a dissenting vote. I think this was a tremendous tribute to the skill of George Saumur and an acknowledgement of the great affection the members of the House felt for him.

Mr. Twitchell was an old timer in the Legislature and didn't suffer fools gladly, and I am sure he thought that anyone sponsoring and supporting such a bill was little short of being demented.

George also lobbied the bill through the State Senate, and as I recall, I didn't even have to appear on that side of the Legislature about the bill.

What this legislation did was to provide a logical plan for the development of the State's oil and gas resources should any ever be discovered. It stipulated what the State Industrial Commission and the State Geologist should do. In other words, we were all set for the development which began on April 4, 1951 when the Amerada #1 Clarence Iverson Well officially opened oil development in North Dakota. (For a story about the discovery of oil in North Dakota, see "A Day to Remember," *NDGS Newsletter*, v. 20, no. 2, Summer, 1993). Very few, if any, states can say that they were so

well prepared for the oil and gas industry to come to their respective states as was North Dakota.

The 1941 law was not perfect, but then what law ever is? Any law has to be the distilled opinion of the many people who enact it, and as a result, few laws ever satisfy everybody. The main thing that the legislation did was to provide the base upon which an even better law was passed in 1953, two years after the discovery of oil. Here again, North Dakota was very fortunate in having a Governor, Norman Brunsdale, who was an intelligent and popular man and familiar with the oil industry from business knowledge of it through his banking connections.

Ten years after the initial bill was enacted, the Legislative Research Council assigned a subcommittee to study the matter of oil and gas regulation in the interim between the discovery in 1951 and the session in 1953. This subcommittee was headed by an eminent lawyer and State Senator, Clyde Duffy of Devils Lake. Hearings were held in various parts of the State, primarily in the western part where the oil and gas occurred. Many people testified, and their views were taken into consideration by the subcommittee. Much concern was expressed about the rights of landowners and mineral owners on whose lands the oil and gas had been found or might be found in the future.

The end result of the deliberations was the writing of another law which again was modeled after the then-current model law of the Interstate Oil Compact. This bill passed almost without change except it had to be tailored to the North Dakota situation. It did not contain the section on compulsory field-wide unitization, an omission I thought was unfortunate, as I regarded it then, and still do, as the best and most efficient way to produce a field which falls under multiple ownership as most United States oil fields do. Unitization also preserves capital as less material is needed to put the field in production. In other words it was, and is, a true conservation measure.

It wasn't until the 1965 Legislative Session that the compulsory field-wide unitization statute was added to the North Dakota oil and gas law. The version of the Unitization Bill that I wanted passed was that which was from the model act of the Interstate Oil Compact Commission as it fitted the rest of the model act that had been passed in 1953. It should be noted that these model acts of the compact were drafted by the best oil and gas legal minds in the country.

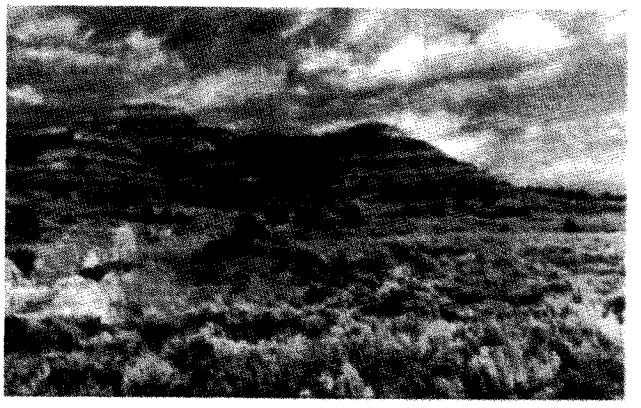
As it turned out, the Democrats had drafted a bill modeled after the Oklahoma statute; this was passed by the House. During this session of the Legislature, Arthur Link was Speaker. This was before he went to Congress and subsequently to the Governor's office. Now an impasse existed; the Senate had passed one, and the House another version of the same idea. It was one of those times when an idea's time had come and everyone was for it, but there was no unanimity of how the law should be worded. The end result was that the Senate acceded to the House version as they felt the law was needed, and they felt as that, as the Governor, Bill Guy, was a Democrat, it was the only way a unitization law would come about. The law has stood the test of time and has been used on a number of occasions. Even though it is far from perfect, and while I still think the Compact version was better worded, North Dakota's law works and that is the ultimate test.

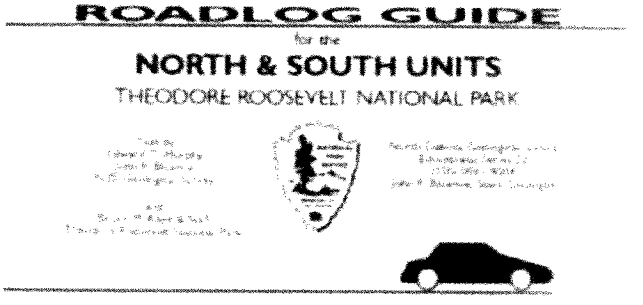
The jury is probably still out as to whether North Dakota will continue its remarkable progress in dealing with the oil industry. Frankly, such a good start has been made, it seems that the chances are good that it will continue. I recognize that some changes have been made in the administration of the law in that the State Geologist has been removed from the supervisory position. This is something that I suppose was inevitable, but the technical advice given the State by the Geological Survey was the best and most unbiased and scientifically oriented possible at the time.

NEW PUBLICATIONS

Roadlog Guide for the North and South Units, Theodore Roosevelt National Park, by Edward C. Murphy, John P. Bluemle, and Bruce M. Kaye & Staff (Theodore Roosevelt National Park), NDGS Educational Series No. 22, (1993), 30 pages, $1.50.

This guidebook, published by the Theodore Roosevelt Nature and History Association, introduces the fascinating roadside geology and natural history of the North and South Units of Theodore Roosevelt National Park. The text - accompanied by 15 wonderful drawings by artist Tamara Sayre, and 12 black and white photographs and diagrams - is keyed to milepost markers and so is easy to use. It brings to life the history behind the scenery and provides readers with a broad understanding of the geological evolution of the North Dakota badlands. This booklet is available from the NDGS, the National Park Service (at the Painted Canyon and North and South Unit Visitor Centers), and through the Theodore Roosevelt Nature and History Association (P.O. Box 167, Medora, ND 58645, tel. 701-623-4884).





NDGS publications and USGS topographic maps are available at our sales office (1022 E. Divide Ave, Bismarck), by telephone (701-224-4109), by FAX (701-224-3682), or by mail (see address below). Cash, money order, or check, payable to the North Dakota Geological Survey, will be accepted. Minimum charge per order is $1.00. Reasonable requests for items for which no price is quoted are sent free of charge. Customers will be invoiced for materials plus shipping costs, if applicable. A free copy of *NDGS List of Publications* will be sent upon request.

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