NEWSLETTER

DGS

A publication of the
North Dakota Geological Survey,
University Station,
Grand Forks, North Dakota 58201
Phone: (701) 777-2231

CONTENTS

June, 1974

MINERAL RESOURCES IN NORTH DAKOTA--

North Dakota is primarily an agricultural state with more than 90 percent of its area in farmland. Its income from farm products in 1970 was more than $690 million, or about seven times its approximately $95 million in income from mineral production. Tourism exceeded mineral production in 1970, providing about $114 million. Mineral production is becoming increasingly important as a major source of income in North Dakota, however. The substantial growth of the mineral industry is largely the result of the development of North Dakota's petroleum and coal resources which, along with natural gas and natural gas liquids, account for most of the total mineral value. Based on projected price increases for petroleum products, the value of North Dakota mineral production may increase even more dramatically in the near future.

Petroleum production in North Dakota dates to 1951. The amount of crude oil produced in the State reached a maximum of about 27 million barrels annually in 1967; but, since then, it has tended to decline, and by 1972 only about 20 million barrels of crude oil were produced annually. As of April 16, 1974, North Dakota had 1,945 producing oil wells. The State ranks 11th in the United States in total known petroleum reserves.

Natural gas output in North Dakota has totaled over 30 billion cubic feet annually in recent years. Bowman County, in the southwest corner of the State, is the principal producer, and much of the gas is used to heat the homes of North Dakotans. North Dakota also produces natural gas liquids, including natural gasoline, butane, and propane.

Lignite production is currently centered in Mercer and Oliver Counties in the west-central part of the State, Burke and Ward Counties in the northwest, and Bowman County in the southwest. Lignite was once laboriously mined with pick and shovel in underground mines, but it is now mined largely by machinery in surface mines where the material above the coal is stripped off, the lignite removed, and the original material replaced. North Dakota law requires reclamation of strip-mined areas.

It has been estimated that North Dakota has lignite resources of over 350 billion tons (see the item in this Newsletter on North Dakota's strippable reserves). Estimates of strippable reserves are about 16 billion tons in beds greater than 5 feet thick and another 17 billion tons in beds 2½ to 5 feet thick. This represents about 80 percent of the recoverable lignite reserves in the United States.

Most of the current lignite production in North Dakota is consumed in the generation of electric power. A much smaller amount is used for various industrial heating purposes and in the manufacture of briquettes. Lignite production more than doubled between 1965 and 1973, when it reached almost 7 million tons. It may reach nearly 12 million tons by 1975. If lignite conversion plants for the production of synthetic natural gas and hydrocarbon liquids become a reality, production will continue to increase dramatically.

Vast deposits of rock salt (halite), discovered during drilling for oil, lie buried beneath the North Dakota plains. At least 1,700 cubic miles of salt is estimated to be present in western North Dakota. Salt is used chiefly in the chemical manufacturing industry, for snow and ice removal and road base construction, for stock feed, for food preservation, as an additive in oil well drilling solutions, and in water softening. Potash occurs with the rock salt in the Prairie Formation of Devonian Age, but at present it is not mined in North Dakota. It occurs as the mineral sylvite in a mechanical mixture with halite known as sylvinite. Potash is used primarily as fertilizer for agricultural purposes. In North Dakota, the potash occurs at depths as shallow as 5,600 feet. Both rock salt and potash can be recovered by solution-mining methods that require the injection of water into the salt bed and the pumping out and processing of the resulting brine. Solution-mining methods for recovering the potash, as now used in Saskatchewan, appear to be feasible in North Dakota.

Other mineral resources include such things as peat, sulfur, sodium sulfate, and uranium. Sand and gravel for highway construction, railroad ballast, paving and sidewalk construction, and buildings is found throughout the State. Volcanic ash, or pumicite, is present in south-central North Dakota near Linton. It may be used as an additive to fortify cement, as a soil conditioner, and as a water purifier. Bentonitic clay, a soapy clay of weathered volcanic ash, may be used as an oil-well drilling mud, as a bond in pelletizing iron ore concentrates, as an acid-activated bleaching agent, and in a variety of other ways. Other clays are used in the manufacture of brick and pottery, and for lightweight aggregate.

THE USE OF ENERGY IN THE UNITED STATES AND IN NORTH DAKOTA--

In 1970, the United States used 530 million tons of coal. This is equivalent to a coal bed one mile square and 900 feet thick. We used 5 billion barrels of oil--equivalent to a tank a mile square and 1000 feet high. We used about 150 cubic miles of natural gas at atmospheric pressure.

The amounts of energy consumed in the USA are so vast that it becomes awkward to talk about it in terms of Btu's (British thermal units), so a new unit of measurement called the C-Unit was devised.* A C-Unit is equal to 10 thousand million million Btu's. In other words, one C-Unit of heat would be approximately equal to burning 400 million tons of coal. It is equivalent to the amount of heat necessary to raise the temperature of Lake Michigan one degree Fahrenheit. In 1973, we used 1.36 C-Units of coal, 3.48 C-Units of oil, 2.68 C-Units of gas, 0.30 C-Units of hydro-energy, and 0.08 C-Units of nuclear energy. These staggering amounts of energy are expected to double in the next 30 years even though our population rise will be relatively modest, from 204 to 266 million.

The amounts of energy we use and the amounts that remain in the USA are shown on the following table. Using oil as an example, the United States has used 60 C-Units of energy that was derived from oil since we started using oil. We know about additional oil resources totaling 188 C-Units of energy, but of this only 26 C-Units is recoverable with our present technology. However, the U.S. Geological Survey estimates that 1,452 C-Units of oil energy remain to be found in the United States.

*The C-Unit was defined by Dr. John C. Fisher, Manager of Energy Systems Planning for General Electric's Power Generation Business Group in New York City.

ESTIMATED POTENTIAL ENERGY CONTAINED IN VARIOUS RESOURCES IN USA

C-Units Equivalent

Source	Cumulative Past Production	Remaining Resources Identified	Remaining Identified Resources Recoverable	Probable Undiscovered Potential
Coal	88	3,975	975	8,164
Petroleum & Natural Gas Liquids	60	188	26	1,452
Natural Gas	40	48	30	642
Oil Shale	Negligible	1,232	336	11,890
Geothermal	Undetermined	6	1	over 4,000
Uranium	Undetermined	2	1	22,000,000 (a)
Thorium	Undetermined	-	-	34,000,000
Hydroelectric	Undetermined	49 (b)	22 (c)	None

(a) With present technology, potential energy available from uranium totals about 80 C-Units. The probable undiscovered potential figures for nuclear fuels require breeder technology.

(b) Based on total estimated megawatt potential x load factor x energy factor x 50 years.

(c) Based on planned capacity by 1990 x average energy input x 50 years.

The relative amount of energy each source contributes to the total energy supply is changing rapidly. As the table below shows, between 1970 and 1973 the use of oil increased substantially, primarily at the expense of coal, which actually showed a decrease in the amount of energy it produced (from 1.38 C-Units to 1.36 C-Units). This was due, primarily, to more stringent health and safety standards that necessitated the closing of many small coal mines as well as new regulations ordered by the Environmental Protection Agency restricting the use of high-sulfur coal. Energy supplied by gas increased from 2.25 C-Units to 2.68 C-Units, but this represents a decreasing share of total energy production, the result of dwindling supplies of natural gas. Approximately 54% of the electricity generated in the USA in 1973 was generated with coal.

CHANGING ENERGY SUPPLY BETWEEN 1970 AND 1973

	1970	1973
Coal	20.0%	17.9%
Oil	42.8	45.9
Gas	32.6	31.2
Hydroelectric	4.2	3.9
Nuclear	0.4	1.1
Total C-Units	6.9	7.6

Total energy consumption in the United States increased 10.1% between 1970 and 1973.

How does North Dakota fit into this picture? In spite of the fact that we produce coal, oil, gas, and electricity in the State, North Dakota was a net importer of energy in 1972, the last year for which I have figures on all sources. According to C. B. Folsom, chief petroleum engineer at the NDGS, North Dakota produced about 20 million barrels of oil in 1972. We consumed petroleum products equivalent to about 22 million barrels of oil. North Dakota produced about 80% of the natural gas it used, importing most of the deficit from Canada. On the other hand, North Dakota produces more electricity than it uses. According to Wallace Owen, Chief Engineer at the North Dakota Public Service Commission, North Dakota generated about 8.7 billion kilowatt hours of electricity, while consuming only 3.6 billion kilowatt hours.

North Dakota used 0.01977 C-Units of energy in 1973 while supplying 0.01947 C-Units of energy (all sources considered). The table below shows the amount of each major energy resource consumed and the amount supplied in North Dakota. All amounts are given on a Btu basis.

ENERGY USAGE IN NORTH DAKOTA (Btu basis)

	Consumed	Supplied
Oil	13.20×10^{13} Btu (a)	12.00×10^{13} Btu
Gas	5.34×10^{13}	4.27×10^{13}
Electricity	1.23×10^{13}	2.97×10^{13}
Lignite (b)	Not known	0.23×10^{13}
TOTALS	19.77×10^{13} Btu	19.47×10^{13} Btu

The deficit amounts to three trillion Btu.

(a) 13.20×10^{13} is another way of saying 132,000,000,000,000 (132 trillion).

(b) Most of the lignite produced in North Dakota was used to generate electricity. Since the energy consumed as and supplied as electricity is already reported (above), the only lignite reported is that that was used for purposes other than the generation of electricity.

ESTIMATED ORIGINAL STRIPPABLE LIGNITE RESERVES AND LIGNITE RESOURCES IN NORTH DAKOTA--

The table below lists the counties in North Dakota that have lignite resources. The figures are given in millions of tons. Original strippable reserve estimates refer to coal seams 5 feet or thicker and overburden of 100 feet or less. Total resources refer to coal seams at least 2½ feet thick and overburden of 1,200 feet or less. The strippable reserve figures for Dunn and Hettinger Counties were supplied by industry. With modern mining methods, it should be possible to recover at least 80% of the strippable reserve, and some authorities expect the figure to be closer to 90%.

County	Strippable Reserve	Total Resource
Adams	163	1,857
Billings	1,078	17,718
Bowman	785	7,021
Burke	117	6,610
Burleigh	156	1,157
Divide	137	8,264
Dunn	2,000	71,042
Golden Valley	278	8,319
Grant	115	4,658
Hettinger	980	12,653
McHenry	15	118
McKenzie	825	32,183
McLean	1,009	16,478
Mercer	1,986	29,912
Morton	342	15,251
Mountrail	148	15,378
Oliver	629	17,839
Renville	8	783
Sheridan	0	660
Slope	2,326	20,091
Stark	1,275	25,698
Ward	501	10,286
Williams	1,130	26,935
TOTAL	16,130	350,911

How much coal does this reserve really represent? At the 1973 rate of production (6.8 million tons), North Dakota's 16 billion tons of lignite would last another 2350 years. Even if large-scale coal gasification becomes a reality, North Dakota's lignite will go a long way. Assuming continued increases in electric generation and six lignite conversion plants by 1990, the lignite would last over 150 years.

COAL MINES IN NORTH DAKOTA

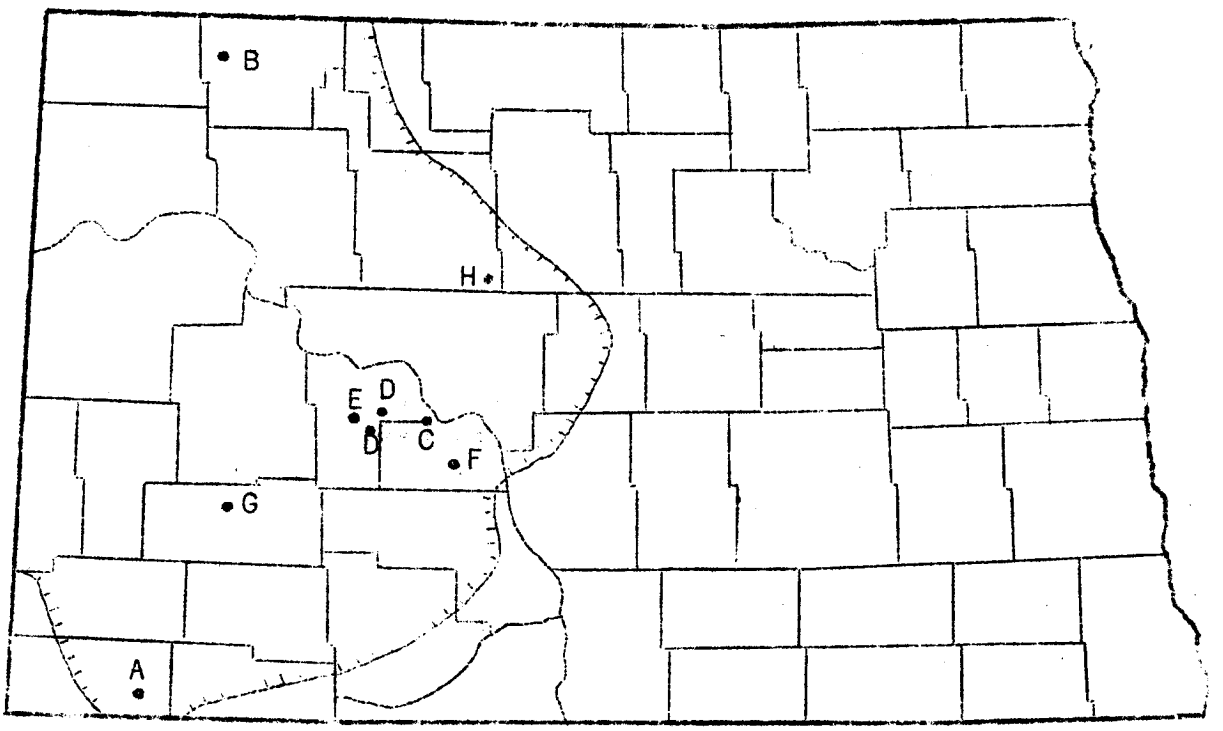
COUNTY		NAME OF MINE	ADDRESS	PRODUCTION (tons)
Adams		Arrowhead Coal Mine	Haynes	2,332
		Olson Mine	Haynes	None
		Smith-Ullman	Haynes	10,142
Bowman	(A)	Knife River Coal Mining	Gascoyne	182,161
Burke	(B)	Baukol-Noonan, Inc.	Noonan	482,299
Grant		Sprecher Coal Mine	New Leipzig	5,000
Mercer	(C)	Consolidation Coal Co.	Stanton	1,327,314
	(D)	Knife River Coal Mining Co. (North and South Mines)	Beulah	1,585,769
	(E)	North American Coal Corp.	Beulah	1,049,416
Oliver	(F)	Baukol-Noonan, Inc.	Center	1,563,446
Stark		Dickinson Coal Mining	Dickinson	2,709
	(G)	Husky Industries	Dickinson	160,657
Ward	(H)	Consolidation Coal Co.	Velva	417,732
Williams		GeoResources, Inc.	Williston	9,630

TOTAL PRODUCTION AND VALUE OF COAL MINED IN NORTH DAKOTA

FISCAL YEAR	PRODUCTION (tons)	VALUE
1973	6,798,607	$13,567,386
1972	6,343,769	12,045,301
1971	5,821,076	10,844,675
1970	5,001,828	9,053,676
1969	4,590,276	8,245,222

Total production-fiscal year 1884 thru 1973: 152,210,656 tons

These figures were supplied by Rudolph Iszler, State Mine Inspector. For purposes of comparison, Kentucky, the leading coal-producing state, produced 122 million tons of coal.



Map of North Dakota showing the limit of commercial lignite (the hatched line) and major producing strip mines in the State. Letters refer to mines listed on the previous page.

GEOLOGY AND LAND-USE PLANNING--

The role that geology and the geologist can play in improving man's environment is discussed by Mike Arndt in NDGS Miscellaneous Series 48. Increased demand for proper land-use planning focuses attention on geology as one of the many scientific components that enter into formulating environmental impact and hazard statements. Geologists who have pointed out hazards have often been ignored in planning processes. The idea of applying geologic techniques and principles to improve man's environment is known as environmental geology. Environmental geology had its beginnings in the large urban areas of our country where the problems are acute. We here in North Dakota have not yet had these problems. We are, however, in the unique position of being able to take someone else's lessons and prepare for the situations before they arise. Environmental geology can be an effective and powerful tool in keeping our State a pleasant and healthy place to live and work.

Many people associate geologic hazards with mountainous areas, but, as Mike points out, geology can play an important role in land-use planning in non-mountainous areas such as North Dakota. He points out numerous specific applications of how geology can help in land-use planning in North Dakota, and he cites several examples of what can happen when the geology is not taken into account.

NDGS Miscellaneous Series 48 can be obtained for $.25.

GEOLOGIC MAPPING PROGRAM--

The North Dakota Geological Survey has been involved in a mapping program of North Dakota's counties since 1960. Conducted with the cooperation of the State Water Commission, the United States Geological Survey, and the commissioners of the counties involved, an eventual goal is to complete the mapping of the surface geology of the State at a scale of ½ inch to a mile, to determine the quantity and quality of the groundwater supplies in the State, and to appraise any other mineral resources that might be found.

The program is a joint effort of the cooperating agencies. In most instances, the NDGS maps the surface geology, the State Water Commission conducts the test drilling program, and the U.S. Geological Survey compiles and interprets the hydrologic data. Results are published by the NDGS and the State Water Commission, usually as a series of three publications. The first published part of each study includes a colored geologic map of the county or counties involved, a discussion of the geology geologic history, and economic geology, and additional maps and cross sections. The second part is a compilation of hydrologic data, and the third is an interpretation of the hydrology.

The list that follows indicates the current status of the mapping program for each county. Parts listed as "Completed" have been published and are available from either the NDGS or the State Water Commission. Parts listed as "In preparation" should be available later this year.

County	Part I	Part II	Part III
Adams--Study in progress			
Barnes	Completed	Completed	Completed
Benson	Report in preparation	Completed	Report in preparation
Billings-- Study will begin this summer			
Bottineau--No program planned at present			
Bowman--Reports in preparation			
Burke	Completed	Completed	Completed
Burleigh	Completed	Completed	Completed
Cass	Completed	Completed	Completed
Cavalier	Report in preparation	Completed	Report in preparation
Dickey--Study in progress			
Divide	Completed	Completed	Completed
Dunn--Study in progress			
Eddy	Completed	Completed	Completed
Emmons--Study in progress			
Foster	Completed	Completed	Completed
Golden Valley--Study will begin this summer			
Grand Forks	Completed	Completed	Completed
Grant--Study in progress			
Griggs	Report in preparation	Completed	Report in preparation
Hettinger	Report in preparation	Completed	Report in preparation
Kidder	Completed	Completed	Completed
LaMoure--Study in progress			
Logan	Completed	None planned	None planned

(List Continued)

County	Part I	Part II	Part III
McHenry--No program planned at present			
McIntosh	Completed	None planned	None planned
McKenzie--No program planned at present			
McLean	Completed	Completed	Completed
Mercer	Completed	Completed	Completed
Morton--Study in progress			
Mountrail	Completed	Completed	Completed
Nelson	Completed	Completed	Completed
Oliver	Completed	Completed	Completed
Pembina	Report in preparation	Completed	Report in preparation
Pierce	Report in preparation	Completed	Report in preparation
Ramsey--Study in progress			
Renville	None planned	Completed	Completed
Richland	Completed	Completed	Completed
Rolette	Completed	None planned	None planned
Ransom--Study in progress			
Sargent--Study will begin this summer			
Sheridan--No program planned at present			
Sioux--Study in progress			
Slope--Study will begin this summer			
Stark	Report in preparation	Completed	Report in preparation
Steele	Report in preparation	Completed	Report in preparation
Stutsman	Completed	Completed	Completed
Towner--No program planned at present			
Traill	Completed	Completed	Completed
Walsh	Completed	Completed	Completed
Ward	None planned	Completed	Completed
Wells	Completed	Completed	Completed
Williams	Completed	Completed	Completed

THE NORTH DAKOTA GEOLOGICAL SURVEY--

The North Dakota Geological Survey was established by legislative action in 1895 with the Professor of Geology of the State University acting ex officio as State Geologist. This integration of the Geology Department and the North Dakota Geological Survey has benefited both agencies over the years, but has been particularly helpful to students who have had the advantage of Survey experience during their training period.

Since its earliest years, the purpose of the Geological Survey has been primarily to collect information about the geology of the State. This information is not given to any individual or company until it has been published or otherwise made available to all citizens of the State. To a lesser extent, it has been a function of the Survey to direct capital to the resources of the State that justify development. When the Survey was established, it was "entrusted with the complete and thorough

geological study of the state, and particularly with those lines of research that promise to develop its mineral wealth. Theoretical problems, however, are not to be neglected. The stratigraphic and topographic features of the state are to be studied and properly mapped, and the historical development of each is to be explained." (Quote from the Second Biennial Report of the State Geological Survey of North Dakota, 1903.) Since the discovery of oil in North Dakota in 1951, the State Geological Survey has had the added duty of enforcing the State's oil and gas production laws for the State Industrial Commission.

North Dakota has had seven State Geologists since 1895. The present Survey head is Dr. E. A. Noble, who is also the chairman of the University of North Dakota geology department. The Survey currently employs six geologists, three engineers, three field inspectors, two draftspersons, and ten people who are involved in administration, bookkeeping, publications, and secretarial work.

The Survey's activities have expanded greatly in the last few years and no letup is in sight. If cooperative money materializes for resource and reclamation projects, Survey activity should be at an all-time high during the coming year. More students are involved with the Survey than ever before.

UND GEOLOGY DEPARTMENT ACTIVITIES--

The University of North Dakota Geology Department members work with the NDGS on many projects. Even though they are involved with teaching duties much of the time, they do find time for considerable research. Nick Kohanowski has finished his translation of the Manual for Silver Miners, 1641, and has started a detailed subject index of it. John Reid is still serving part time as associate dean of Arts and Sciences. He has been working with the Ecological Studies Institute at UND on three environmental projects: preliminary environmental evaluation of a proposed Army Corps of Engineers project at Warroad River, Minn.; preliminary and final environmental impact evaluation of a proposed Corps project, Roseau River, Minn.; and an environmental impact assessment of completed Corps Projects on Homme Reservoir, Walsh Co., and Lake Ashtabula, Barnes Co., North Dakota. Lee Clayton, in addition to making a reconnaissance of Lake Sakakawea on a motorized houseboat raft, spent some time in central North Dakota and Alberta looking at glaciers and evidences of glaciers along with eight students and a film crew from Canada. Lee provided the special effects for the film about glaciers. As reported elsewhere in this Newsletter, he and Steve Moran have devised a glacial process-form model. Alan Cvancara has nearly completed his study of living aquatic mollusks of North Dakota. He presented the invited paper at the North Dakota Academy of Science last spring on this subject. Bud Holland is involved with the 101-102 investigative blocks and the new resource center. Frank Karner is studying the Tunk Lake pluton. Walt Moore is mapping in southwest North Dakota during the summer, studying the early Tertiary formations. Frances Ting returned from his studies in Germany this fall and is continuing his research on North Dakota lignite. He will be leaving for the University of West Virginia next autumn.

NEW GLACIAL PROCESS-FORM MODEL DEVISED--

Drs. Lee Clayton of the University of North Dakota geology department and Stephen Moran of the North Dakota Geological Survey have collaborated in devising a new glacial process-form model. Prepared for a glacial geomorphology symposium to be held next September in Binghamton, New York, the model goes a long way toward explaining the origin of the landforms in glaciated areas such as North Dakota. Even though geologists have known for a long time that glaciers sculpted the landforms in areas they covered, the mechanisms of just how they did this have been only poorly understood.

The Clayton-Moran model helps to explain how glaciers erode, transport, and deposit sediment. It explains how glacial landforms are produced. The model theorizes a quarrying zone near the glacier's margin and an abrasion zone behind the margin. Most erosion takes place in the quarrying zone, producing a thoroughly mixed sediment that is contained within the ice. Most of this sediment is eventually deposited as mudflows when the glacier finally melts.

A glaciated landscape, such as we have in much of North Dakota northeast of the Missouri River, involves four elements: preadvance, subglacial, superglacial, and postglacial. First, the preadvance landscape is modified by subglacial erosion as the glacier advances over an area, and either longitudinal (parallel to the direction of ice movement) shear marks or transverse (normal to the direction of ice movement) compressional features may be formed. As more of the sediment carried within the ice is deposited, it obliterates the underlying preadvance or subglacial elements. Washboard ridges may result when small amounts of glacial sediment are concentrated along transverse shear zones. Topography with hummocks 200 meters in diameter will result if the glacial sediment is distributed evenly. The hummocks result from superglacial mudflows on the surface of the glacier down the side of glacial sinkholes. Finally, postglacial erosion or deposition gradually modifies the superglacial, subglacial, or preadvance elements.

An article in the last Newsletter included a listing of theses that deal with the subsurface. I suggested that some of the material in these theses might be useful to people in the oil industry. We have had some response to the article, but our librarian, Mary Scott, pointed out to me that some of the material in the theses has been duplicated as North Dakota Geological Survey publications. The following NDGS publications repeat all or parts of theses listed in the last Newsletter:

Geomagnetic Survey of Part of the East Edge of the Williston Basin, by Harald C. Haraldson, 1953. Report of Investigation 10.

Subsurface Correlations of the Cretaceous Greenhorn-Lakota Interval in North Dakota, by Dan E. Hansen, 1955, Bulletin 29.

Stratigraphy of the Winnipeg and Deadwood Formations in North Dakota, by Clarence G. Carlson, 1960, Bulletin 35.

The Bakken and Englewood Formations of North Dakota and Northwestern South Dakota, by Jack Kume, 1963, Bulletin 39.

Structural and Stratigraphic Relationships in the Paleozoic Rocks of Eastern North Dakota, by Frederick V. Ballard, 1963, Bulletin 40.

The Spearfish Formation in the Williston Basin of Western North Dakota, by Wallace G. Dow, 1967, Bulletin 52.

The Newcastle Formation in the Williston Basin of North Dakota, by Mark Reishus, 1968, Report of Investigation 47. (This report is out of print, but it could be supplied in copied form.)

Newburg-South Westhope Oil Fields, North Dakota, by Hussein Marafi, 1972, Miscellaneous Series 47.

In most cases where no equivalent NDGS publication exists, the thesis or dissertation can be borrowed from the library. The UND library (Chester Fritz Library) loan policy on graduate theses is outlined below:

1) Dissertations dated prior to June 15, 1965 can be loaned, provided the library has at least two copies. If there is no second copy, a second copy will be made and sent out unbound so as not to delay the borrower too long.
2) Dissertations dated after June 15, 1965 are on microfilm, and the microfilm is available from University Microfilm, Ann Arbor, Michigan.
3) Master's theses can be loaned subject to the same conditions outlined in 1), above.

Complete copies of dissertations or theses can be purchased from Sigma Gamma Epsilon, in care of the Geology Department at UND. In this case, the dissertation or thesis is copied, and the buyer is billed for the cost.

EDUCATIONAL AIDS AVAILABLE--

The North Dakota Geological Survey has several educational aids that are available to North Dakota schools and other interested organizations. The aids include taped lectures and collections of selected slides, which may be borrowed free of charge. We also have small collections of North Dakota rocks and minerals that can be obtained for a nominal cost. Members of the Survey staff give illustrated lectures and lead field trips for groups on arrangement.

DRILL STEM TEST CATALOG NOW READY--

As reported in the last issue of the NDGS Newsletter, Mary Scott, our librarian, has prepared a catalog of drill stem tests that recovered oil from wells located a half mile or more from a producing well and, in most cases, outside a field boundary. The catalog is now available from the North Dakota Geological Survey at a cost of $5.00.

REVISION OF CIRCULAR 5 UNDERWAY--

Sid Anderson, subsurface head at the North Dakota Geological Survey, has been revising Circular No. 5, which is a compilation of all oil well records in the State. The revised version will locate wells according to county, then by township, range, and location within the section, so it should be easier to find a given well than it was in past versions of Circular 5. The circular will provide a summary of available information on elevation, completion, initial production, and oldest formation penetrated for over 5000 North Dakota oil wells and dry holes. It will include information on logs, cored intervals, and samples that are on file and are available for study at the Survey in Grand Forks.

PRE-MESOZIC MAP NEARLY READY--

Drafting has begun on a new pre-Mesozoic paleogeologic map of North Dakota. The map will be published in color at a scale of 1:1,000,000 and is a revision of Miscellaneous Maps 3 and 7, showing the subcrop of the pre-Mesozoic rocks of North Dakota. Included on the publication will be four electric and gamma ray logs on which the various lithologic units are indicated.

The map should be a valuable tool for oil and gas explorationists.

RECENT DRILLING PERMITS ISSUED BY THE NORTH DAKOTA GEOLOGICAL SURVEY--

Permit	Operator Lease, and Formation	Well Type	Location	County
5405.	Willis L. Walker-Marie Demars No. 2. Madison	Development Kuroki	SENW Sec. 12-163-81	Bottineau
5406.	Tom Brown, Inc.-Anna Hatling No. 1. Madison	Wildcat	SENW Sec. 9-159-103	Williams
5407.	Farmers Union Central Exch., Inc.-Wm. Tomchuk N. 6-30. Otter	Outpost Zenith	SENW Sec. 30-140-98	Stark
5408.	Cities Service Oil Co.-Werner State No. 1. Madison	Wildcat	NESW Sec. 16-146-93	Dunn
5409.	Farmers Union Central Exch., Inc.-Melvin Miller No. 4-21. Ordov.	Development Coyote Creek	NWNW Sec. 21-131-104	Bowman
5410.	True Oil Company-Burlington Northern No. 44-27. Madison	Development Red Wing Creek	SESE Sec. 27-148-101	McKenzie
5411.	Inexco Oil Company-Hibl No. 1. Madison	Wildcat	NENE Sec. 30-141-96	Dunn
5412.	PanCanadian Petroleum Ltd.-Skagen No. 1. Kibbey	Wildcat	NESE Sec. 25-148-80	McLean
5413.	Cardinal Petr. Co. & Tom Stock-Hauf No. 1. Madison	Wildcat	SWSE Sec. 19-151-81	Ward
5414.	Kenneth Luff & Hanover Planning, Inc.-Jett No. 1-28. Red River	Wildcat	NENW Sec. 28-129-101	Bowman
5415.	Kenneth Luff & Hanover Planning, Inc.-Hughes No. 1-27. Red River.	Development State Line	SENW Sec. 27-129-103	Bowman
5416.	Tiger Oil Company-Mathews No. 1-23. Duperow	Wildcat	NWSE Sec. 23-163-99	Divide
5417.	Gas Producing Enterprises, Inc.-Adolph Kudrna No. 1. Tyler Heath	Outpost South Heart	SENE Sec. 2-139-98	Stark
5418.	Depco, Inc.-Tyler No. 1-9. Madison	Wildcat	NWNW Sec. 9-160-85	Renville
5419.	Farmers Union Central Exch., Inc.-Repetowski No. 16-25. Heath	Extension Zenith	SESE Sec. 25-140-99	Stark
5420.	Amerada Hess Corp.-Beaver Lodge Dev. U. E-310. Devonian.	Development Beaver Lodge	CNW Sec. 36-156-96	Williams
5421.	GeoResources, Inc.-Walter G. Nelson No. 2. Madison	Development SW Haas	SESW Sec. 32-163-83	Bottineau
5422.	Texaco, Inc.-Devonian Unit No. 7. Red River	Development Charlson-Dev.	CSW Sec. 34-154-95	McKenzie

(Permits Continued)

Permit	Operator Lease, and Formation	Well Type	Location	County
5423.	Hunt Oil Company-No. 1-19. Madison.	Development North Tioga	SWSWNE Sec. 6-159-94	Burke
5424.	Texaco, Inc.-Devonian Unit No. 8 No. 1. Silurian	Development Charlson-Dev.	CNE Sec. 3-153-95	McKenzie
5425.	Rainbow Resources, Inc.-Clarence Hestekin No. 2. Red River	Development Medicine Pole Hills	SWNE Sec. 15-130-104	Bowman
5426.	Rainbow Resources, Inc.-Tank-Updegraff No. 1. Madison.	Wildcat	CSWSW Sec. 11-151-96	McKenzie
5427.	Inexco Oil Company-Anna Hoff No. 1. Madison	Wildcat	NWNW Sec. 11-140-93	Stark
5428.	Farmers Union Central Exch., Inc.-Jearmchuk No. 1-25. Heath.	Extension South Heart	NENE Sec. 25-140-98	Stark
5429.	Lamar Hunt-M. P. Freer No. 1. Madison	Wildcat	SENW Sec. 33-141-94	Dunn
5430.	Continental Oil Company-Newton-Moore No. 1. Otter	Extension Zenith	SESE Sec. 4-139-99	Stark
5431.	Earl Schwartz Company-Stanley Kitzman No. 2. Madison	Development Pratt	SENW Sec. 5-158-80	McHenry
5432.	Earl Schwartz Company-Ivan & Albert Christiansen No. 2. Madison	Extension S. Starbuck	NESW Sec. 32-161-78	Bottineau
5433.	Rainbow Resources, Inc.-Clarence Hestekin No. 2A. Red River	Development Medicine Pole Hills	SWNE Sec. 15-130-104	Bowman
5434.	Tiger Oil Company-Hawronsky et al No. 1-11. Madison	Wildcat	SWNE Sec. 11-145-99	McKenzie
5435.	Farmers Union Central Exch., Inc.-Federal No. 14-32. Bakken	Development Elkhorn Ranch	SESW Sec. 32-144-101	Billings
5436.	Oil Development Co. of Texas-Louis Sailer No. 1. Red River	Wildcat	NWNW Sec. 11-145-85	Mercer
5437.	Trend Expl. Ltd. & Patrick Petr.-O. Haugen No. 1. Red River	Development Round Prairie	NWSE Sec. 7-154-103	Williams
5438.	Tiger Oil Company-Burlington Northern No. 1-29. Red River	Development Red Wing Creek	SENE Sec. 29-148-101	McKenzie
5439.	Amerada Hess Corp.-Beaver Lodge Dev. U. F-309. Duperow	Development Beaver Lodge	CSE Sec. 36-156-96	Williams
5440.	Amerada Hess Corp.-Beaver Lodge Dev. U. C-307. Duperow	Development Beaver Lodge	SWSW Sec. 2-155-96	Williams
5441.	Amerada Hess Corp.-Beaver Lodge Dev. U. D-309. Duperow	Development Beaver Lodge	CSE Sec. 35-156-96	Williams
5442.	Farmers Union Cen. Exch.-Amer. Luth. Church No. 3-26. Otter	Development Rocky Ridge	NENW Sec. 26-137-100	Billings
5443.	Continental Oil Co.-Wagner-Pavel No. 2. Otter	Extension Zenith	NWNW Sec. 10-139-98	Stark
5444.	Amerada Hess Corp.-Fryburg Heath Madison U. G-816. Madison	Development Fryburg	NENW Sec. 2-139-101	Billings
5445.	Rainbow Resources, Inc.-John Braaten No. 1-3. Red River	Development Medicine Pole Hills	NWSE Sec. 3-130-104	Bowman

(Permits Continued)

Permit	Operator Lease, and Formation	Well Type	Location	County
5446.	Continental Oil Co.-Dickinson Heath Sand Unit No. 48. Tyler	Development Dickinson	SWNE Sec. 33-140-97	Stark
5447.	Amerada Hess Corp.-Fryburg Heath Mad. U. G-812. Madison	Development Fryburg	CNW Sec. 11-139-101	Billings
5448.	Amerada Hess Corp.-Fryburg Heath Mad. U. H-814. Madison	Development Fryburg	CSE Sec. 2-139-101	Billings
5449.	Amerada Hess Corp.-Fryburg Heath Mad. U. F-810. Madison	Development Fryburg	NESE Sec. 10-139-101	Billings
5450.	Texas Gas Exploration Corp.-Guy M. Brown et al No. 1. Ordovician	Wildcat	NENW Sec. 27-141-105	Golden Valley
5451.	Koch Exploration Company-Vedquam No. 1A. Madison	Development-Replace. Blaine	SENE Sec. 27-160-83	Bottineau
5452.	Bomac Exploration Co.-Charles Marsh No. 1. Tyler Heath	Wildcat	NWNE Sec. 9-140-97	Stark
5453.	Wessely Energy Corp.-Smighberg No. 1. Madison	Development Baukol Noonan	NESW Sec. 8-162-95	Divide
5454.	Farmers Union Central Exch., Inc.-Krushensky No. 16-34. Otter	Development Zenith	SESE Sec. 34-140-99	Stark
5455.	Farmers Union Central Exch., Inc.-Obach No. 8-30. Otter	Development Green River	SENE Sec. 30-140-98	Stark
5456.	John B. Hawley, Jr. Trust No. 1 Lewis Man No. 1. Madison	Development Lone Tree	NWSW Sec. 12-155-86	Ward
5457.	Cardinal Drilling & St. Croix Expl.-Paul Christianson No. 1. Madison	Extension Glenburn	SWSW Sec. 4-158-81	Renville
5458.	Amerada Hess Corp.-Fryburg Heath-Mad. U. I-817. Madison	Development Fryburg	SWSW Sec. 36-140-101	Billings
5459.	W. H. Hunt-Valentine Senn No. 1. Red River	Wildcat	CSESW Sec. 15-136-92	Hettinger
5460.	Shell Oil Company-Howie No. 34X-2. Heath	Development Rocky Ridge	SWSE Sec. 2-136-100	Slope