

**A  
HISTORY  
OF THE  
NORTH DAKOTA  
GEOLOGICAL SURVEY**

by  
C. B. Folsom, Jr.



MISCELLANEOUS SERIES NO. 58

NORTH DAKOTA GEOLOGICAL SURVEY

Lee C. Gerhard, State Geologist

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The Geology Department and the Survey moved from Merrifield Hall to this building in 1948. Expansion of the Survey staff led to moving of the Geology Department to Babcock Hall in 1951, with the Survey remaining in this building until the construction of Leonard Hall.



## FOREWORD

For much of what follows, I have had to rely on a manuscript prepared by Dr. Wilson M. Laird in 1944. From 1953 to the present, I have my own remembrances but for the intervening years I have had to rely on the memories of others and the sparse notes in the various Biennial Reports rendered during the period.

I have been able to add some color to the early years by referring to the field notes of Dr. Leonard and correspondence still in the files of the Survey.

If I have left out anything which seemed important to someone, or if I have included something that might have been better left unsaid, I apologize.

C. B. Folsom, Jr.

Grand Forks,  
North Dakota  
1980

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## A SURVEY IS BORN!

By act of the Legislature, in 1895, the position of State Geologist was created and Professor E. J. Babcock was appointed to the post.<sup>1</sup> He had come to the University of North Dakota as a new graduate of the University of Minnesota and had been appointed an Instructor in Chemistry. When the University obtained a Post Office, in 1890, he became its first Postmaster.

The State Constitution had directed that a State University and a School of Mines be situated at Grand Forks, and construction of the first University building began in October, 1883. In spite of the Panic of 1893, the Legislature made a most generous provision for the University that included \$5,000 to launch the School of Mines; however, Governor Shortridge vetoed that portion of the bill.<sup>2</sup>

The collapse of agricultural prices, in 1893, pointed up the need for diversification in the state's economy, and Babcock argued repeatedly for the need for the practical development of mining and geology. He had published two pamphlets, in 1890 and 1892, in which he outlined the studies he had made on the clays and coals of North Dakota, and these were used as a basis for a request for \$10,000 to open the School of Mines.<sup>3</sup>

The appropriation was refused, but Babcock utilized the title of State Geologist to expand his laboratory facilities in the Chemistry Department and carried on studies of the combustion of fuels. In 1896, he began a survey of the northern part of the state, particularly that area near Pembina where clays and potential cement rocks were known to exist. A plant was built at Pembina in 1899, and Babcock's brother, Otto, became the first General Manager of the Pembina Portland Cement Company. The plant was not able to produce a proper grade of Portland Cement and was closed in 1909.<sup>4</sup>

In 1897, the School of Mines was formally opened with Babcock as its first Director. Without appropriated funds, Babcock continued to work, donating his time and expenses. In 1899, the Legislature recognized that the time had come to organize the Geological Survey and a small appropriation was made for the purpose.

The act which created the Geological Survey specified that it should "effect a complete account of the mineral resources of the state, including a study of the geological strata, their richness in ores, coals, clays, peats, salines, mineral waters, marls, cements, building stones, and other useful materials, the value of the substances for economic purposes, and their accessibility."

Babcock used his earlier studies as the framework for the First Biennial Report. In cooperation with the United States Geological Survey, several hundred samples of water from various sources were collected and examined and the information included in the report. Babcock saw the First Biennial Report as preliminary in nature and not to be considered complete.

During the subsequent biennium, the activities of the Survey grew so rapidly that Babcock could no longer discharge the duties of both the State Geologist and

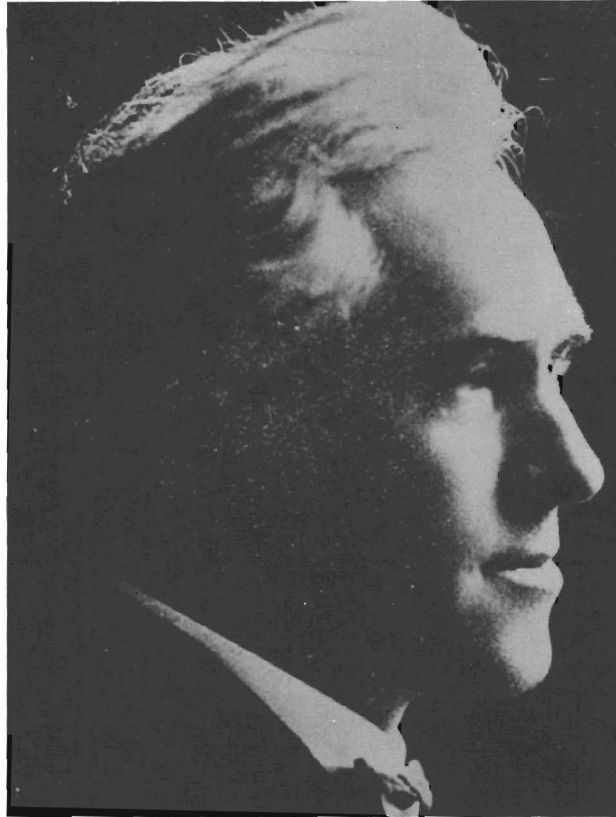


Figure 1. Professor E. J. Babcock, State Geologist, 1895-1902. Professor Babcock was the first Director of the School of Mines. Chester Fritz Archives.

the Director of the School of Mines. Accordingly, the work of the State Geologist was turned over to Dr. Frank A. Wilder in June of 1902.<sup>5</sup>

In the Second Biennial Report, Frank A. Wilder, the new State Geologist, summarized the proposed scope of the Survey as follows: "As definitely stated in the law under which the Survey was organized, it is entrusted with those lines of research that promise to develop the state's 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. A proper order for work is suggested in the statute of organization in which primary stress is laid in the economic problems, to which the attention of the Survey is specifically directed. It shall be my endeavor, therefore, to direct the initial work of the Survey so that the value of the natural resources of the state may be known, and at the same time, so far as practicable, to collect other data bearing on the theoretical problems that the state presents, which shall furnish matter for the later publications.

"With the consent of the Board of Trustees, the first bulletins of the Survey will treat of the coals and clays, the water resources with special reference to



Figure 2. Dr. Frank A. Wilder, State Geologist, 1902-1903. Chester Fritz Archives.

irrigation, the building stones and cement materials; probably in the order named. Preliminary reports as thorough as the time and means available allow will be made, and these will be followed by more minute studies in which the convenient unit of area will be the county. After the completion of the series of county reports, material will be available for exhaustive topical papers."

The First Edition of the Second Biennial Report, 1,500 copies, was quickly exhausted and the Legislature authorized a second edition of 2,500 copies. It dealt primarily with lignite deposits. It was designated Volume 1, Number 1, and was printed at Bismarck.

Analyses of the water samples, mentioned above, were carried out by Marcia Bisbee, an Instructor in the Chemistry Department.

During 1901, Mr. L. H. Wood was named a Special Assistant. He was a graduate student at the University of Chicago with a M.A. degree from the University of Michigan. Professor Babcock was listed as Chief Chemist and Professor Chandler was named Surveyor of Irrigation.<sup>6</sup>

Mr. Wood carried out a study of the lignites in Ward County and on the Fort Berthold Reservation. Dr. Wilder commented that the state had been saved considerable expense since Mr. Wood's travels were accomplished by bicycle.



Dr. Wilder visited the larger mines in Ward County, with Mr. Wood, and then travelled to Williston to study the exposures of lignite and clay along the banks of the streams and rivers in the area. Opportunities for irrigation along the Missouri River were studied and data collected for the preparation of a report to the state and federal governments. A month was spent along the valleys of the Little Missouri, Heart, and Green Rivers as a part of the irrigation studies.

In 1901, the Legislature established an Agricultural and Geological Survey at the Agricultural College in Fargo. The first director was Daniel E. Willard, a geologist. He was the author of a book entitled "The Story of the Prairies," which was highly recommended by Dr. Wilder. Some confusion was caused by the fact that both agencies came to be referred to as the "Geological Survey." The confusion was resolved when the Legislature disbanded the Fargo group in 1913.

Beginning with the 1903-1904 fiscal year, the Legislature increased the Survey's appropriation to \$1,000 per year and this remained fixed through the fiscal year 1917.

The irrigation studies were continued along the lines of utilizing lignite as a fuel for the pumps. Professor Babcock had previously demonstrated that a gaseous fuel could be derived from the coal. Results of these studies were included in the Third Biennial Report.

Mr. Wood continued as a Special Assistant to Dr. Wilder. Henry Hinds, Windsor R. Holgate, Herbert A. Goodall, and Harry Pease served as field assistants. All were students from the University. Wood's party started from Medora with two of the students and followed the Little Missouri to its mouth where it was met by Dr. Wilder's party, which had followed the main stream of the Missouri from the Montana line in a small boat. After a conference at Mannheim,<sup>7</sup> Mr. Wood's party started up the Knife River by wagon while Dr. Wilder's party continued downstream to the mouth of the Cannonball River.

Wilder followed the Cannonball, by wagon, upstream to its forks at Wade and then along Cedar or South Fork to the Standing Rock Reservation. On the return trip, the party made observations along the Upper Heart River. The two parties prepared separate reports.

At the close of the field season, Dr. Wilder announced that he would be leaving the state and was resigning his post as State Geologist. Dr. A. G. Leonard was named to the vacant office and assumed his new duties with the beginning of the new school year.

#### THE LEONARD ERA

Arthur Gray Leonard came to the University from the Iowa Geological Survey. He had received a Doctoral Degree from Johns Hopkins University after earlier studies at Oberlin and Salt Lake Academy.

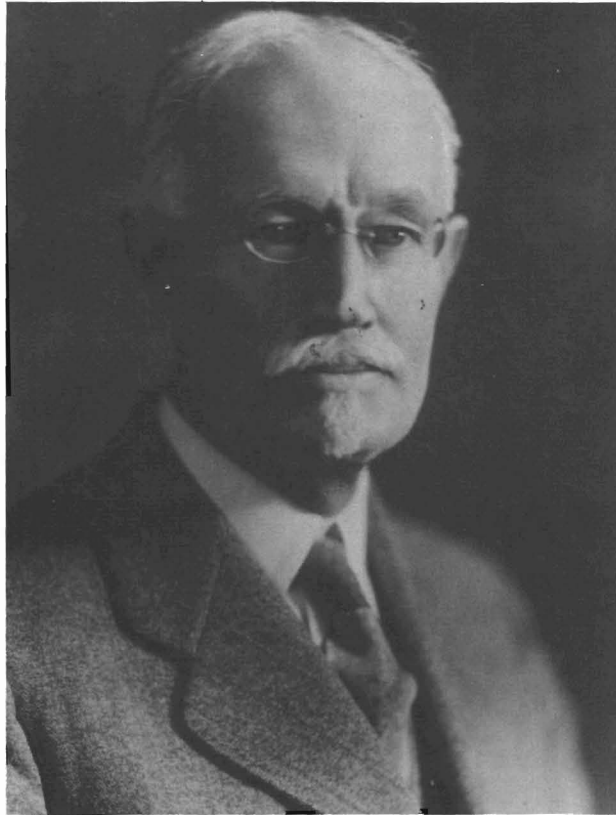


Figure 3. Dr. Arthur Gray Leonard, State Geologist, 1903-1932. Geology Department Archives.

Dr. Leonard spent the summer of 1904 becoming familiar with his adopted state. He visited areas where he could observe outcrops of various formations and noted their characteristics. He decided to continue the work of the investigations of the clays of the state. The North Dakota exhibit at the St. Louis World's Fair had contained beautiful examples of pottery made from clays in the Dickinson area.

In the Turtle Mountain area, the possibility of finding lignite deposits was a prime objective. Glacial materials cover the coal-bearing Laramie Formation and no outcrops were observed. Possible sites for the quarrying of building stones were sought and a trip was made to the Pembina Mountains to study the clays and cement rock in that area.

Professor Chandler, who had been designated Hydrographer, carried out a project in cooperation with the United States Geological Survey designed to measure the flow of all of the principal streams in North Dakota.

During the year 1904, the State Geologist initiated a program of exchange of publications with other agencies and societies which became the base of the large library that is presently shared by the North Dakota Geological Survey and the Department of Geology of the University. The work of the previous biennium was reviewed in the Third Biennial Report, which was published in Bismarck in early



Figure 4. Dr. Leonard in his office in Old Science Hall on the campus of the University.

1905. Dr. Leonard had spent considerable time in Bismarck proofreading and correcting the manuscript.

Due to the shortage of funds, Dr. Leonard took charge of a field party for the U.S. Geological Survey during the summer of 1905. The party studied the lignite deposits in eastern Montana, as well as western North Dakota. He bought nine blankets at Fort Lincoln, got horses from Custer Trail Ranch, and rented a new wagon at Dickinson. September 10th to the 19th were spent looking for the horses, after they had strayed away.<sup>8</sup>

C. H. Clapp had been appointed Assistant State Geologist and headed a field party which conducted further studies of the clay deposits in the Dickinson area. Mr. Clapp was a graduate of MIT. He was assisted by Herbert A. Goodall and J. Marshall Brannon of the University. White, high-grade clays were found to cover a wide area extending north to the Fort Berthold Reservation, east beyond Hebron, south to the forks of the Cannonball, and west to the divide between the Missouri and Little Missouri Rivers.

Dr. Leonard's party included two students from the University. It is not clear who these students were since the names of Innis Ward, H. L. McDonald, Windsor R. Holgate, and W. H. Clark are all included in the list of Survey personnel at that time.

In the early summer of 1906, Dr. Leonard made another visit to the Pembina Mountains before going to Dickinson to resume his work with the U.S. Geological

Survey on the lignite beds in the area. The results of this work would appear in a U.S. Geological Survey publication on the lignites of North Dakota. On August 6, a gale hit the camp at Sather,<sup>9</sup> doing severe damage.

Mr. Clapp visited the various clay plants in the state and collected specimens which were tested and analyzed by Professor Babcock in his laboratory at the School of Mines. Miss Bisbee continued to assist in this work. One plant was operated by the state at the penitentiary.

Following a directive of the Legislature, the Board of University and School Lands requested that the State Geologist examine certain lands in McLean County to determine if they were coal bearing. Dr. Leonard made two trips to the county for that purpose and prepared a report which he submitted to the Board.

During the summer of 1906, a quadrangle just east of Williston and another in the Bismarck area were mapped by parties from the U.S. Geological Survey. The expense of this work was borne, in its entirety, by the federal government since the Legislature had made no matching funds available.

The Fourth Biennial Report was devoted to results of the clay investigations of the Survey. Because of the large number of clay samples to be analyzed, publication of the Fourth Biennial Report was delayed beyond the usual date of publication.

During the 1907 field season, Dr. Leonard, in association with Carl D. Smith of the U.S. Geological Survey, led a party of five in completing the work of the previous two years. Later in the summer he took charge of a North Dakota Geological Survey party to extend the investigation beyond the area covered by the federal party. He was accompanied by J. W. Bliss<sup>10</sup> and W. J. Smith, students from the University.

On Little Beaver Creek, in Bowman County, the party collected a large number of fossil shells from the Pierre shale. These, together with fossil leaves from the Medora area and some fossil fish from the top of Sentinel Butte, were sent back to the University to be included in the Geology Department's collection. In the vicinity of White Butte, near the Sand Creek Post Office, the party studied Oligocene Formations which had yielded an extinct three-toed horse and a rhinoceros a few years earlier. While the party did not find many new bones in the area, they did discover several dens of rattlesnakes which provided a change of routine.

Additional work was carried out in the Pembina Mountain area by V. J. Melsted, a student assistant. All outcrops were carefully mapped.

In 1908, John G. Barry replaced C. H. Clapp as Assistant State Geologist. He was also a graduate of MIT. His work consisted of mapping portions of Pembina, Cavalier, Walsh, and Ramsey Counties. The larger deposits of sand and gravel were mapped and the data added to that obtained by Melsted the previous year. Later in the season he made a trip to the Bottineau area to investigate reports of natural gas in the area.

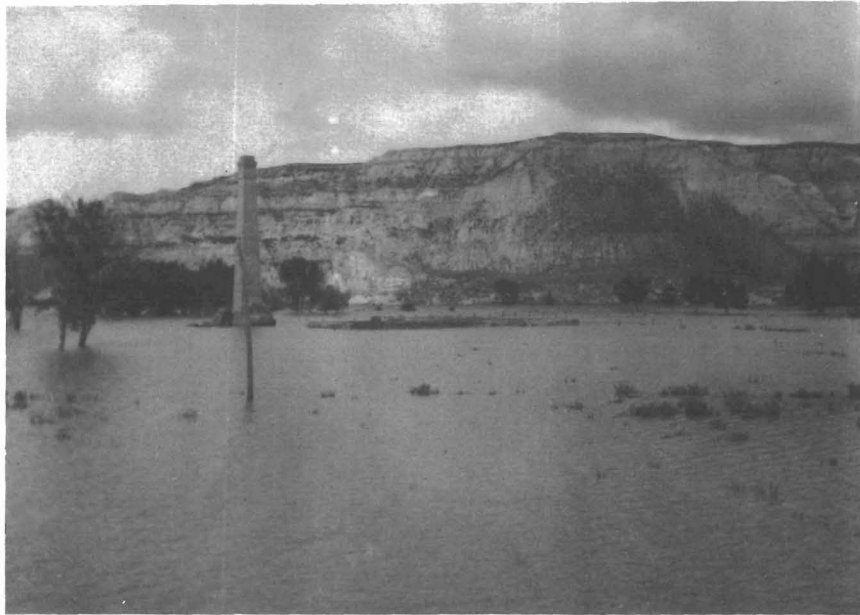


Figure 5. The flood at Medora in 1907. The smokestack marks the site of the DeMores packing plant. The waters of the Little Missouri rose almost to the Survey's camp.

The Director of the U.S. Geological Survey, in May of 1907, invited the several State Geologists to Washington to confer on plans to coordinate the work of the state and federal surveys in the hope of eliminating duplication. Dr. Leonard attended the meeting and made arrangements to continue previous cooperation in the gathering of mineral statistics and water well records, with the Federal Survey bearing all of the expenses.

New provisions which required that the states bear one-half of the expense involved in topographic mapping precluded any of that work in North Dakota during the biennium.

It was while the U.S. Geological Survey party was camped near Medora, in 1907, that they were almost wiped out by a flood, one of the highest since 1880. The water rose to within a few inches of the tents. U.S. Geological Survey geologists had joined the party to collect fossils that might determine the true age of the coal-bearing strata. They found the beds to be a more recent formation, the Fort Union (Tertiary), rather than Laramie (Cretaceous) as had been supposed. The finding of an unconformity in southern Billings County substantiated this interpretation.

The work in the vicinity of Sentinel Butte indicated that this was the highest point in the state with an elevation of 3,350 feet above sea level.<sup>11</sup>

In 1908, a party of students, led by Dr. Leonard, completed an appraisal of the coal resources of Billings County. Included in the party were two University students, Edgar H. Wells and Harry A. Hanson. The party arranged for three

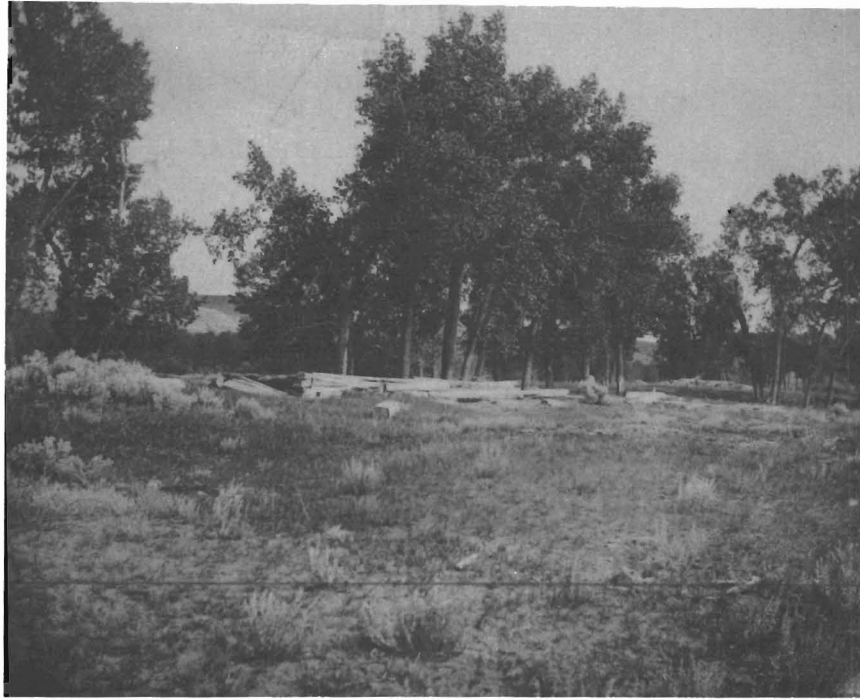


Figure 6. The remains of Theodore Roosevelt's Elkhorn ranch site 28 miles north of Medora, Billings County, ND (1908). View looking south.

horses from George Donaldson at the Custer Trail Ranch, east  $\frac{1}{2}$  sec 10, T139N, R102W, Billings County. This would become the first dude ranch in the United States. A wagon was rented from George Dremkil for \$3 per month and harness for \$43. They identified 21 different coal beds aggregating as much as 100 feet, with areas as great as 500 square miles. Many of the beds were previously unknown. At this time the U.S. Geological Survey estimated the reserves of lignite coal in North Dakota to exceed 500 billion tons.

A boat was borrowed from Charles Clark who lived about  $1\frac{1}{4}$  miles south of Mikkelson Post Office. It was used to inspect the banks of the Little Missouri for coal beds. Leonard stopped to take pictures of the remains of Roosevelt's Elkhorn Ranch cabin. He reported that it was made of logs based on blocks of sandstone and measured 60 feet by 36 feet.

The discovery of the remains of dinosaurs in the vicinity of Marmarth, at the mouth of Bacon Creek, sec 20, T133N, R105W, was an important result of the summer's work. Several bones were shipped to the University to aid in the dating of the deposition of the sediments.

Dr. Leonard usually refrained from work on Sunday, even in the field, although he might use the opportunity to move camp. The field equipment was stored at the Heaton Lumber Company, in Dickinson, at the end of the season.

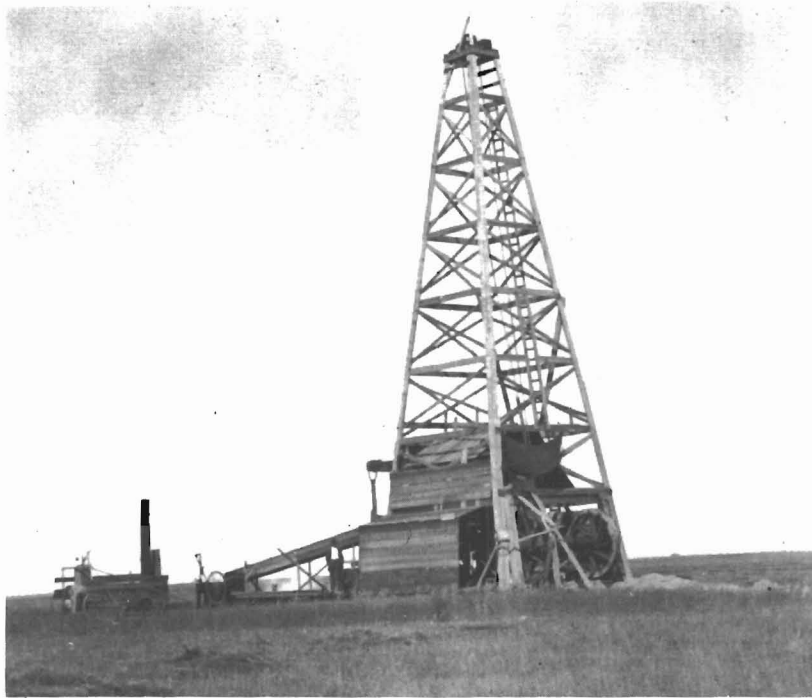


Figure 7. Standard cable-tool rig drilling for natural gas on the Parker farm south of Westhope, Bottineau County, on June 15, 1910. The operator was North Dakota Gas Co. The boiler was fired with gas from nearby wells (T161N, R80W).

Toward the end of the summer another effort was made to determine the source, and extent, of the natural gas producing areas of Bottineau County, and it was found that the area was restricted to the general area of the Parker Farm, about 10 miles south of Westhope.<sup>12</sup> The gas was determined to be coming from the base of the glacial drift and is probably a form of marsh gas. Many of the local farmers had installed separators on their water wells and were using the gas to heat barns and other structures.

At this point it should be noted that the North Dakota Geological Survey was receiving an increasing number of inquiries about the resources of the state from citizens of the state, as well as outsiders. The problem of answering the correspondence was to become an increasing burden on the time of the State Geologist who also had to attend to his teaching duties at the University and prepare reports on his fieldwork, as well as to discharge the various duties which a department head in a University must accept. Dr. Leonard was most diligent in performing all of his duties in these areas and still maintained the scholarly mien which he exhibited throughout his life.

Dr. Leonard recognized that the duty of the Survey was not only to promote the development of the existing natural resources of the state but to discourage the investment by state citizens, as well as others, in proposals which had little chance of success. He also recognized the educational value of the Survey and, accord-

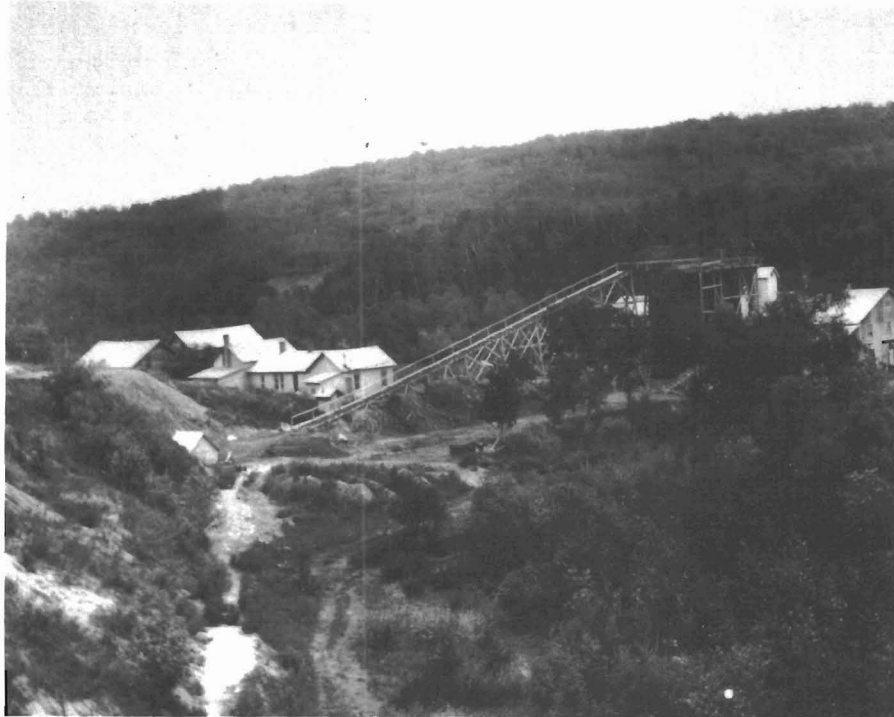


Figure 8. Plant of Northern Plaster and Cement Company at Concrete, North Dakota in 1907.

ingly, many of the early publications were worded so as to be understandable to the teachers in the public schools of the state. It is understandable that this goal is not always attainable, but Dr. Leonard was very patient with teachers who inquired about details. He also demonstrated an understanding of the concept of "land-use" which places him well ahead of his time. He recognized the needs of practical men, such as water well drillers, for good information on the conditions they might anticipate in certain areas and made an effort to satisfy each of their inquiries in detail. About 700 copies of each biennial report were earmarked for distribution to schools and additional copies were set aside for answering inquiries from people involved in the direct development of natural resources.

In 1908, a railroad was built from the site of the cement rock mine at Pembina, near the present site of Concrete, to Edinburg, a distance of 21 miles. The Northern Dakota Railway Company was formed by Thomas D. Campbell and Daniel F. Bull, along with subscriptions from local farmers, for the purpose of hauling the products of the mine. It made its last run in November, 1919, and the rails were removed in 1921. The locomotive was purchased from the Minneapolis, St. Paul & Pacific Railroad and was known, locally, as Maude.

Up to this time, the U.S. Geological Survey had published topographic maps of eleven quadrangles in North Dakota. The geology of these areas could now be mapped in detail. A nominal charge of 5 cents per sheet was made for these maps.



Dr. Leonard continued to point out to the Legislature that much more could be accomplished if they would provide matching funds for this work.

Mr. W. H. Clark, a field assistant, read a paper at a meeting of local people, at Larimore, in which he pointed out the help that the Geological Survey could provide in the construction of good roads in rural areas.

In 1909, Howard E. Simpson was appointed Assistant State Geologist replacing John G. Barry. Mr. Simpson came to the Survey from Colby College, Waterville, Maine, where he served as an Instructor in Geology and as a field assistant to the U.S. Geological Survey in the groundwater studies in Iowa during the summers.

Much of the early months of 1909 were spent by Dr. Leonard in the preparation of the Fifth Biennial Report, which was published in Bismarck. This report contained a report on southwestern North Dakota emphasizing lignite and a report on northeastern North Dakota including a summary of cement possibilities. The printing was completed in May, but it was not bound and ready for distribution until later in the summer.

Dr. Leonard and a party, composed of W. H. Clark and R. L. Sutherland, were able to spend most of the summer of 1909 in mapping the geology of the Bismarck Quadrangle, which the Topographic Division of the U.S. Geological Survey had completed the previous year.

In June of 1910, Dr. Leonard spent several days in Bottineau County preparing a report on natural gas occurrences in the area for the U.S. Geological Survey.

Gas had been used for heat and light in 13 homes in Lansford. The pressure at the first well was 64 psi but declined to about 20 psi. The gas was found at depths from 175 feet to 210 feet. The sand was about 19 feet thick. Six-inch casing was used. When the well was opened, sand, small rocks, pieces of lignite, and twigs were blown out and formed a dune 100 feet in diameter and six feet high around the well.

A company known as the North Dakota Gas Company supplied gas to the town of Westhope. The gas was brought to town through a 20-mile pipeline. The 8 wells cost 13.6 cents per foot to drill. The charges to the townspeople were 30 cents per 1,000 cubic feet in summer, and 40 cents in winter. Mr. W. H. Williamson was manager of the company.<sup>13</sup>

The work on the Bismarck Quadrangle was extended to include all of Morton and part of adjacent counties. Preglacial and glacial drainage patterns were determined and the extreme extent of glacial activity was delimited.

Dr. Simpson and W. R. Holgate spent a month in the Devils Lake and Stump Lake area investigating the old lake beaches and former outlets.

In addition to the earlier personnel, M. A. Brannon<sup>14</sup> was added as a biologist, R. T. Young as a zoologist, T. R. Atkinson as a consulting engineer, and W. H. Greenleaf and F. B. Farrow as field assistants. Mr. S. L. Ruediger, Director of the State Public Health Laboratory, was also added to the staff as a consultant.

The early months of 1911 were spent in completing the manuscript for the Bismarck Quadrangle. During the summer, a party composed of Dr. Leonard, T. T. Quirke, and O. A. Baarson studied the coal deposits of McKenzie County as they related to the geology and topography of the area and located the coal outcrops on the map.

Professor Simpson spent the summer investigating the underground waters of the Red River Valley.

Dr. Leonard continued his investigations in McKenzie County during the 1912 field season and was assisted by T. T. Quirke and Theodore Bay. Many old river valleys were identified.

The manuscript of the Sixth Biennial Report was prepared in April, 1912, and was submitted to the printer in December of that year. It was distributed in the spring of 1913. It contained a report on the geology of south-central North Dakota. Enough work had been done to permit the construction of a preliminary geological map of the state, which was published separately.<sup>15</sup>

Professor Simpson was consulted by the communities of Carrington, Cooperstown, Casselton, Max, and New Rockford regarding water supplies and spent a good deal of time in preparing reports for them. In addition, he began preparation of a report on the three seasons of fieldwork which he, and Dr. Ruediger, had completed. More than 800 water samples had been analyzed and the results would be included in the final report.

Professor Herbert A. Hard, former Director of the Agricultural and Geological Survey of the Agricultural College, requested appointment to the North Dakota Geological Survey staff in order to complete his work on the Edgeley and LaMoure Quadrangles. Mr. Frank Leverett, of the U.S. Geological Survey, supervised this work under a cooperative agreement.

Dr. Leonard spent a part of the summer of 1914 in McKenzie and Dunn Counties with Theodore Bay and J. B. Johnson. It was while in camp in SE $\frac{1}{4}$  sec 17, T149N, R99W, McKenzie County, that the party first heard of the war in Europe. They mapped the terminal moraine of the continental glacier and the bed of the glacial lakes which had occupied the valleys of Cherry and Tobacco Garden Creeks. A wagon had been purchased for \$80.

During the biennium, Dr. Leonard attended the International Geological Congress and toured the eastern Canadian provinces studying the geology and the mining operations in the area.

In his Seventh Biennial Report, Dr. Leonard reiterated his contention that North Dakota was among the lowest of the states in financial support of its Geological Survey. He pointed out that Oklahoma provided 15 times as much for its Survey. He pointed out that one-third of the area of the United States had been covered by topographic mapping but only 13 percent of the area of North Dakota. He ascribed this situation to the fact that matching funds had not been provided by the Legislature as required by the federal legislation.

The Seventh Biennial Report was devoted in its entirety to the underground water resources of the state. Water Well Drillers held a convention in Grand Forks, in June of 1915. Dr. Leonard addressed them and pointed out the services which the Geological Survey could provide and asked for their cooperation in providing the Survey with well logs.

Dr. Leonard spent the 1915 field season mapping the geology of the Ray Quadrangle and located the ancient valley of the Missouri River. He mapped the margin of the Kansan drift in Morton and Stark Counties. Professor Simpson and Dr. Heath visited the Turtle Mountains to study the springs that occur in the region and the mineral deposits connected with them.

In 1915, a wildcat was started by Des Lacs Western Oil Company on the farm of A.F. Blum, 1½ miles southeast of Lone Tree, Ward County. The well was abandoned at 244½ feet in October, 1916.

In April, 1916, Dr. Leonard visited the Williston area to determine the probability of finding oil or gas in that vicinity. He reported to John Bruegger, a local merchant, on his findings and advised against going to the expense of drilling a well. The following month he visited Marmarth for a similar purpose at the request of Governor Hanna and recommended drilling in the area. June and July were spent in Dunn County with Ralph Roy and Lyle Helmkey. The margin of the glacial drift was studied for the purpose of determining its age.

At the start of the 1917 field season, Leonard bought a team of horses from P. J. Reagan, on the Knife. He paid \$325 for Rowdy, a seven-year-old Bay Gelding, and Rocky, a six-year-old, lighter in color and larger than Rowdy.<sup>16</sup>

The Survey had procured an automobile which Professor Simpson used to study the artesian water basin in the Mouse River loop. With Walter Belyea, he constructed cross sections from Bottineau to Crosby, Kenmare to Kramer, and from Bottineau to St. John. The automobile enabled them to cover more territory than had been possible before.

During the summer of 1916, the North Dakota Geological Survey entered into an agreement with the U.S. Geological Survey for the mapping of the geology of the Ray Quadrangle. The U.S. Geological Survey party, under the direction of A. J. Collier, would map the coal outcrops in the badlands along the Little Missouri while the North Dakota Geological Survey party would study the geology in the rest of the quadrangle. The federal government would bear one-half of the expense. The North Dakota Geological Survey party, in 1917, consisted of Dr. Leonard and two University students, J. D. Leith and Doyle Watt.<sup>17</sup> His party visited Collier's camp, on Willow Creek, on August 10. The field equipment was stored at Smith's ranch, five miles from Manning. Leonard would use Smith's Ranch for several years.

Natural gas occurrences had been reported in water wells in northwestern North Dakota. These were investigated by Professor Simpson, in company with Harry Polk, a former University student. A large amount of data was procured which was included with the continuing study of underground waters by Professor Simpson.

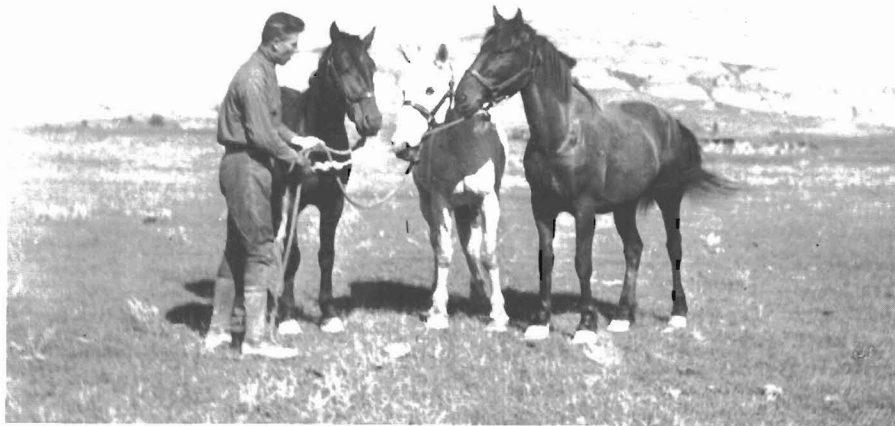


Figure 9. The three horses at the Little Missouri camp on August 28, 1918. The white horse was ridden by Dr. Leonard. The camp was on the Dave Warren Ranch in McKenzie County.

In September, 1917, the Des Lacs Western Oil Company, of Minot, asked the Survey to investigate the possibilities of finding oil and gas in the Minot area. Dr. Leonard and Professor Simpson found enough evidence to recommend further exploration. On the basis of their report, a well was drilled in the NW NE of sec 9, T155N, R85W, in 1923. The well drilled to a depth of 3,980 feet but proved to be nonproductive. It was four miles east of present production in the Lone Tree Field.

In 1918, the study of the Ray Quadrangle continued with Doyle Watt, Douglas Leith, and Lyle W. Bittinger assisting Dr. Leonard. Professor Simpson was teaching summer school at the University and was unable to do any fieldwork.

The 1919 Legislature increased the Survey's appropriation to \$3,000 which enabled the Survey to expand its activities. Dr. L. P. Dove was employed for part-time work with the Survey, in addition to his teaching duties in the Department of Geology. He began his fieldwork in 1919 but was forced to stop his work when the car in which he was riding overturned. He suffered a broken ankle. On August 1, Dr. Leonard and Dr. Ray put a plaster cast on the foot and Dove left for Grand Forks the next day. He had intended to attempt a correlation of the various coal beds in the Garrison area.

Dr. Leonard continued his investigation of the state's lignite resources. He concentrated his efforts in Ward and Mercer Counties. He was assisted by Wesley R. Johnson and Lester T. Sproule. The work in the Garrison area led to a request



Figure 10. On August 15, 1918, Dr. Leonard met with a party from the USGS at their camp 4 miles southeast of Springbrook in Williams County (sec 34, T155N, R99W). Seated left to right are two members of the USGS party (unidentified), Dr. Leonard, C. K. Wentworth, and A. J. Collier. The man standing in the rear is presumed to be either J. D. Leith or Doyle Watt, Dr. Leonard's assistants. Both were UND students.

that the U.S. Geological Survey map the topography of the area. To secure this work, the Survey provided \$1,500 in matching funds. The work was carried out by a party under the direction of J. E. Blackburn and two assistants from the U.S. Geological Survey.

Dr. Leonard continued his work on the Ray Quadrangle manuscript but took time to prepare a report on the "Possibilities of Oil and Gas in North Dakota." The report was published as Bulletin 1, in 1920, and was the result of the numerous inquiries received in the previous two years.

Dr. Dove and H. N. Eaton extended the lignite study into the northwestern counties and mapped the extent and thickness of the major beds. Samples were collected for analyses. The importance of a particular deposit was determined by its proximity to railroad facilities.

The Legislature, in 1919, had made a special appropriation for lignite investigations, and Dr. Leonard was able to draw \$18,000 against this fund during the biennium. Of this amount, \$3,000 (\$1,500 each year) was used as matching funds for topographic mapping by the U.S. Geological Survey. The results of the investigation can be found in Bulletin 4 of the Survey.

In 1921, Dr. Dove made a plane-table map of southeastern Williams County with the assistance of W. F. Key. The area was selected because of the large lignite



Figure 11. The Survey party's camp kitchen at Cusick's Spring SW NE sec 12, T154N, R98W, Williams County, North Dakota. Photo taken August 23, 1918.

beds previously located and the apparently favorable structural conditions for the accumulation of oil and gas. The area covered by his map is now a major oil and gas producing area in the state.<sup>18</sup>

Dr. Dove also carried out an investigation, in cooperation with the State Highway Department, to locate suitable supplies of gravel in the vicinity of highways under construction. The Highway Department paid the expenses of the investigators while the Survey paid their salaries. The investigation was concentrated in the central and eastern portions of the state and ample supplies were found. The Highway Department was sufficiently impressed by the results that it agreed to extend the arrangement for another year and allocated \$1,000 to pay the expenses of the investigators. This was double the amount contributed in 1921.

The 1921 Legislature had appropriated \$2,500 for the conservation and control of artesian waters in the state. The State Geologist was given the responsibility for carrying out the provisions of the act. Since Professor Simpson had devoted many years to the study of the state's water supplies he was placed in charge of the work and, with an assistant, he covered an area six miles wide from Fargo to Jamestown. Each flowing well was checked and tested. A census of all flowing wells in the state was taken and an index was compiled which showed the location of 5,000 artesian wells. Six artesian basins were identified as a result of pressure and flow rate tests.<sup>19</sup> Mr. John P. Buchanan collected 200 typical samples of well waters



Figure 12. The Survey automobile purchased in 1922. Dr. Leonard in middle with two unidentified assistants.

which were analyzed and reported in a publication of the U.S. Geological Survey. A new automobile was purchased in 1922 and completed its first 1,000 miles on July 15. The day before it had made 150 miles on 7 gallons.

The Legislature continued the \$3,000 appropriation for the Survey but added, for the first time, \$1,250 for matching funds to continue the topographic mapping of the state. In addition, the State Highway Department provided \$1,000 toward the expenses of a party to study the "clinker" deposits between Sentinel Butte and Glen Ullin. This material was widely used for road surfacing material in the western part of the state where gravels are scarce.

#### EMERGENCY AND OPPORTUNITY

The 1923 Legislature made no appropriation for the Geological Survey, although it continued the appropriation of \$1,250 for matching funds for the topographic mapping program. A thousand dollars, which had been set aside for the topographic mapping program, was used to continue the lignite investigation. The funds provided by the Highway Department permitted Dr. Leonard to continue the survey of gravel deposits. He was assisted by Herbert A. Hard.

Bulletin 2 (Artesian Water Conditions in North Dakota) was published in 1923, and Bulletin 3 (Methods of reducing the Flow of Artesian Wells) was published in 1924. Both were written by Professor Simpson and published at Grand Forks.

During the biennium, the Survey received several requests for evaluations of particular areas as to oil and gas possibilities. The areas included Bismarck, Turtle Lake, Kathryn, Cooperstown, Marmarth, and McClusky.

From 1925 through the 1934-35 biennium, the Legislature made no appropriation for the Survey or for topographic mapping matching funds. During this period, the

office expenses of the Survey were borne by the Geology Department of the University. Professor Simpson was out of the state during the 1925 field season, and no fieldwork was done since no one could be found to carry out the artesian well inspection program for the per diem allowed by the Legislature.

An automobile had been purchased by the Artesian Water Fund in 1921, and Mr. Simpson used it to conduct well measurements in the summer of 1925. By utilizing sleeping adjustments in the car, as well as tents and doing their own cooking, Professor Simpson and his assistant, Robert B. Simpson,<sup>20</sup> were able to reduce their expenses to a minimum. The areas surveyed included portions of Grand Forks, Cass, Richland, Ransom, and LaMoure Counties.

Due to the lack of funds, about the only work carried out in the 1927-1928 biennium was the inspection of artesian wells, which could be done with funds allocated to the State Water Geologist. Professor Simpson was assisted in this work by Robert B. Simpson and Herbert H. Sand.<sup>21</sup>

The U.S. Army Corps of Engineers held a hearing at Jamestown, on May 9, 1930, to consider the Missouri River Diversion project. Professor Simpson testified at the hearing; and in July he accompanied Secretary of War, Patrick J. Hurley, on an inspection of the Devils Lake basin. On the recommendation of the U.S. Geological Survey he carried out several groundwater studies in Canada.

On December 17, 1932, Dr. Arthur Gray Leonard died at Grand Forks. He had served as State Geologist for 30 years. For 9 of those years, the Legislature had withheld appropriations for the Survey and 14 of those years the appropriation had been restricted to \$1,000 per year. Yet, Dr. Leonard was able to keep the Survey a working agency. Professor Simpson was appointed Acting State Geologist in January of 1933, and State Geologist in June of the same year.

In November, 1933, the Civil Works Administration, the Emergency Relief Administration, the Emergency Administration of Public Works, and the National Resources Board began their activities in North Dakota. They utilized the Geological Survey as the key to their programs and the Survey became more active than at any time in its prior history. Since the funds for these activities became available after the close of the field season, the first months were spent in repairing the ravages of the years without funding.

The Library, of more than 16,000 items, was cleaned, repaired, catalogued, and shelved according to the latest accepted practice. The Museum was reorganized and 5,900 items were cleaned, sorted, and labeled. New material, accumulated over the years, was prepared and catalogued. The collection of 15,000 maps was cleaned and repaired and many were mounted on cloth. The field notes of the Survey were indexed and all material relating to the artesian well survey was rearranged in permanent files.

The State Geologist was made Principal Water Geologist for the Public Works Administration. Herbert H. Sand was designated Deputy State Geologist and Frank C. Foley, Assistant Professor of Geology, was given the job of directing ground-





Figure 13. Professor Howard E. Simpson, State Geologist, 1933-1940. Chester Fritz Archives.

water investigations in the northwest part of the state which had experienced the least rainfall for the previous five years.

Illness, brought on by the strain of years of keeping the Survey going without state support, caused the State Geologist to request leave of absence during the 1935-36 academic year. His duties were assumed by Frank C. Foley, Assistant State Geologist. During the summer months, Dr. Foley took charge of a field party for the Newfoundland Geological Survey. While he was away, Herbert H. Sand became Acting State Geologist.

Simpson resumed his duties in September, 1936, except for the ex-officio membership on the State Planning Board on which he was represented by Foley. During August of 1935, Foley, assisted by Andrew G. Alpha, made a study of the sodium sulfate deposits in Divide and Williams Counties. The deposits were mapped and samples were analyzed by Philip W. West. The fieldwork supplemented the work of Dr. Irvin Lavine done in 1934, as a FERA Project.

Herbert Sand, assisted by Sverre Scheldrup and Alpha, studied pressure changes in deep artesian wells near Edgely and Ellendale.

The State Geologist maintained an active interest in the Missouri River Diversion Project and presented briefs and testimony at various hearings concerning the

proposal. As a result of the interest shown, the federal government allocated \$100,000 for a study of the economic benefits of the project by the Corps of Engineers.

The 1935 Legislature had appropriated \$1,725 per year, which was increased to \$3,750 by the 1937 Legislature, which also added \$1,250 as matching funds for topographic mapping.<sup>22</sup>

In 1933, Professor William E. Budge, of the School of Mines, had taken an interest in the occurrence of oil shale and oil seeps along the Sheyenne River south of the Fort Totten reservation. These had been called to his attention by interested citizens of Warwick. He made several trips to the area and attempted to get an appropriation from the 1935 Legislature to make further studies of the area in secs 20 and 21, T151N, R65W, but was unsuccessful. Since the area is covered by glacial drift, Professor Budge felt that only seismic methods could determine the structural features of the area.

On August 15, 1938, the California Company abandoned its Nels Kamp #1, located in NW NE sec 3, T145N, R96W, Williams County. This well would prove to be only 1,866 feet from a producing well drilled in 1956. At 10,281 feet, total depth, the Kamp well had penetrated the Madison Formation which is the productive formation in the area. It appears that the Kamp well was circulating mud at the time and any shows were overlooked.

Upon the death of Howard Simpson in 1938, Dr. Frank C. Foley became State Geologist. He had received his Ph.D. from Princeton. In April, 1939, the Survey staff consisted of Dr. Foley and he was also supposed to be teaching full time.<sup>23</sup>

No appropriation for the Survey was made by the 1939 Legislature, but the 1941 Legislature did allocate \$3,365 per year plus \$5,000 per year for topographic mapping.

Dr. Foley and Dr. Robert B. Witmer, of the Physics Department at the University, constructed an instrument for the measurement of resistivity and conducted a geophysical survey in the vicinity of West Fargo. They used a Model A panel truck and were accompanied by Allen Byers of the U.S. Geological Survey. The study was undertaken in cooperation with the city of Fargo in an effort to solve the water supply problems of that city. The instrument did not prove very successful. Mr. Byers drove the truck back to Grand Forks where it was allowed to sit outside until the radiator froze.

Dr. Wilson M. Laird came to North Dakota in February of 1941 with his Ph.D. from the University of Cincinnati and earlier degrees from North Carolina and Muskingum. He was appointed State Geologist July 1, 1941, and shortly after assuming the duties of State Geologist, Dr. Laird was invited to attend a meeting of the American Association of State Geologists in Washington, D.C. He was undecided as to whether he should attend since he might be considered a young "whipper-snapper" by the older members. He took his problem to Dr. John C. West, President of the University. "By all means go to the meeting, Wilson," West said,

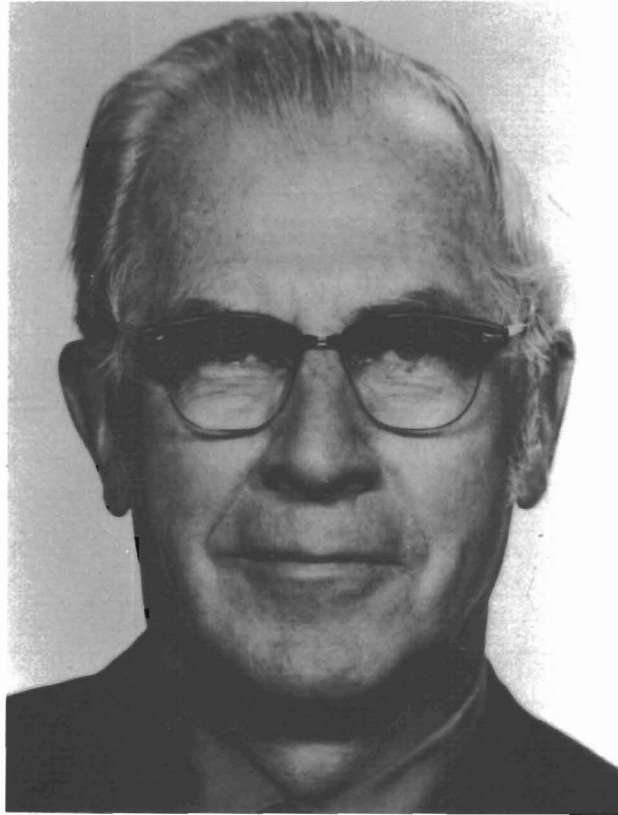


Figure 14. Dr. Frank C. Foley, State Geologist, 1940-1941. Geology Department, University of North Dakota.

"and sit by the radiator so you can remind them you are there if they try to overlook you." Dr. Laird was elected Vice-President of the Association in 1948 and became President in 1950.

In 1939, a party composed of E. E. Tisdale and Bert Timm did some fieldwork in the Heart Butte area. Their work culminated in the publication of Bulletin 13 of the Survey (The Geology of the Heart Butte Quadrangle). This bulletin appeared in 1941, after Dr. Foley had left the Survey. It was the second publication, since Bulletin 4 (1925), which had not been published by using Water Geologist's funds. Bulletin 12 (Selected Deep Well Records, compiled by Wilson M. Laird) had been published earlier in 1941.

The 1941 Legislature appropriated \$3,365 per year for the operation of the Survey and \$5,000 per year for topographic mapping. The Model A van had been traded for a 1934 Plymouth and it was used to transport a field party of E. E. Tisdale, Howard A. Garaas, and Kenneth Peterson to the mouth of the Cannonball River where they camped on the John Sullivan ranch (the Cannonball Ranch). The Plymouth developed tire and fuel pump troubles and detracted from an otherwise successful field season.



Figure 15. Dr. Wilson M. Laird, State Geologist, 1941-1969. University Relations.

Dr. Laird was at the field camp and spoke at the 4H camp at Lake Metigoshe before traveling to Winnipeg to confer with Mr. Ed Leith, of the University of Manitoba, about a field trip for the Northern Great Plains Geological Society in October. Mr. Tisdale left the Survey at the end of the field season and was replaced by Dr. J. Stevens Templeton.

Dr. Templeton was interested in glacial geology and set out to study the leaching of calcium carbonate in the glacial till. He found the depth of the leaching to be, generally, less than eight inches. He also completed the geologic mapping of a quarter of the Emerado Quadrangle. In 1942, Dr. Laird and Professor R. H. Mitchell, of Muskingum College, completed the mapping of southern Morton County and began the manuscript which would become Bulletin 14 (*The Geology of the Southern Part of Morton County, 1942*).

Miss Marie Lange, an assistant in the Geology Department, did some laboratory work on the heavy minerals in the Hell Creek and Cannonball Formations. She was assisted by Miss Ada Swineford.

An Oil and Gas Conservation Law was enacted by the 1941 Legislature, although the only production in the state consisted of a minor gas field in the Eagle Pool on the Cedar Creek anticline, Bowman County.<sup>24</sup> The Law was based on the then Model

Act drawn up by the Legal Committee of the Interstate Oil Compact Commission. It made the Industrial Commission the regulatory power and designated the State Geologist as the advisor and enforcer of the regulations promulgated by the Commission.

Dr. Laird and an attorney with the Carter Oil Company, Forrest Darrough, were active in seeking the passage of this legislation. They got vigorous support from such members of the Legislature as Clyde Duffy, of Devils Lake, and George Saumur, of Grand Forks County. The Industrial Commission enacted rules based on those recommended by the Regulatory Practices Committee of the Interstate Oil Compact Commission.<sup>25</sup>

The Survey had no full-time employees in 1941, and its work was generally carried out as a cooperative venture with the U.S. Geological Survey which published any reports which resulted. Because of this, most of the work involved water studies such as the augmentation of supplies for Oakes, Fargo, and Camp Grafton. It was proposed that the observation of wells and study of Pembina County be continued.

During the fall of 1942, the 22nd Biennial Report was prepared for publication. The Army Specialized Training Program at the University began in 1943, and the Geology Department became involved in the program. This caused fieldwork to be restricted to the area near Grand Forks. As a result, the fieldwork consisted of completing the mapping of the Emerado Quadrangle which had been started by Dr. Templeton. "The Geology of the Turtle River State Park" was published in the State Historical Society Quarterly and reprints were issued as Bulletin 16 of the Survey. Bulletin 15 (The Manganese Deposits of the Turtle Mountains, North Dakota, 1943) was reprinted from Economic Geology, v. 38, no. 7. It was written by Thomas A. Hendricks, of the U.S. Geological Survey, and Wilson M. Laird.

The appropriation for the 1943-1945 biennium was \$3,467 per year plus \$5,727 for topographic surveying. Beginning on July 1, 1944, the state contribution for topographic mapping was made through the State Water Commission. This program initiated by Leonard has continued so that through 1978, 75 percent of the state has final copy coverage, 90 percent has preliminary or advance copy available and the remaining 10 percent is authorized.

During the second year of the biennium, Dr. Laird began detached service with the U.S. Geological Survey in Montana. He was able to return to the state during the legislative session to present the Survey's budget request. His presentation resulted in an appropriation of \$7,575 per year for the 1945-1947 biennium.

During the summer of 1944, the State Geologist was on leave of absence to work with the U.S. Geological Survey in its studies of the oil and gas possibilities in Montana. Dean L. C. Harrington, of the School of Mines, watched after the business of the Survey.

A permit was issued for the drilling of a well in Emmons County, by Northern Ordinance-Franklin Investment Company. It was a dry hole. A "blow-out" was

reported from Slope County but it turned out to be only a rather interesting landslide. Dr. T. T. Quirke continued an investigation of ancient shorelines of Devils Lake. A study was conducted for the town of Fessenden and enough water was found to save the town the expense of trucking from Heimdal, 14 miles away.

The 1945 Legislature passed an appropriation of \$7,575 per year. In the summer of 1945, the State Geologist continued his work for the U.S. Geological Survey in Montana. Cooperative work on water supplies continued with the State Geologist representing the State Water Conservation Commission in its dealings with the Groundwater Branch of the U.S. Geological Survey. Projects underway included a study of the Oberon Quadrangle, by Paul R. Tetrick; the Flora Quadrangle, by John R. Branch; the Maddock Quadrangle, by John R. Ball; the Lake Agassiz Basin, by Wilson M. Laird; and a popular treatise on the geology and geography of North Dakota for use by the public schools in the state.

In 1947, Mr. Irving Grossman was appointed Assistant State Geologist and worked on a study of the sodium sulfate deposits in the northwestern part of the state. The appropriation for the biennium was \$8,512.50, annually. Dr. Laird continued the practice of hiring graduate students for summer work, paying them expenses, and a small stipend in some cases. Some of those employed in 1947 were Eric Engbrecht, David Easker, Howard Garass, John Manry, Stanley Fisher, and Kouang Shu Toung.

During the summer of 1949, Dr. Laird worked in Canada on a study of formations present there. He felt that the work in Montana and Manitoba had given him an unusual opportunity to become acquainted with the strata of the Williston Basin before the advent of oil production in North Dakota. The Geology Department's collections contain many specimens that he acquired in the pursuit of these projects.

State Geologist, Wilson M. Laird, became President of the American Association of State Geologists in 1950. In May, he was granted leave of absence to carry out a confidential mission for the United States Government in Turkey and Germany. During his absence, Stanley P. Fisher was Acting State Geologist from June 1 to September 1, 1949. Nicholas N. Kohanowski who had joined the Geology Department faculty in May, 1949, replaced Irving Grossman as Assistant State Geologist.

## OIL!

Due to the absence of Wilson Laird, Mr. Kohanowski signed the drilling permit for Amerada Petroleum Corporation's #1 Clarence Iverson well to be drilled in the SW SW sec 6, T155N, R95W, Williams County. The permit was issued on August 4, 1950. Drilling began at 6:00 a.m. on September 3. On January 4, 1951, a drill-stem test, from 10,452 to 10,803 feet, recovered one pint of free oil in the bottom of the

test tool. The recovery was from the Devonian Formation. The well was completed in Silurian Formation on April 4, 1951. Dr. Laird was present at the completion.

The 1951 Legislature had raised the Survey's appropriation and had adjourned before the discovery of oil in the Iverson well. They had appropriated \$11,250 per year but the work of the Survey was so greatly increased in connection with its oil and gas conservation responsibilities that it was necessary to apply to the Emergency Commission for additional funds. The Commission allocated an additional \$7,977 to supplement the main appropriation. Two additional personnel were added to handle the extra workload.

One of the duties imposed on the State Geologist by the Oil and Gas Conservation Law was the collection and storage of cores and samples from wells in the state. These had been stored in several sheds around the UND Campus and, in 1953, the Survey asked for funds to provide a steel storage building to be erected east of the stadium.<sup>26</sup> Twenty thousand dollars was allowed for the purpose. The regular appropriation for the Survey was \$155,000 per year. This sizable increase allowed the State Geologist to expand his staff by 15 people after July 1, 1953. During the period 1952 to 1958 the geological staff was increased by six with the work being concerned primarily with subsurface studies of the information provided by oil exploration.

Miller Hansen had joined the Survey in May 1951,<sup>27</sup> and he carried out a number of geophysical studies, primarily geomagnetic, in the Tioga area; he also conducted a study of limestone for a cement plant in southwestern North Dakota. Other investigations were carried out by graduate students and by Oscar Manz, from the Ceramics Department. A number of mimeographed circulars were prepared for distribution. These consisted of the well history and core and sample descriptions of various discovery wells and important wildcats. These found wide acceptance by prospective drillers. Two hundred and seventy-four of these circulars were compiled before the series was discontinued, in 1967, due to the reduction in exploratory drilling in the state.

The 1953 Legislature had revised the Oil and Gas Conservation Law to conform to a more recent version of the Model Act of the IOCC.<sup>28</sup> They adopted all but the special provision for statutory unitization. The new act included market demand proration. C. B. Folsom, from the New Mexico School of Mines, was appointed Chief Petroleum Engineer for the Survey in September, 1953. He immediately started to update the rules to reflect the new law. As might be expected, the new rules reflected the rules in effect in New Mexico to a great extent. Exceptions were to be found in the proration allocation formula which included a factor for spacing and in the provision for a temporary spacing in a new pool which would allow time to collect reservoir data before establishing a "proper" spacing. Other differences included reporting procedures.

The new rules were adopted as of December 1. The first spacing order under the new rules provided for 160-acre temporary spacing in the Sanish Pool, McKenzie County (Order 4, January 19, 1954).

By including the spacing unit in the allocation formula, the royalty owners' interest in well spacing became moot because the royalty owners received the same amount of production regardless of the number of wells on the spacing unit.

Over the next two years, a series of hearings set temporary and proper spacing patterns for most of the existing pools. Others were brought up for hearing as they were discovered. Within five years after the Iverson discovery, 30 oil pools had been discovered in North Dakota. As of 25 years after the discovery, there were 180 pools in the state.

In early 1965, North Dakota became the first state to suspect that market demand proration had not preserved the original productive capacities as had been supposed. In November 1965, proration was halted and operators were challenged to produce the amounts of oil that their records indicated that they could. None could respond and this information was passed on to other states; but it was not until about 1974 that the last of the states accepted this view and abandoned market demand proration, although some still make a pretense of it.

On October 1, 1964, the well-head price of Grenora-Madison crude oil in Williams County, North Dakota, was \$2.215 per barrel delivered into the pipeline. In 1969, this price was \$2.32 per barrel, and today it is over \$5.00 per barrel. When the oil was selling for \$2.32 in the field, the producers of a similar oil in Saskatchewan and Alberta were selling their oil to refineries in St. Paul, Minnesota, for 9¢ a barrel below that of the North Dakota producers. It was this situation that contributed to the decline of exploratory drilling in North Dakota. It did not recover until 1973, after OPEC had imposed their greatly increased prices. During the summer of 1978 there were more rigs drilling in North Dakota than at any time since the mid-fifties.

During the 1955-1957 biennium, the major interests of the Survey focused on subsurface geology as it might apply to oil and gas exploration, but there was an attendant rise in interest in uranium geology and glacial geology.

During the early years of the oil development in North Dakota, Bismarck was the active center of the exploration activities. Several major companies, a number of independent producers, and a great many consulting geologists and landmen set up their offices there. Williston remained the center of operations and supplies with a number of company offices located there.

Almost from the beginning there was considerable criticism of the location of the Survey at Grand Forks. This was occasioned by the fact that the well records and well logs were at the University and this made them difficult for the consultants and small operators to examine. Each session of the Legislature was faced with requests that the Survey be moved to Bismarck. Dr. Laird was able to defeat these proposals by pointing out the advantages of having the Survey and the Geology



Department together at the University. He made it a practice to provide financial aid to graduate students of the Geology Department for North Dakota studies and several theses and dissertations were published by the Survey. Department faculty were also employed by the Survey during summers.

However, he moved to blunt the criticism by setting up branch offices at Bismarck and Williston. Field inspectors were stationed at these offices and were furnished with duplicate well files and well logs. As the oil activity waned toward the end of the fifties, most of the companies and independent operators closed their Bismarck offices leaving only a few consulting geologists and some local drilling contractors.

Another conflict arose over the matter of the well-spacing policies of the Industrial Commission. Because of the greater average depth of the producing reservoirs and the low permeabilities and porosities in the limestones, the operators usually requested that initial spacing be set at least no denser than one well to eighty acres. Almost without exception these requests were opposed by the landowners. The operators appeared before the Commission with carefully prepared exhibits and expert witnesses while the landowners generally presented nothing more than their feelings on the matter. When represented by attorneys, they were usually attorneys with little or no knowledge of petroleum production. As a result, the Commission usually granted the applications since the only evidence in the record was that which supported the request.

Dr. Laird was accused of advising the Commission to approve the applications because he had many acquaintances in the oil industry. As a corollary he was accused of being against the landowners. Some people felt that the Commission had no control over their technical advisors since the State Geologist was appointed by the University President. These people felt that the Commission should be allowed to hire and/or fire their advisors at will.

The attack on Dr. Laird was opened with a radio broadcast by Mayor Walter G. Burk, of Williston.<sup>29</sup> Mayor Burk was an attorney who had appeared before the Commission on several occasions as a representative of landowners. At the time of the broadcast, he was a candidate for the State House of Representatives. He was elected. His primary campaign issue was a proposal that an Oil and Gas Commission be set up to take over the regulatory duties of the Industrial Commission and with authority to name its own technical advisors.

The debate reached a crescendo on February 18, 1959, when Representative Burk arose on the floor of the House to accuse Dr. Laird of having accepted favors from oil companies, including air transportation and entertainment, in return for his support of their interests. It was true that oil companies had provided air transportation for the Industrial Commission and members of its staff attending meetings of the Interstate Oil Compact Commission of which the Governor was a member and Dr. Laird was a Vice-Chairman.

Dr. Laird pointed out that no request for reimbursement had been made to the state for these trips and was able to document the dollar savings to the state.

When Representative Burk moved that his remarks be printed in the Journal of the House, his move was opposed by Representatives Streibel, Esterby, Link, and Wolf, all of whom delivered extended remarks praising the Commission and Dr. Laird for their work. The request to have Representative Burk's remarks included in the Journal was defeated. Also defeated was Burk's proposed resolution to have a legislative research committee study the possibility of a separate commission.<sup>30</sup>

As the petroleum industry settled into the doldrums of the '60s, the criticism subsided.

#### A CHANGE IN DIRECTION

As the decade of the sixties dawned, a cooperative program to study the groundwater resources of the state was initiated. Under the program, a Board of County Commissioners or Water Management Boards could request such a study of their county and upon furnishing part of the cost of the study, it would be undertaken as a joint effort of the NDGS, USGS, and the North Dakota State Water Commission.

The State Survey mapped the geology of the county, the USGS provided studies of the water quality, and the Water Commission did the test drilling and testing. The reports of the study, in three parts, were published jointly by the Survey and the Water Commission.

The first of these studies was undertaken in Kidder County and the reports appeared as Bulletin 36 of the State Survey in 1962. In the ensuing years, similar studies have been completed in 30 counties with partial completion in 21 others. The reports have been very popular in several quarters. When interest developed in possible shallow oil production in eastern North Dakota, the geologic parts of these reports were in good demand. Many editions have been exhausted.

Dr. Laird was confined to the hospital in May and June of 1961 and was unable to do much fieldwork that year. It had become apparent that a knowledge of glacial deposits resulting from ablation of stagnant ice was going to be essential to the understanding of the surficial deposits which covered most of the state and would be of primary importance in the understanding of the groundwater conditions in that area.

The University of North Dakota Institute for Glacial Research was formed in 1961, and a request for a grant was made to the National Science Foundation which would permit the Institute to send a party to study glaciers in Alaska which were deemed to provide similar conditions to those that had created the surface deposits in North Dakota.

A glacier on the Martin River, east of Cordova, was selected and a party arrived on the location in the summer of 1962. The operation was financed by NSF Grant #22016. Dr. Laird led the party but left after a short time to conduct other Survey business. In the party were Dr. John Reid, from the Geology Department; graduate students Lee Clayton and Sam Tuthill; and an undergraduate, Gerald McDonald. The party established its camp at the foot of the glacier and named it Camp Cameron in honor of the Survey's technician who had done most of the work in getting together, packing, and shipping the party's equipment.

Prior to their departure, the Survey held a going-away party for them at which Miller Hansen introduced the following song that he had composed for the occasion:

Doc Laird left North Dakota in 1962  
He took along Sam Tuthill and he took Lee Clayton too  
With Dr. Reid his partner they made a merry band  
Headed north to the Martin Glacier  
In a dark and lonely land

North to Alaska--North the rush is on, etc.

They borrowed for equipment  
They borrowed for their fares  
They borrowed for their weapons  
To chase away the bears  
They cared not for mosquitos  
And for a note of cheer  
They took 3 jugs of whiskey  
And a thousand cans of beer

North to Alaska, etc.

Out on the Martin Glacier the wind was wild and free,  
Doc Laird said, "This ice field's just not the place for me,  
I'd give all the ice in the glacier  
and the salt in the deep blue sea  
To be back in my Grand Forks office with \_\_\_\_\_ on my knee."

The party returned in 1963 to complete its work and, upon its return, filed a request with the U.S. Board of Geographic Names to have the glacier named Sioux Glacier. This request was denied.

Following the earthquake, in 1964, Laird, Tuthill, and Ted Freers, a Survey geologist, returned to the site to determine the changes that might have resulted from the earthquake. They found that a great many landslides had occurred and the glacier was subsequently named the Slide Glacier.



Figure 16. The Geological Corps in 1965. Left to right: Wilson M. Laird, John Bluemle, Sid Anderson, Dan Hansen, Clarence (Kelly) Carlson, Ted Freers, E. A. Noble. Compare the 1964 Ford Station Wagon with the earlier Survey vehicle. Picture by Jack Kume.

From 1896, when Babcock made his survey of possible cement rock potential in the Pembina area, interest in the development of a cement plant in North Dakota has continued to the present.

In 1961, Dr. Laird proposed that the Survey make a study of the limestones which might occur near enough to the surface in eastern North Dakota to be minable. The study would include a core drilling program and analyses of the cores. The North Dakota Economic Development Commission agreed to provide the necessary funds.

In the fall of 1962, Miller Hansen and a party of Survey geologists made reconnaissance surveys which aided in the selection of specific sites for the test holes. Clarence Carlson and Ted Freers supervised the drilling program. The cores were analyzed chemically and by X-ray diffraction techniques. The results indicated that the best materials encountered were deficient in calcium carbonate and would have to undergo beneficiation by the addition of imported limestone.

Again, in 1967, at the request of the North Dakota Resources Development Corporation, the Survey entered into a contract with the U.S. Department of Commerce for a further study. This study was aimed primarily at determining if Ordovician limestone of the Red River or Winnipeg Formations might be available for blending with the Niobrara. The Commerce Department furnished a portion of the

funds for the drilling program with the balance of the cost of the program furnished by the North Dakota Resources Development Corporation. The program was administered by the Survey with assistance of the UND Geology Department.

The results of this program were that limestone is present at shallow depths in the Grand Forks area but magnesium might be a problem for a Portland grade product. The drilling was supervised by Sidney B. Anderson and Harald C. Haraldson, who had joined the Survey after leaving Canada during the decline in oil exploration there.

A third drilling program, funded by the Economic Development Commission, had for its purpose the location of possible deposits of gypsum in northeastern North Dakota. The presence of large deposits in Canada, just north of the border, was the catalyst for the program. The State Water Commission drilling rig was used and several holes were drilled in Pembina County. One of these encountered a heavy flow of water which was contained with great difficulty. Anderson and E. A. Noble were in charge of the drilling program. The drilling did not encounter the beds being developed in Manitoba and only thin stringers were noted in the older formations.

During the summer of 1962, Dr. Laird went on a tour to visit other campuses and study their geology buildings. The trip was the result of a legislative appropriation in the amount of 1 million dollars which was supplemented by a gift of \$33,000 from Amerada Petroleum Corporation (donated for the purpose of equipping an X-ray laboratory) and a grant of \$117,500 from the NSF.

Contracts were let in the summer of 1963 and ground was broken on September 16 of that year. A cornerstone-laying ceremony was conducted on May 8, 1964, by the Masonic Grand Lodge of North Dakota. The Survey and the Department moved into the new structure during the Christmas break in 1964.

The building is located on an extension of Cornell Street near the southern boundary of the UND campus. It contains 67,000 square feet of area on three floors and a basement. It is air-conditioned and the cost was about \$1.20 per cubic foot. It was named Leonard Hall in honor of Arthur Gray Leonard. The building committee was made up of F. D. Holland, Jr., Chairman, Wilson M. Laird, Nicholas N. Kohanowski, Walter L. Moore, John R. Reid, Frank R. Karner, Alan M. Cvancara, and C. Burton Folsom, Jr. The architects were Wells, Denbrook, and Associates, and the general contractors were Lenci and Englund, Inc.

Leonard Hall was dedicated on October 7 and 8, 1965, with a Symposium on "Geology in Modern Science." The principal speaker was J. Cordell Moore, Assistant Secretary of the Interior--Mineral Resources. Other speakers were Wilson M. Laird, UND President George W. Starcher, Lt. Gov. Charles Tighe, Martin J. Kruse,<sup>31</sup> and F. D. Holland, Jr.

Speakers at the symposium were William T. Pecora, Director, U.S.G.S.; Gerald E. Eddy, State Geologist of Michigan; James W. Snider, Chief Geologist with Amerada Petroleum Corporation; and Carey G. Croneis, Chancellor, Rice University.



Figure 17. Air view of campus area in 1962 showing the geology building, Babcock Hall and sites of Leonard Hall and the new core library. The geology building housed the Survey and the Geology Department from 1948 until the expansion of the Survey staff following the discovery of oil in 1951. The Department then moved to Babcock Hall and the Survey was housed in the geology building until its move to Leonard Hall in 1964. Chester Fritz Archives.

Miller Hansen resigned the position of Assistant State Geologist in the fall of 1964 and was replaced by Dr. E. A. Noble in February of 1965. Dr. Noble received his Ph.D. from Wyoming and had earlier degrees from New Mexico and Tufts. He had been with the AEC prior to coming to North Dakota. At that time some uranium ore was being recovered from lignite in North Dakota by burning the material and recovering the ash. The project was discontinued in 1967 after about 85,000 tons of ore had been shipped.

In July, 1969, Dr. Laird took a leave of absence from UND and served as consultant to the State of Alaska, in regard to the proposed oil pipeline from the North Slope. Later that fall, he was appointed Director of the Office of Oil and Gas in the Department of Interior. He later resigned from the Faculty of the University to become Director of the Exploration Committee of the American Petroleum Institute. He was given the rank of Professor Emeritus of Geology by the University.

Dr. E. A. Noble became State Geologist when Dr. Laird began his leave of absence. During his tenure the Survey continued the county groundwater cooperative studies with the State Water Commission and the U.S. Geological Survey. The practice of providing financial assistance for graduate student studies in North Dakota and the use of students by the Survey was also continued.



Figure 18. Dr. Wilson M. Laird turns the first shovel of earth for the construction of Leonard Hall on the campus of the University of North Dakota on September 16, 1963. Left to right, Myron Denbrook, architect, F. D. Holland, chairman of faculty building committee, Sulho Norri, Superintendent Lenci & Englund, Dr. George W. Starcher, President of UND.

About this time, the Survey began to put greater emphasis on its activity in the areas of environmental geology and assistance to the state's educators. Members of the Survey had routinely participated in camps and other educational activities but no effort had been made to cover the field completely. John Bluemle made a large contribution with his guides to the geology of the various regions of the state, together with field trip road log guides designed for use by earth science teachers in the public schools. He also revised and updated the geology of North Dakota for use by nongeologists in a publication entitled "The Face of North Dakota, the Geologic Story."

With the increased interest in the mining of lignite, the Survey turned its attention to problems that would arise from the increased activity including the problems relating to the reclamation of mined lands. Assistant State Geologist Miller Hansen, in 1964, had published a brochure reviewing the lignite resources of the state and in the same year, Clarence G. Carlson made a study of the spoil banks at existing mines in response to a resolution passed by the Legislature. The 1969 session resulted in Chapter 332, Session Laws 1969, providing that the Public Service Commission would be responsible for regulation of reclamation of mined lands. The Survey has been part of an advisory committee to the PSC on reclamation matters and as such had input in revisions of the reclamation laws in subsequent legislative sessions. The Survey also began studies of problems associated with reclamation and these studies are continuing in Dunn, Mercer, Oliver, and McLean Counties, mostly under the supervision of Gerald Groenewold.

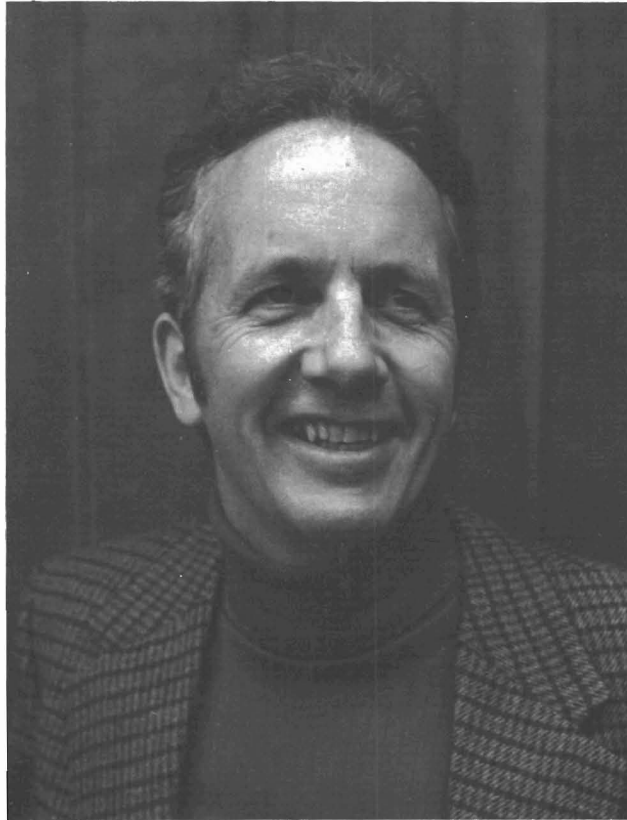


Figure 19. Dr. E. A. Noble, State Geologist, 1969-1978. University Relations.

The 1975 session of the Legislature passed laws providing for regulation of exploration for coal and subsurface minerals. These laws were similar to the oil and gas law in that they provided that the Survey, acting for the Industrial Commission, has the task of issuing permits and enforcing regulations. They also provide that information obtained from exploration shall be filed with the State Geologist. However, the laws provide for confidentiality periods which for coal may extend for as long as seven years.

The Survey began a cooperative drilling project in 1975 with the Conservation Branch of the U.S. Geological Survey to evaluate the lignite resources of western North Dakota. This program has provided public information in many areas of 16 counties during four seasons of drilling.

Exploratory drilling for oil and gas provided a great deal of information on the subsurface geology of the state which had not been available before. From this information it appeared that salt and potash might be mined by solution methods if the economics were favorable. A salt plant was established at Williston dissolving salt of the Madison Formation. Potash development in Saskatchewan led to interest in North Dakota and Carlson and Anderson published a study on North Dakota





Figure 20. Dr. Lee C. Gerhard, State Geologist, 1978 to present. University Relations.

possibilities in 1965. An oil test in Burke County was deepened to look at potash, but the results were not forwarded to the Survey.

Anderson has continued the studies of the potash potential and when Saskatchewan began to push for greater participation with the mining companies, many of them began to take a serious look at the possibilities of potash production in North Dakota. This has resulted in a number of coring operations to determine the character of the deposits in the northwestern part of the state.

Dr. Lee C. Gerhard joined the Survey as Assistant State Geologist in September, 1975. He is a carbonate geologist and came to the Survey from the directorship of Fairleigh Dickinson University's West Indies Laboratory on St. Croix, U.S. Virgin Islands. He was educated at Syracuse and Kansas Universities, receiving his Ph.D. from Kansas.

Dr. Noble took a one-year leave of absence in September 1, 1977, to take a position as Deputy Director for Uranium-Thorium, Office of Energy Resources, U.S. Geological Survey. Dr. Gerhard succeeded to Dr. Noble's duties as Acting State Geologist and Acting Chairman of the Geology Department at that time. On July 1, 1978, he was appointed State Geologist and Chairman of the Department.

The Survey now occupies one-half of the third floor of Leonard Hall with additional areas being shared with the Geology Department. In addition to the accommodations in Leonard Hall, the Survey also has a 120' x 80' steel building east of the UND football stadium where it stores its cores, samples, and survey equipment. The Survey owns two truck-mounted power augers and sixteen other vehicles. It also has two house trailers for the use of field parties.

#### EPILOGUE

Following the Arab oil embargo of 1973, the rapid increase in the well-head price of domestic oil created renewed interest in oil and gas exploration. The results, in North Dakota, were immediately evident.

#### New Pool Discoveries in North Dakota

1973	2
1974	8
1975	10
1976	18
1977	15
1978	15

The 55 drilling rigs, operating in North Dakota in August, 1978, were the largest number in the history of the state. Some major new pools added to reserves and reversed the decline in daily production which began in 1967.

The energy situation also focused interest on the state's lignite coal reserves. Several proposals were made for coal-gasification projects although none has materialized to date. Large potential coal producing areas were leased and core drilling was set in motion to evaluate these leases. As a result of a law passed in 1975, the Survey receives the data and information from these programs.

Several operators undertook drilling programs in search of possible uranium deposits.

As a result of this increased activity, the Survey found it needed additional people in the field and now has 42.5 full-time personnel in Bismarck, Grand Forks, and Williston.

Professor Babcock would be pleased!

## FOOTNOTES

<sup>1</sup>S. L. 1895, ch. 66.

<sup>2</sup>Geiger, Louis G., University of the Northern Plains, UND Press, 1958.

<sup>3</sup>Babcock, Earle J., Coal in First Report, Comm. of Agriculture and Labor to the Governor of North Dakota for the year ending October 31, 1890: N. Dak. Public Doc. 14, p. 33-48.

Babcock, Earle J., Clays of economic value in North Dakota, in Second Biennial Report, Comm. of Agriculture and Labor: N. Dak. Public Doc. 6, p. 135-167, illus.; reissued 1892, Bismarck, N.D. Tribune, State Printers and Binders, 36 p. illus.

<sup>4</sup>Grand Forks County Historical Society.

<sup>5</sup>The first professional geologist at the University; he had a Ph.D. from the University of Chicago.

<sup>6</sup>In the early years the Geological Survey was overseen by a Geological Board, which was, in fact, the Board of Trustees of the State University. The members of the professional staff of the Survey were referred to as the "Geological Corps."

<sup>7</sup>A small river town on the west bank of the Missouri River in sec 7, T146N, R84W, Mercer County. It was abandoned when river boat traffic ceased.

<sup>8</sup>The details of Dr. Leonard's fieldwork have been taken from his notebooks which are in the Geology Library at the University of North Dakota. Unless otherwise indicated, the pictures herein are from negatives taken by Dr. Leonard and on deposit in the Geology Department Library.

<sup>9</sup>This has not been positively identified with a present day site. At the time the party was in the vicinity of Glendive, Montana, collecting fossils from the Eagle bluffs. There is a Sather Lake (artificial) in NE $\frac{1}{4}$  sec 4, T148N, R103W, McKenzie County, N.D. Probably named for M. Sather who, at one time, owned most of the land covered by it.

<sup>10</sup>Later City Manager at Minot.

<sup>11</sup>Recent surveys indicated that the highest elevation in North Dakota is at White Butte in Slope County (3,506 feet above sea level).

<sup>12</sup>Leonard, Arthur G., 1911b, Natural gas in North Dakota: U.S. Geol. Survey Bull. 431, p. 7-10, illus.

<sup>13</sup>The 1911 Legislature passed an oil/gas conservation law (S. L. 1911, ch. 195) which prohibited the production of gas from natural gas wells unless tied to a distribution system. It appears that the law was the result of complaints from neighbors that were disturbed by the noise resulting from the practice of the promoters of opening up wells for the benefit of potential investors.

<sup>14</sup>Later president of University of Montana.

<sup>15</sup>After the Sixth Biennial Report, in 1912, subsequent Biennial reports were mimeographed until 1942. Names of survey personnel and the details of legislative appropriations are taken from the manuscripts of these reports which are in the Geology Library in Leonard Hall at UND.

<sup>16</sup>The field notes for the season are reprinted in the North Dakota Quarterly for Spring, 1970, Volume 38, Number 2 (pages 56-80).

<sup>17</sup>In the North Dakota Quarterly, Spring 1970, Volume 38, Number 2, these men were mistakenly identified as McLeod and Gunnell. The error was brought to the writer's attention by Leith in a personal letter on September 24, 1970.

- <sup>18</sup>Dove's map is reproduced in NDGS Bulletin 4 (1925) on page 62 as Plate XVI.
- <sup>19</sup>Carbon copies of these reports are available in the Geology Dept. Library at UND.
- <sup>20</sup>Robert Simpson was Professor Simpson's son.
- <sup>21</sup>A second Oil and Gas Conservation Law was passed in 1929 (S. L. 1929, ch. 184). It was intended to require the filing of all information on wells drilled in the state and met with considerable opposition from the oil and gas industry. Because of the lack of funds, the State Geologist was not able to enforce the law and it was repealed in 1937 (S. L. 1937, ch. 135).
- <sup>22</sup>The Oil and Gas Conservation Law of 1929 was repealed by Session Laws 1937, c. 135.
- <sup>23</sup>Excerpt from a personal communication from Dr. Foley, Nov. 1977: "I arrived in Grand Forks on January 31, 1933 on a bright morning with temperature well below zero. I had come directly from graduate school at Princeton. Fortunately, my credit was adequate but I was glad when the first of March arrived and I appeared at the Business Office to collect my first paycheck. It was a real blow to be told, 'sorry, Mr. Foley, but the State was unable to meet December payroll and the checks we are issuing now are salary for the month of January.' I started work only on February 1. The State caught up with salary payments in July 1933."
- <sup>24</sup>S. L. 1941, ch. 170; N. D. Revised Code ch. 38-08 (1943).
- <sup>25</sup>Dr. Laird also gave credit to Walter Bubel, of Center, and T. O. Rhode, of Van Hook, for making the legislation an accomplished fact.
- <sup>26</sup>The size of the building was doubled in 1961.
- <sup>27</sup>He was named Assistant State Geologist in September 1953.
- <sup>28</sup>Laws of North Dakota, 1953, ch. 227; Revised Code of North Dakota Sess. 38-0801 to 38-0818 (1957 Supp.).
- <sup>29</sup>The Great Northern Broadcasting System, November 2, 1956.
- <sup>30</sup>Journal of the House, Thirty-sixth Legislative Assembly, Wednesday, February 18, 1959.
- <sup>31</sup>President of N. D. Board of Higher Education.

APPENDIX A

CITATIONS

## APPENDIX A

### CITATIONS

- \* S.L. 1895, ch. 66, 1 (Establishment of the North Dakota Geological Survey)
- N. D. Laws 1911, c. 195 (First Conservation Statute)
- N. D. Laws 1929, c. 184 (Second Conservation Statute)
- N. D. Laws 1937, c. 135 (Repealed the 1929 measure and enacted its replacement)
- N. D. Laws 1941, c. 170; N. D. Rev. Code c. 38-08 (1943) (First of the Modern Oil & Gas Conservation Statutes)
- \* Laws of North Dakota 1953, ch. 227; Revised Code of North Dakota, secs. 38-0801 to 38-0818 (1957 Supp.) (Update of 1941 Law)
- S. L. 1961, ch. 251 (Allows use of Trial Examiners)
- \* S. L. 1965, ch. 260 (Allows Statutory Unitization)
- \* S. L. 1967, ch. 289 (Subsurface Minerals)
- S. L. 1969, ch. 333 (Common Purchaser)
- S. L. 1971, ch. 349 (Unitize two or more pools)
- S. L. 1975, ch. 321 (Severance of Minerals and Surface Damage)
- \* S. L. 1975, ch. 317 (Coal exploration drilling)
- S. L. 1977, ch. 318 (Mineral Exploration Permit Fees)
- S. L. 1977, ch. 319 (Modify Spacing Units)
- S. L. 1977, ch. 320 (Unit Area Enlargement and Unitization Plan Amendment)

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\*Principal Enactments

APPENDIX B

NORTH DAKOTA GEOLOGICAL SURVEY STAFF

## APPENDIX B

## NORTH DAKOTA GEOLOGICAL SURVEY STAFF

NOTE: This listing is in order by year of entry and does not include most of the temporary personnel. Prepared by Clara B. Laughlin, January, 1980.

<u>Year of Entry</u>	<u>Name</u>	<u>Year of Termination</u>
1899	1. Babcock, E. J.	1910
1899	2. Bisbee, Marcia	1908
1899	3. Johnson, Edith	1899
1901	4. Wilder, Frank A.	1903
1901	5. Wood, L. H.	1904
1901	6. Chandler, E. F.	1910
1903	7. Leonard, A. G.	1932
1905	8. Clapp, C. H.	1906
1907	9. Barry, John G.	1908
1909	10. Simpson, Howard E.	1938
1909	11. Ruediger, G. F.	1916
1909	12. Brannon, M. A.	1910
1909	13. Young, R. T.	1910
1909	14. Atkinson, T. R.	1910
1915	15. Heath, Fred H.	1916
1919	16. Dove, L. P.	1924
1919	17. Eaton, H. N.	1922
1923	18. Turnbaugh, C. E.	1928
1927	19. Sand, Herbert H.	1936
1933	20. Foley, Frank	1941
1933	21. Abbott, G. A.	1936
1933	22. Voedisch, Frederic W.	1936
1933	23. Lavine, Irvin	1934
1933	24. Budge, William E.	1934
1935	25. West, Philip W.	1936
1938	26. Tisdale, Ernest	1941
1938	27. Timm, Bert	1939
1939	28. Holmes, Chauncey D.	1940
1940	29. Laird, Wilson M.	1969
1940	30. Meblin, Denise	1941
1940	31. Garaas, Howard	1947
1941	32. Templeton, J. Stevens	1942
1941	33. Mitchell, Robert H.	1942
1941	34. Supernant, Grace	1942
1941	35. Kaloupek, Virginia	1943
1942	36. Rasmussen, William C.	1942
1943	37. Greenlee, Arthur L.	1944
1943	38. Blide, Louise	1945
1943	39. McLaughlin, Thad G.	1944
1944	40. Bosard, Geraldine	1944
1944	41. Ness, Norma Sue	1944
1944	42. Pitsenbarger, Elsie	1945
1945	43. Bentley, Virginia	1946
1945	44. Nevin, Charles	1945
1945	45. Powers, William E.	1945
1946	46. Ball, John R.	1946
1946	47. Branch, John R.	1946
1946	48. Tetrick, P. Roderick	1946
1946	49. Grossman, Irving	1949
1946	50. Easker, David G.	1947
1947	51. Stennes, Ione Monger	1950
1948	52. Fisher, Stanley	1953



## APPENDIX B--Continued

## NORTH DAKOTA GEOLOGICAL SURVEY STAFF

<u>Year of Entry</u>	<u>Name</u>	<u>Year of Termination</u>
1949	53. Jenkinson, Lewis	1950
1949	54. Riski, Bette	1950
1950	55. Kohanowski, N. N.	1958
1950	56. Klipfel, Clarence	1952
1950	57. Neff, Juanita	1952
1951	58. Hansen, Miller	1964
1951	59. Ness, Marjorie	1953
1952	60. Green, Elsie	1954
1952	61. Anderson, Sidney B.	Current
1952	62. Fredrickson, Beverly Mathison	1958
1952; 1964	63. Weir, Patricia Livingood	1961; 1964
1952	64. Dallas, Dois D.	1955
1952	65. McCabe, William	1955
1953	66. Flatten, Joann	1953
1953	67. Cameron, Richard J.	1972
1953	68. Folsom, C. B., Jr.	Current
1953	69. Hanson, Marcella O.	1965
1953	70. Smith, Carole	1954
1953	71. Strassberg, Morton	1954
1953	72. Caldwell, John	1953
1954	73. Carlson, Clarence G.	Current
1954	74. Hansen, Dan E.	1967
1954	75. Arneson, William	1957
1954	76. Bock, Shirley Everson	1955
1954	77. Danielson, Ray O.	1956
1954	78. Larson, Louis	1959
1954	79. Miller, Lois Gamme	1956
1954	80. Nelson, Laverne	1955
1954	81. Nielsen, Jeannine D.	1956
1955	82. Sperling, Joyce	1962
1955	83. Hainer, John	1956
1955	84. Turner, Perry	1956
1955	85. Voorhees, Thomas R.	1956
1956	86. Bubb, Lois Skavlem	1957
1956; 1967	87. Keena, Jean Becker	1957; 1968
1956	88. Maywald, Richard	1957
1956	89. Peterson, James D.	1957
1956	90. George, Robert S.	1962
1956	91. Recktenwald, Herbert A.	1956
1956	92. Johnson, David S.	1960
1956	93. Wilch, Lamont O.	1957
1957	94. Garske, Jay	1958
1957	95. Christianson, Gloria Gangelhoff	1958
1957	96. Madenwald, Kent A.	1963
1957	97. Gilbert, Rose Marie Charbonneau	1959
1957	98. Wilborn, Floyd E.	Current
1957	99. Hennessey, Diane A.	1959
1957	100. Hentges, Collette	1959
1957; 1964	101. Stoltman, Mary Jane	1960; 1966
1957	102. Guttenberg, Ronald E.	1960
1957	103. Eisenhard, Robert M.	1958
1957	104. Eastwood, William P.	1962
1958	105. Clayton, Lee S.	1965
1958	106. McKay, Judie Rohrer	1959
1958	107. Thoraldson, Sharon	1959

APPENDIX B--Continued  
NORTH DAKOTA GEOLOGICAL SURVEY STAFF

Year of Entry	Name	Year of Termination
1958	108. Bergstrom, Sylvia	1959
1958	109. Kume, Jack	1966
1959	110. Berg, Larry D.	1960
1959	111. Machovsky, Bonnie	1960
1959	112. Mendoza, Herbert A.	1960
1959	113. Larsien, Mary Pladson	1967
1960	114. Anderson, Fae M.	1963
1960	115. Carter, Arthur D., Jr.	1962
1960	116. Caster, Alva M.	1961
1960	117. Pflaum, Mary Lou	1967
1960	118. Sorlien, Janet Larson	1961
1960	119. Pasbrig, Bonnie	1960
1960	120. Olsen, Ann Marie	1961
1960	121. Stennes, Sally	1961
1960	122. Norton, Wesley D.	Current
1961	123. Bosh, Judy R.	1962
1961	124. Nybo, Patricia	1963
1961	125. Jackson, Jean Loveid	1962
1961	126. Hunt, John B.	1963
1961	127. Skjonsby, Barbara S.	1962
1961	128. Erickson, Alice	1962
1961	129. Cook, Heidi	1962
1961	130. Tuthill, Samuel J.	1964
1962	131. Anderson, Joyce	1963
1962	132. Edwards, Mary M. McGill	1964
1962	133. Freers, Theodore	1969
1962	134. Gunderson, Karlyn L.	1964
1962	135. Klug, Geraldine	1979
1962	136. Meldahl, Charles	1965
1962	137. Reiswig, Beverly	1963
1962	138. Warthen, Robert	1963
1962	139. Wisler, Judy	1963
1962	140. Bluemle, John	Current
1962	141. Zoller, Alice	1963
1962	142. Brown, Gail P.	1962
1963	143. Carr, Betty Lou	1964
1963	144. Huizenga, Sylvia	1965
1963; 1977	145. Schroeder, Ethel	1974; 1977
1963	146. Auch, Florine	1965
1964	147. Bell, Myrtle	1967
1964	148. Jones, Audrey	1965
1964	149. Linder, Nicolai	1965
1964	150. Salwerowicz, Frank	1966
1964	151. Williams, Juanita	1968
1964	152. Nesland, Carol	1965
1965	153. Brostuen, Erling	Current
1965	154. Jeanotte, Jeanette	1966
1965	155. Johnson, Trudy	1966
1965	156. Laughlin, Clara B.	Current
1965	157. Noble, Edwin A.	1977 (Res. 7-1-78)
1965	158. Ryyth, Bonnie	1965
1965	159. Strehse, Cheryl O'Connell	1967
1966	160. Cowan, Madelyn	1966
1966	161. Haraldson, Harald	1968
1966	162. Nelson, Betty Ann	1967

## APPENDIX B--Continued

## NORTH DAKOTA GEOLOGICAL SURVEY STAFF

<u>Year of Entry</u>	<u>Name</u>	<u>Year of Termination</u>
1966	163. Nelson, Mavis	1967
1967	164. Roth, Bonita Redman	1969
1967	165. Thompson, Ruth	1968
1967	166. Winger, Edgar I.	1968
1967	167. Bradshaw, Robert	1970
1967	168. Brownell, Donna M.	1969
1967	169. Filipi, Susan D.	1969
1967	170. Giesinger, Jane	1969
1968	171. Barta, Cynthia	1970
1968	172. Kallestad, Kenneth	Current
1968	173. Knight, Linda	1969
1968	174. Pederson, Judith	1969
1968	175. Arndt, B. Michael	1976
1969	176. O'Shaughnessy, Sheila	Current
1969	177. Bjerklie, Linda	1972
1969	178. Haake, Ellis V.	Current
1969	179. Kramer, Michele	1969
1969	180. Moran, Stephen R.	1976
1969	181. Nehring, Mary Lou	1970
1969	182. Rivinius, Joyce	1970
1969	183. Simons, Raymond A.	1973
1969	184. Sweeney, Helen	1970
1969	185. Johnson, Duane C.	1969
1970	186. Ferguson, John I.	Current
1970	187. Lawrence, Connie	1970
1970	188. Johnson, Fern	1970
1970	189. Johnson, Deborah Lee	1970
1970	190. Lawrence, Lee K. Nerby	1972
1970; 1973	191. Miller, E. Kathleen	1972; Current
1970	192. Klym, Elizabeth	1972
1970	193. Knudson, Karol-lyn	1979
1972	194. Sevigny, Denise	1977
1972	195. Adams, Linda	1973
1972	196. Nehring, Deborah	1978
1972	197. Borboa, Connie	Current
1973	198. Roos, Palmer	Current
1973	199. Lechner, David	Current
1973	200. Hjelmstad, Kathi	Current
1974	201. Rood, Marilyn	Current
1974	202. Groenewold, Gerald H.	Current
1975	203. Borchert, Roger	Current
1975	204. Dannewitz, Doren A.	Current
1975	205. Gerhard, Lee C.	Current
1975	206. Novak, Paulette Schulz	1977
1975	207. Gutenkunst, Karen	Current
1976	208. Hobbs, Howard	1977
1977	209. Kehew, Alan	Current
1977	210. Harris, Kenneth	Current
1977	211. Nichols, Debra	1979
1977	212. Nelson, Kathy	Current
1977	213. Walker, Daniel	Current
1978	214. Ruddy, David	Current
1978	215. Baugh, Debbie	1978
1978	216. Latka, Robert	Current
1978	217. Tucci, Nicholas J.	1979

## APPENDIX B--Continued

## NORTH DAKOTA GEOLOGICAL SURVEY STAFF

<u>Year of Entry</u>	<u>Name</u>	<u>Year of Termination</u>
1979	218. Kroese, Debra J.	Current
1979	219. Stenvold, Cheryl	Current
1979	220. Umphrey, Howard	Current
1979	221. Burke, Randolph B.	Current
1979	222. Wollan, Glenn L.	Current
1979	223. Kadrmas, Connie M.	Current
1979	224. Beaudry, Donna	Current
1979	225. Duggan, Cheryl	Current
1979	226. Priddy, John K.	Current
1979	227. Garbe, Robert K.	Current
1979	228. Savoy, Luke	Current
1979	229. Mailloux, Eula M.	Current