INSTITUTIONAL PROGRAM REVIEW
SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY

GEOLOGY PROGRAMS:
BACHELOR OF SCIENCE
MASTER OF SCIENCE
DOCTOR OF PHILOSOPHY

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Department of Geology and
Geological Engineering

March 2000
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REVIEW OF THE GEOLOGY PROGRAMS

SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY

The Bachelor and Master of Science and the Doctor of Philosophy degrees in Geology are offered through the Department of Geology and Geological Engineering. The programs are designed to use the unique natural setting of the Black Hills and Badlands as natural laboratories in which students develop a strong understanding of the fundamentals of science and a specific focus on understanding the theoretical, practical, and philosophical nature of geological studies. Faculty and students work within the overall school mission of instruction, research, and service and provide the state and region with a valuable source of knowledge about our natural resources. The programs continue to be very popular among students and employment opportunities are steadily growing, especially in water and environmental fields. As a result of these opportunities the graduate enrollment has maintained a nearly constant level and the number of undergraduates is increasing. Studies by the faculty and graduate students form the base of a nationally recognized research effort.

Considerable interest now is being shown by undergraduate students in the pursuit of education in the Geology program. There are several reasons for this trend. They include: 1) increased emphasis by the faculty on the undergraduate program, 2) more flexibility in course selection in the Geology program as opposed to the Geological Engineering program, 3) the Geology program has the same firm basis in science and mathematics as in the Geological Engineering program, and 4) redesign of the undergraduate Geology program to make it more attractive to the undergraduate population. Two new undergraduate tracks have been added;
Paleontology and GIS/Remote Sensing.

Studies by our graduate students have contributed significantly to an increased understanding of the geology and the environment of the region. Over 195 graduate theses, most of which deal with topics of local and regional concern, provide useful information for industry, state and local agencies and general geologic understanding. This could not have been developed in such an economical manner in any other way, and probably would not have been developed at all without the human resources represented by the Geology programs. They provide a focus for the faculty and staff to refine our knowledge of the subject area for the betterment of the State and region. A large number of our graduates find employment in the state government, as well as local and national companies.

Three and three-quarters state-funded FTE’s are assigned specifically to Geology. Numerous other members of the research staff are involved in the teaching program at virtually no cost to the educational funds for the state. Groups that provide such support include members of the Museum of Geology, three of whose members have Ph.D’s in Geology/Vertebrate Paleontology, and the Engineering and Mining Experiment Station, two of whose members have Ph.D.’s in Geology.
1. DESCRIPTION OF PROGRAM

The programs in Geology are located within the Department of Geology and Geological Engineering. A Bachelor of Science, Master of Science, and Doctor of Philosophy in Geology are offered. Other programs taught within the Department include Bachelor of Science, Master of Science, and Doctor of Philosophy in Geological Engineering, and the Master of Science in Vertebrate Paleontology.

1.1 Name of Geology Programs

- Bachelor of Science with major in Geology
  Initiated in 1935

- Master of Science with major in Geology
  Initiated in 1935

- Doctor of Philosophy with major in Geology
  Initiated in 1967

1.2 Department Responsible for Programs

The Department of Geology and Geological Engineering

1.3. Institution

South Dakota School of Mines and Technology (SDSMT)

1.4 Organization of Programs

The Geology programs are administered through the Department of Geology and Geological Engineering, Dr. James Fox, Chairman. The Department is part of the College of Earth Systems, of which Dr. Sanchul Bang is the dean. Dr. Karen Whitehead is the Vice-president of Academic Affairs. She reports to the President, Dr. Richard Gowen. The department chair has responsibility for the geology, geological engineering, and paleontology programs.

1.5 Current Area(s) of Concentration:

The undergraduate program in Geology includes the following tracks:
The graduate programs include the following areas of potential emphasis:

- Structural geology
  - Sedimentation/stratigraphy
  - Paleontology
  - Igneous/metamorphic petrology
  - Economic geology/mineral exploration
  - Crystal chemistry/mineralogy
  - Geomorphology
  - Geophysics
  - Glacial and Pleistocene Geology
  - GIS

1.6 Program Changes Planned:

The undergraduate program is being altered to include the tracks shown in 1.5 above. This will allow the students to follow their interests more clearly. Ultimately, it should increase enrollment in the Geology program and also deliver a product that is more clearly aligned with the interests of the students.

No fundamental changes in the graduate programs are anticipated.

II. PROGRAM OBJECTIVES

2.1 Statement of Program Objectives

The objectives of the undergraduate Geology program are to develop a strong background in basic sciences and permit considerable variation in course choice depending on individual interests. The students should be able to specialize in paleontology/sedimentology, environmental geoscience, or petrology/ore deposits. The students should have a significant research experience, typically within the senior year.

The objectives of the graduate programs are to provide additional specialization in geology and paleontology, usually including research on regional or local problems.

2.2 Relationship to Existing Unit Mission and Academic Plan

The program in Geology fully utilizes the magnificent geologic setting of the Black Hills and adjacent Badlands to develop geologists for careers in geology including environmental applications, mineral and petroleum exploration, governmental agencies, museums, academic
fields, and entrepreneurship. Both undergraduate and graduate programs are available. The undergraduate program develops a strong background in basic sciences and permits considerable variation in course choice depending on individual interests. Students may choose from tracks of Geology/Geoenvironmental, Paleontology, and GIS/Remote Sensing. The senior year culminates in an individual research project.

2.3 Relationship to Institutional Mission

The mission of the South Dakota School of Mines and Technology is:

- To prepare men and women for an enhanced quality of life by providing a broad educational environment which fosters a quality educational experience leading to baccalaureate and post-baccalaureate degrees emphasizing science and engineering.

- To contribute to the expansion of knowledge through programs of basic and applied research, scholarship, and other creative endeavors.

- To utilize the special capabilities and expertise on the campus to address regional, national, and international needs.

The programs in Geology, both at the undergraduate and graduate level support the mission of the South Dakota School of Mines and Technology.

2.4 Closely Related Unit Programs and Areas of Strength:

The program that is most closely related to the undergraduate Geology program is the Geological Engineering program. The two programs are orchestrated to such that Geology students often take Geological Engineering classes, typically at the junior and senior levels, whereas the undergraduate Geological Engineering students take numerous Geology courses, typically at the freshman and sophomore levels. This allows courses to be filled efficiently and ensures that the students have access to the coursework without course duplication.

The graduate programs combine the disciplines of Geology and Geological Engineering in that the name of the degrees are, respectively, M. S. in Geology and Geological Engineering and Ph. D. in Geology and Geological Engineering.

2.5 Changes in Program Objectives:

The undergraduate program in Geology was changed to include the tracks described in 1.6 above. The graduate programs in Geology and the graduate programs in Geological Engineering were combined to make one master’s program in Geology and Geological Engineering and one Ph.D. program in Geology and Geological Engineering.
2.6 Anticipated Changes in Program Objectives:

No major changes in the programs are anticipated in the near future.

III. PROGRAM STRUCTURE

3.1 Program Rationale

3.1.1 Bachelor of Science in Geology

The undergraduate degree in Geology is designed to utilize to the greatest extent possible the geologic setting of the Black Hills and adjacent Badlands to develop geologists for careers in the mineral industries, government agencies, museums, academic fields, and entrepreneurship. The undergraduate program develops a strong background in basic sciences and permits considerable variation in course choice, depending on individual interests. Because research on the undergraduate level is emphasized, the senior year culminates in an individual research project. The course of study offers an alternative to the student who does not wish to follow an engineering curriculum but who wishes to acquire an education that is equally, or more, rigorous in terms of science and mathematics. The B.S. curriculum has recently been redesigned with these goals in mind and student interest has increased substantially.

3.1.2 Master of Science and Doctor of Philosophy in Geology and Geological Engineering

The graduate programs, both Masters and Doctoral, involve additional specialization and commonly include research on regional or local problems. Completion of graduate degrees leads to higher level professional employment including college-level instruction. The student has the opportunity to undertake programs of study in several, specific areas within the framework of geology in general. If the student arrives from another institution, the undergraduate coursework is examined for deficiencies as judged by the undergraduate curriculum at the South Dakota School of Mines and Technology. If deficiencies exist, their program of study is constructed with this in mind, and these deficiencies cannot be used to satisfy the course requirements for their graduate program.

3.2 Breadth of Program Coverage

The Master of Science in Geology and Doctor of Philosophy in Geology programs concentrate in areas of geology which are offered by staff present in the Department of Geology and Geological Engineering. These include:

- Structural Geology
- Economic Geology
- Petroleum Geology
- Environmental and Engineering Geology
- Geophysics
- Sedimentation
- Hydrology
Mineralogy and Crystallography
Igneous Petrology
Metamorphic Petrology

3.3 External Relationships of Program

Close ties exist with industrial and governmental interests. Because the discipline of geology is practical and applied, many of our graduates support the earth materials industries as well as governmental agencies concerned with the environment. A departmental advisory board exists and has met within the last three years.

The Geology programs, particularly on the graduate level, cooperate closely with the United States Geological Survey in its hydrology and petroleum programs. Interaction with industrial concerns are also encouraged, and practiced (e.g. interaction with Wharf Resources, Homestake Mining Company), including resource and environmental interests. The GIS program has benefited greatly from its interaction with EROS Data Center in Sioux Falls, SD.

IV. PROGRAM NEEDS

4.1 Outside Interest in the Program

Outside interest in the Geology programs ranges from the private to the industrial to the governmental sectors. From the standpoint of employment of students, the students are highly sought after by all segments of industry and the government. The employment demand rose during the late 1980's as employees requirements increased in conjunction with a national decrease in the number of students available for employment. Although the numbers of students available for employment during the early part of the 1980's were great in comparison to the number of jobs available, this trend has reversed itself and student numbers have stabilized.

The Geology programs provide a focus for geologic investigation within South Dakota for local and regional problems as well as having an impact upon national studies. The Department of Geology and Geological Engineering brings together a wide range of research interests which involve student, staff, and faculty researchers for the betterment of the understanding of the geologic history and environment of the area. Many of the staff and faculty within the Department are nationally recognized for their excellence in research. This resource is used on a daily basis by members of the private sector as well. Countless inquiries are made by private citizens regarding geologic questions. The Department and the staff within it provide a means of focusing and resolving those inquiries.

4.2 Justification for the Program

The Geology programs are a fundamental asset to South Dakota and the nation. They
provide an avenue for education of the young people of the State and region, work on resolving geologic concerns of a regional and national nature, and provide a center of excellence in geologic studies in western South Dakota. The list of theses demonstrates that the Geology students of the South Dakota School of Mines and Technology have contributed substantially to the improvement of the understanding of the geology of the region. Furthermore, the Geology programs are extremely cost-effective because many of the faculty teaching within the program are supported by outside funds in the form of federally-funded programs.

4.3 Relationship with Other Programs

The Geology, Geological Engineering, and Paleontology programs are closely linked through the Department of Geology and Geological Engineering. The staff of all of these programs cooperate closely, and students within the Department can take courses throughout the offerings of the Department. Both the Geology and Geological Engineering programs include the Bachelor of Science, Master of Science, and Doctor of Philosophy degrees, whereas the Paleontology program offers only the Master of Science degree.

V. STUDENT DEMAND

5.1 Pool of Applicants

The undergraduate population for Geology, as with most programs at SDSM&T, is composed chiefly of South Dakota residents. Participants in the Masters and Doctoral programs have varied backgrounds. Some are drawn from our own undergraduate program and many others come from universities in the upper Midwest. A majority, however, have earned undergraduate degrees elsewhere in the United States and approximately 25% are international students. Through the years we have maintained ties with universities in Saudi Arabia, Thailand, Turkey, and Libya. Students from approximately 15 foreign countries have participated in the graduate programs.

5.2 Enrollment in Geology Program

Enrollment in the program at present is shown below. The number of degrees granted during the past 10 years is indicated in Section 5.3 and also is a partial indicator of enrollment during that time, given that some students who begin programs do not complete them.
5.3 Degrees Granted in Geology

Through December of 1999, 290 candidates have earned degrees in the Geology Program at SDSMT. Twenty-three Doctorates have been awarded since 1970. One hundred eighty-eight Masters degrees have been awarded since 1948.

Figures for graduates of the past 10 years are listed in the table below.

<table>
<thead>
<tr>
<th>Year</th>
<th>MS - Geology</th>
<th>Ph.D. - Geology</th>
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<td>90</td>
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<td>98</td>
<td>15</td>
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</tbody>
</table>
5.4 Placement of Geology Graduates

Geology graduates have been placed in several areas of geologic investigation. These include mining geology positions, with several instances of employment in the local Black Hills economy. Most of the graduates, however, have found employment in some part of the environmental characterization and remediation field or within state/federal government that regulate or investigate these issues.

5.5 Enrollment Capacity

The enrollment capacity of the Department of Geology and Geological Engineering is at 75 percent capacity in terms of the Ph.D. program and at approximately 85 percent capacity in the Master of Science program. It should be noted that three major areas share the resources and facilities of the Department: Geology, Geological Engineering, and Paleontology. The population of the undergraduate program has risen to approximately 75 percent of capacity. The geology curriculum was changed recently to appeal to students who are not be inclined toward an engineering approach and students that are primarily interested in paleontology. As such, numbers in the undergraduate program are expected to increase further.

5.6 Anticipated Changes in Enrollment

No significant changes in the graduate enrollment are anticipated. The number of graduate students are matched reasonably well with the facilities and resources of the Department. The undergraduate enrollment is expected to change upward, however. The undergraduate Geology program offers a real alternative for the student that is interested in environmental problems and has the flexibility to provide a program of study that can be tailored to the student’s needs.

VI PERSONNEL

Geology and Geological Engineering is a combined program at SDSM&T. Within the department there are 3.75 state funded (FTE) positions assigned specifically to Geology. In addition, there are other participants in the Geology program through the Museum of Geology and the Engineering and Mining Experiment Station. Appendix B contains the individual vitae for those who participate in the Geology program.

6.1 Faculty in Direct Participation in Program

Four faculty members comprise the core of the Geology group. These are:

James Fox (Stratigraphy/Sedimentology; Petroleum Geology)
Alvis Lisenbee (Structural Geology)
Colin Paterson (Ore Deposits)
Maribeth Price (GIS)

Part-time assistance is provided by:

Edward Duke (Mineralogy, Igneous and Metamorphic Petrology)
Phil Bjork (Vertebrate Paleontology)
James Martin (Vertebrate Paleontology, Stratigraphy)

See Appendix A for faculty Vitae.

6.2 Support and Advisory Faculty

Strong supporting assistance is given to the Geology program by the following individuals:

<table>
<thead>
<tr>
<th>Arden Davis</th>
<th>Geological Engineering</th>
<th>Ground Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>W. M. Roggenthen</td>
<td>Geological Engineering</td>
<td>Geophysics</td>
</tr>
<tr>
<td>L. Stetler</td>
<td>Geological Engineering</td>
<td>Geologic Hazards</td>
</tr>
<tr>
<td>Paul Gries</td>
<td>Professor Emeritus</td>
<td>Petroleum Geology, Ground Water, Stratigraphy</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Perry Rahn</th>
<th>Professor Emeritus</th>
<th>Ground Water</th>
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</thead>
<tbody>
<tr>
<td>Jack Redden</td>
<td>Professor Emeritus</td>
<td>Metamorphic Petrology</td>
</tr>
</tbody>
</table>

6.3 Support Staff

Mr. Dale Nickels is assigned to the Mineral Industries Building to assist in equipment maintenance. His services are shared between the departments and offices housed in the MI Building.

6.4 Areas of Competency of Existing Faculty

The individuals listed in the immediately preceding sections provide a group knowledge appropriate to the presentation of effective programs through the Ph.D. level in Geology. They are capable of presenting all major topics appropriate to the discipline, as well as their individual specialties.

In the area of research they are particularly noted for their contributions to the understanding of geology of the northern Great Plains and Rocky Mountains. They are recognized authorities in regard to studies of the geology of the Black Hills and Badlands regions and are also noted for studies of the geology and natural resources of the adjoining sedimentary basins in Wyoming and North Dakota.
Areas of specialization include ore deposits, petroleum geology, sedimentology, structural geology, igneous petrology, and ground water. Various members of the Department have applied their skills in areas throughout the U.S., as well several foreign countries.

6.5 Anticipated Staff Changes

No staff changes are anticipated for the Geology program in the near future. As enrollments increase, it is expected that additional FTE support will be made available.

VII. CURRICULUM

7.1 Course Listing

Undergraduate curriculum:

GEOLGY CORE CURRICULUM (12899)

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<tr>
<th>FRESHMAN YEAR</th>
<th>JUNIOR YEAR</th>
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<tr>
<td>_MATH 123  Calculus I</td>
<td>_GEOL 341  Elementary Petrology</td>
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<tr>
<td>_CHEM 112  General Chemistry</td>
<td>_ENGL 379  Technical Communications II</td>
</tr>
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<td>_ENGL 101  Freshman Composition</td>
<td>_Track requirements/electives^</td>
</tr>
<tr>
<td>_MATH 201  Physical Geology</td>
<td>_Hum./S.S. Elective</td>
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<tr>
<td>_MATH 205  Physical Geology Lab</td>
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<tr>
<td>_Humanities Elective^</td>
<td>_GEOL 322  Structural Geology</td>
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<td>_CHEM 114  General Chemistry II</td>
<td>_ENGL 403  Regional Field Geology</td>
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<td>_CHEM 115  Exper. Gen. Chemistry I</td>
<td>_GEOL 416  Intro. to GIS</td>
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<td>_MATH 231  Historical Geology</td>
<td>_Track requirements/electives</td>
</tr>
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<td>_Track requirements^</td>
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<td>_PE       Physical Education</td>
<td>_GEOL 410  Field Geology</td>
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<td>_CHEM 115  Exper. Gen. Chemistry II</td>
<td>_GEOL 491  Senior Research I^</td>
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<td>_Stratig. and Sedimentation</td>
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<td>_Social Science Elective^</td>
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<td>_MATH 212  Mineral and Crystallog</td>
<td>_GEOL 492  Senior Research II^</td>
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<td>_Track requirements</td>
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<td>_PE       Physical Education</td>
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TRACK REQUIREMENTS (by semester)

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<th>Geology/Environmental</th>
<th>Palaeontology</th>
<th>GIS/Remote Sensing</th>
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<td>_MATH 124  Calculus II</td>
<td>_BIOL 121 Basic Anatomy</td>
<td>_MATH 124  Calculus II</td>
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<tr>
<td>_PHYS 211  Univ. Physics I</td>
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<td>_PHYS 111 Intro. Physics I</td>
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<td>_PHYS 213  Univ. Physics II</td>
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<td>_MINE 301 Mine Surveying</td>
<td>_PHYS 271 Search for the Past</td>
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128 semester credits are required.
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<tr>
<th>Junior Fall</th>
<th>GEOL 471 Invert. Paleo*</th>
<th>(2-1) 3</th>
<th>GEOL 471 Invert. Paleo</th>
<th>(2-1) 3</th>
<th>GEOL 351 Earth Resources</th>
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<td>BIOL 211 Principles of Ecology</td>
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<td>ATM 320 Int. Remote Sensing</td>
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<tr>
<td>GEOE 442 Optical Petrology*</td>
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<td>MATH 181 Intro. to Statistics</td>
<td>(3-0) 3</td>
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<td>GEOE Vert. Tech. Exhib.</td>
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<td>GEOE 417 GIS Data Manag.</td>
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<tr>
<td>Senior Spring</td>
<td>GEOE 482 Applied Geomorph*</td>
<td>(2-1) 3</td>
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<td>GEOL 451 Economic Geology</td>
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<td>Total track electives</td>
<td>16</td>
<td>18</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Total credits</td>
<td>128</td>
<td>128</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
</tbody>
</table>

* Courses offered alternate years.

Curriculum Notes

1. Students must complete 3 credits of humanities and three credits of social science within their first 48 credit hours.
2. See table of track requirements and electives on next page.
3. A student may register for 6 credits of Senior Research each semester, in this case it will substitute for a 3 credit geology elective. The minimum requirement for senior research is 3 credits per semester. Under exceptional circumstances, a student may petition the department chair to substitute geology electives for senior research.
4. At least half of the track electives must be from courses with prefix GEOL or GEOE. Other electives appropriate to the student’s specialization are chosen from the lists below, and must have the approval of the student’s advisor and department chair.

- Additional course work in mathematics and statistics is encouraged. MATH 498 and MATH 499 are recommended statistics courses; MATH 332 is recommended for students interested in numerical modeling of partial differential equations.

Graduate Programs:

The graduate programs require a core curriculum to be taken as shown below. A close relationship between the student and the advisor is encouraged and required.

I. M.S. COURSEWORK REQUIREMENTS FOR GEOLOGY EMPHASIS

(a) Core Courses:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 633</td>
<td>Sedimentation</td>
</tr>
<tr>
<td>GEOL 704</td>
<td>Advanced Field Geology</td>
</tr>
</tbody>
</table>

(b) One course from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 614</td>
<td>GIS for Research</td>
</tr>
<tr>
<td>GEOE 766</td>
<td>Digital Modeling of Ground Water</td>
</tr>
<tr>
<td>MINE 633</td>
<td>Computer Applications and Methods in Mining Operations (VULCAN)</td>
</tr>
</tbody>
</table>

(c) One course from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 621</td>
<td>Advanced Structural Geology</td>
</tr>
<tr>
<td>GEOL 622</td>
<td>Geotectonics</td>
</tr>
</tbody>
</table>

(d) One course from:

<table>
<thead>
<tr>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOE 626</td>
<td>Environmental Geophysics</td>
</tr>
<tr>
<td>GEOE 641</td>
<td>Geochemistry</td>
</tr>
</tbody>
</table>
GEOE 664  Advanced Ground Water  3 cr
GEOE 652  Geochemical Exploration  3 cr

TOTAL  15 cr

Optional courses: Remainder of required coursework related to student's research/specialty.

PHD COURSEWORK REQUIREMENTS FOR GEOLOGY EMPHASIS

a) Core Courses:
   GEOL 633  Sedimentation  3 cr
   GEOL 704  Advanced Field Geology  3 cr
   GEOL 808  Fundamental Problems in GEOL/GEOE  3 cr

b) One course from:
   GEOL 615  Advanced GIS for Research  3 cr
   GEOE 766  Digital Modeling of Ground Water  3 cr
   MINE 633  Computer Applications and Methods in Mining Operations (VULCAN)  3 cr

c) One course from:
   GEOL 621  Advanced Structural Geology  3 cr
   GEOL 622  Geotectonics  3 cr

d) One course from:
   GEOE 626  Environmental Geophysics  3 cr
   GEOE 641  Geochemistry  3 cr
   GEOE 664  Advanced Ground Water  3 cr
   GEOE 652  Geochemical Exploration  3 cr

TOTAL  18 cr

c) Optional courses: Minimum of 10 credit hours in courses related to student’s research/specialty.

Background Requirements

All Geology Ph.D. students are expected to be proficient in Geology.

a) For the incoming student with a degree in a geological science -- means that all candidates for the degree in geology will have completed the equivalent of this department’s undergraduate requirements in geology, chemistry, physics, and mathematics.

b) Those students without a geologically related undergraduate degree are expected to
complete the undergraduate requirements of this department in math, physics, and chemistry and to take or show proficiency in:

For the Ph.D. in Geology

- Physical Geology
- Historical Geology
- Petrology
- Mineralogy
- Structural Geology
- Field Geology
- Ground Water
- Thermodynamics

Qualifying Exam

To monitor progress, Ph.D. students who are bypassing the M.S. degree are expected to take a qualifying exam.

Students may propose hybrid fields of specialization utilizing other disciplines providing such hybrids are approved by the candidate's dissertation committee.

The second part of the exam requires that the student prepare a research proposal. The proposal is due one month prior to the week of the comprehensive examination. This is necessary so that the candidate's committee can review the proposal to assure that it is defensible. The committee must give its findings to the candidate at least two weeks before the week of the comprehensive examination. The proposal is defended for scientific merit and thoroughness in an oral examination.

The three written exams are of approximately three hours duration and are taken on three successive days. The oral examination follows the written examination and is of similar duration. Weighting of the exam is: 3/4 for the written exams; 1/4 for the research proposal. The examination may be repeated once in a succeeding semester.

The written examinations and the defense of the research proposal are to be completed during a one-week period. The faculty will inform the candidate of the results of the examination the end of that week.

If the student has not completed all requirements for the Ph.D. degree by the fifth year following the comprehensive examination, his active status will be automatically terminated and the comprehensive examination must be repeated.

Admission to Candidacy

Four months before the dissertation defense, the doctoral student must apply to his or her
Major Professor for admission to candidacy on an official certification form available from the Graduate Division.

Dissertation

The dissertation should conform to the specifications of the SDSM&T publication entitled Instruction for Preparation of Theses and Dissertations.” The dissertation must demonstrate technical proficiency in the field of study and will be a study on a fundamental geologic problem.

It will be a public document representing a definite contribution and addition to some phase of geology.

Dissertation Defense

Following an initial review of the dissertation by the student’s advisor, and a subsequent review by the entire committee, the student defends the dissertation in an examination open to the public.

7.2 Unique Features and Strengths of Program

The programs offered in Geology constitute a series of challenging curricula, which yield excellent graduates, who compare favorably with other geologic programs. Research is emphasized throughout the program including the B.S. program. During the senior year, the undergraduate geology students must undertake a Senior Research project. This normally amounts to a three to six credit hour effort for both of the final semesters. The work is performed in cooperation with a member of the staff and results in a written paper followed by a public presentation at the end of each semester.

Besides the curricula, the strength of the program lies in its dedicated faculty, who have wide-ranging interests and who demonstrate a depth of understanding of the discipline that is seldom seen in departments and programs of an equivalent size. The location of the institution is a prime asset, not only because of the opportunities for teaching and research, but also for its attraction to potential faculty and researchers. Because of the magnificent location, the Geology program has successfully attracted extremely competent faculty members and retained them as they developed their expertise.

7.3 Program Deficiencies and Planned Remedies

Any analysis of program deficiencies must include some input regarding the mission of the program and the direction that the program is headed. It would be possible to point to many areas of geology that are not covered by the existing faculty, but it is unrealistic that any program should be so wide and far-ranging that all areas of a particular discipline should be represented
equally. Consequently, the present program is regarded as having the proper mixture of disciplines represented within it for the Geology program for the student numbers that are presently available and for the present resources of the institution and State. An obvious addition to the staff would include a low-temperature geochemist who would complement the undergraduate and graduate program in the environmental geology areas. This area has been helped considerably, however, by interactions with Dr. C. Webb of the Chemistry/Chemical Engineering Department, who cooperates well with the department in teaching and research in the field of low-temperature geochemistry. The general area of mineralogy and petrology has suffered as a result of the retirement of Dr. I. Redden. The part-time assistance (25%) of Dr. Ed Duke helps fill this need, however.

Support for graduate students is an important deficiency that results in problems of maintaining the degree of excellence in the graduate programs. The present levels of state support are far too small and should be increased substantially. The graduate support is supplemented to a much greater extent by externally funded research projects but this effort would be assisted as well by increased state support to aid in the base for the instructional and research efforts.

7.4 Instructional Methods

Traditional classroom and laboratory teaching methods are used for most of the classes within the Geology curricula. Class sizes are sufficiently small that individual attention can be given to the students, which is important due to the required level of understanding of the work needed to complete the programs. The indoor laboratories are complemented by field trips to areas of local geologic interest, and a maximum amount of field experience is attempted to be placed within most of the courses. This is a major strength of the programs and it is capitalized upon at every opportunity. The graduate programs require individualized attention during the course of work on the thesis and dissertation.

The summer field course, a required field experience, is organized through the Black Hills Natural Sciences Field Station. This camp consists of five credit hours of coursework performed over the course of five weeks in the field. The course is conducted from the Ranch A facilities in the northern Black Hills in conjunction with several other institutions as part of a consortium dedicated to the teaching of field geology.

7.5 Interrelationships with Other Programs

The program interfaces with other School of Mines programs such as Geological Engineering, the Museum of Geology, the Engineering and Mining Experiment Station, and the Black Hills Natural Sciences Field Station.

Courses taught by Geology faculty members comprise much of the science base upon which the Geological Engineering curriculum is built. Many of the courses taken by students in
the Paleontology program are taught by Geology faculty members who may also serve on thesis committees of students in the program. The summer program of the Black Hills Natural Sciences Field Station is supported by our faculty members who teach there.

7.6 Anticipated Changes in Curriculum

A new thrust has been added to the M.S. and Ph.D. in Geology which emphasizes Geographic Information Systems (GIS). A close relationship with the EROS Data Center has developed as a result of the completion of NASA Space Fellowship by three members of the SDSMT Geology faculty during the last three successive summers.

VIII. INFORMATIONAL RESOURCES

8.1 Library Resources

Access to the entire Library system is available by computer search (SDLN/PALS ONLINE AT THE LIBRARY) at no charge. There is a hands on procedure for the user. In a short period the requested material can be obtained from other libraries in the system. For a charge, there is computer access to Nationwide Search.

The library is in the process of establishing the School’s archives in regard to our history as well as Black Hills mining. The later will serve as a resource for the Department as well as the general public mining-related activities during the past 120 years. This was accomplished with assistance from a grant from NHPRC in Washington, D. C.

The Devereaux Library’s holdings in Geology are marginally adequate, especially in the area of research. Improvement would clearly be helpful. As an example, the library is underfunded for journal acquisitions, but recent allocations of indirect costs from research grants to journal purchases will improve the situation. In addition, shelf space is limited; some older issues of journals have been stored and are not available on shelves. Funding for book purchases for the Geology and Geological Engineering programs is based on student credit hour formula, and thus minimal amount is available for geology books.

Internet connections are available on the SDSMT campus. This provides access to the CARL System and electronic mail, as well as other global resources.

8.2 Special Informational Resources

8.2.1 Departmental Ore Collection

The Department maintains a catalogued and cross- referenced collections of ore specimens obtained over the past 80 years of the School’s development. This collection contains
both individual specimens and suites of unusual as well as representative minerals from deposits around the world. Over 4,000 specimens are present for classroom as well as research use.

8.2.2 Departmental Map Collection

The geology department is responsible for a catalogued and cross-indexed collection of roughly 4,000 maps. These run the gamut from simple claim maps from the Black Hills to geological maps covering entire continents. In addition, the School is a designated repository for many maps issued by the U. S. Geological Survey. The collection is available to students and the general public.

8.2.3 Departmental Petrology Collection

The department maintains a catalogued collection of approximately 1,200 hand specimens of rocks from around the world. The collection is used chiefly for demonstration in petrology, optical mineralogy, and general geology classes. It also includes special collections referenced to the graduate theses for which they were taken.

8.2.4 Departmental Well Records Collection

Records of oil and water wells of the Black Hills and region are available for the use of students, staff and the public. These include about 2,500 drillers and geologists logs, 675 sets of well cuttings, and roughly 2,000 electric and radioactivity logs.

8.3 Anticipated Changes in Informational Resources

These data bases grow yearly with the input from staff, students, alumni, and the public. There is no anticipated change in this process- of accumulation.

IX. FACILITIES AND EQUIPMENT

9.1 Current Facilities

As noted previously the two programs of Geology and Geological Engineering are administered through one Department. In general, funding and facilities for one program directly or indirectly affects the other. The following list makes no attempt to separate facilities relative to one of the programs in favor of the other.

9.1.1 GIS Laboratory: A GIS laboratory was added in 1993, and includes a IBM RISC 6000 workstation, a 486 PC, and drafting table. ARC INFO and IDRISI software are available for GIS.
9.1.2 **Ground-water Laboratory:** This is used for hydrologic work and contaminant transport studies. The lab also houses ground-water field equipment. This laboratory space covers 400 square feet and is housed in part of Room MI 323. Equipment for this laboratory includes a hydrologic analysis system that is connected to an operational well field outside the MI Building, water level/temperature meters, ion-sensitive probes, a field chemical-analysis kit, permeameters, and sand-tank models.

9.1.3 **Engineering geology and geotechnics Laboratory:** This laboratory occupies 400 square feet in part of Room MI 323. Equipment for this laboratory includes ground-penetrating radar, soil-testing equipment, and a 12-channel engineering seismograph.

9.1.4 **Scanning electron microscope:** This instrument is operated by the Engineering and Mining Experiment Station (EMES) and is available for student use.

9.2.1 Capital Equipment

A complete list of capital equipment available in the Department is included in Appendix C.

9.3 **Computational Support**

9.4 Technician support is modest but is improving. A technician is now assigned to the Mineral Industries Building.

9.5 **Museum of Geology** The Museum of Geology provides superb collections for work in mineralogy, petrology, and ore deposits. The Museum is a strong resource, and there is excellent cooperation between it and the Department.

9.6 **Needed Additional Facilities**

Computer facilities for micro, mini, and time-sharing systems continues to be a critical need. Strides are being made to improve the existing systems, but non-mainframe resources are distinctly lacking.

Specific pieces of equipment that would enhance particular aspects of each of the portions of the curricula could be detailed. These would include such items as:

- Stable Isotope Laboratory
- Cathodoluminescence apparatus and microscope
- Student microscopes (5)
- Rock Thin Section Preparation Equipment
- Field Vehicle

**X. FINANCING OF PROGRAM**
10.1 Financial Support Currently Available

10.1.1 Salaries

During the 1999-2000 school year four state funded faculty positions were assigned to the Geology program. The dollar amount of these positions was $215,000.

10.1.2 Teaching Assistantships

The Department of Geology and Geological Engineering, which includes graduate programs in Geology, Geological Engineering, and Paleontology has been awarded seven Graduate Teaching Assistants for the academic year 1999-2000.

10.1.3 Equipment

The combined Department of Geology and Geological Engineering received a total of $17,520 in Operations and Maintenance Support during the academic year 1999-2000. An additional $10,400 was generated in laboratory and thesis fees through the combined programs of Geology, Geological Engineering, and Vertebrate Paleontology. A total of $3,600 was received for the purchase of capital asset equipment in addition to the funds detailed above.

10.2 Future Financial Support

The financial position of the Department appears to be stable for the near term. The student enrollment appears to have stabilized and new recruiting initiative appear to offer the possibilities of additional expansion of the student body. Considerable success has been enjoyed through increasing the enrollment in service courses such as Oceanography and Earth Resources. Because South Dakota is an enrollment driven system, additional state funds must be acquired by additional enrollments.