EXTERNAL REVIEW

OF THE

INTERNAL REVIEW

MASTER OF SCIENCE IN PALEONTOLOGY

AN INSTITUTIONAL SELF STUDY

By

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for

SOUTH DAKOTA SCHOOL OF MINES & TECHNOLOGY

and the

SOUTH DAKOTA BOARD OF REGENTS

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Bonafides and Review Procedure

The reviewer, Dr. Gale A. Bishop, is a semi-retired geologist and paleontologist who now resides in Spearfish, South Dakota. He has taught for 32.5 years in a University setting and published some 75 peer-reviewed papers, mostly in Paleontology supported by over 70 competitive grants. Because of his proximity to the School of Mines, numerous formal visits and informal observations were possible within the contractual interval. A general meeting was held with Graduate Students and verbal observations recorded. Additional information was solicited via telephone from specific graduate students. Each staff member was interviewed and comments solicited by e-mail or written form from all students and staff. Internal review documents of the Department of Geology and Geological Engineering (Dr. James E. Fox, Chairman) and the Dean of Earth Systems, Dr. Sangchul Bang were examined. The Internal Review document of Dr. James Martin was relied upon heavily for structure and content of this review. Special thanks to Dr. Martin for allowing is structure to be used and edited to this purpose. Dr. Martin’s edited report is encased in quotation marks to indicate what portion of this report is essentially his work. That document was enhanced by observation and interview data. The external review was an ongoing process from time of contracting until submittal of a preliminary report on May 12. Summaries of the review document are presented herein as a heavily edited cut and pasted copy of Dr. Martin’s Internal Review document with notes in each section to reflect the reviewer’s comments and opinions.

DESCRIPTION OF PROGRAM

“The Master of Science (M. S.) with major in Paleontology is taught from within The Department of Geology and Geological Engineering with considerable support from the Museum of Geology (as an academic support unit it cannot directly support a degree program) a unit of South Dakota School of Mines and Technology. The Paleontology Degree Program is administered through the Department of Geology and Geological Engineering (Dr. James E. Fox, Chairman) who reports to Vice-President of Academic Affairs, Dr. Karen Whitehead (who is also the acting Director of the Museum of Geology due to illness of the Director). The paleontology program receives major support from the Museum of Geology, with Dr. Philip R. Bjork, Director until his retirement and a new director assuming duties on July 1, 2000. The Museum Director reports to the Dean of Earth Systems, Dr. Sangchul Bang and thence through the Vice-President of Academic Affairs. The Office of Graduate Education under the direction of Dr. Sherry Farwell administers all campus graduate programs, overseeing graduate student admission and progress.”

“Area of Concentration - The paleontology degree program specializes in vertebrate paleontology, including such interrelated subdisciplines as evolutionary biology, taphonomy, zoo archaeology, taxonomy, biostratigraphy, paleoecology, and functional morphology. The
opportunity for students to specialize in invertebrate paleontology is available, but has had few active students. The Museum of Geology also supports one of the world's most extensive mineral collections, especially minerals of the Black Hills."

[The growth in Invertebrate Paleontology will strengthen the Paleontology Program and also build additional links into Geology.]

"Proposed Program Changes - The primary program change envisioned is the addition of a vertebrate paleontologist faculty to be hired through the Department of Geology and Geological Engineering and a new Director of the Museum of Geology. The staff would also like to broaden the base of the program by including paleobotany/paleoecology input from Dr. Mark Gabel at Black Hills State University."

[The support from Geology in hiring a Vertebrate Paleontologist will go a long way toward sharing professional loads with the Museum. The partnering options between Universities in the region, either by direct sharing of expertise or by distance learning needs to explored and expedited.]

"Program Objectives - The location of South Dakota School of Mines and Technology near the very rich and significant deposits of fossil vertebrates within 200 miles of the institution affords unparalleled learning opportunities for the staff and students. The program requirement of a thesis is based on the student's hands-on participation in the collection, curation, and study of vertebrate fossils. The student normally uses and contributes to the extensive collections of fossil vertebrates in the permanent collections of the Museum of Geology. The paleontology program prepares students to pursue doctoral level research in either geology or zoology after completing this program. and serves as an introduction to research on fossil vertebrates with a strong geological emphasis. Thus, students participate in data acquisition that establishes the context for research on fossil vertebrates, gain experience in a museum environment through the preparation and curation of vertebrate fossils. The vitality of students and the aggressive research activities of the Museum work synergistically in accomplishing the objectives of both."

"Relationship to Departmental Mission - The mission of the Department of Geology and Geological Engineering is primarily the education of students in geological engineering and geology and application of that understanding. Paleontology is integral to the history of the earth, provides the principal dating methodology, and provides insights into the ecology in shaping the earth. The curriculum of the Geology provides the temporal, sedimentological, and depositional environmental context in which the paleontology students place fossils."

"Relationship to Institutional Mission - The mission of the South Dakota School of Mines and Technology is to provide quality educational opportunities leading to baccalaureate and graduate degrees, to contribute to the expansion of knowledge, and to serve the public with
expertise for the general good. The paleontology program is woven inextricably into all three components of the mission. The educational program ensures that faculty and students form a partnership in learning that is symbiotic and synergistic. Faculty and students interact with the public by identifying specimens, providing lectures and programs, and through media reports of discoveries."

[The outreach to South Dakotans should not be under emphasized, it is a real and valuable function for recruitment at SDSMT and to tourism in the Northern Great Plains.]

"Closely Related Programs - Paleontology and Geology and Geological Engineering students and faculty are mutually involved in Geology course work and seminars. Students teach laboratories for the department and participate in departmental open houses and other recruiting activities. Graduate students and Museum personnel are crucial to the success of the undergraduate track in paleontology that is part of the B.S. in Geology."

"The Museum of Geology as an academic support program is the intellectual home of the degree program providing a major share of the logistical support for the degree program. This support is a natural outgrowth of the fact that student research is based on collections that are housed in the Museum of Geology. The activities of the Museum also provide opportunities for employment of students."

"The Haslem Post-Doctoral Fellowship is an endowed fellowship that permits the institution to bring to campus a recently graduated doctoral student in paleontology for a period of up to six years. The Haslem Fellow conducts research in paleontology that is germane to the paleontology of this region. The first fellowship was awarded in 1993 and has added an important dimension to the vitality and diversity of the paleontological research at the South Dakota School of Mines and Technology. Some fellows have aided in teaching and advising paleontology and geology graduate students when time and financial reimbursement are available."

[The Haslem Post-Doctoral Fellowship may need to be better defined by a short job description to better define expectations. As with many positions, the work expectations are often greater than expected. By defining such expectations future recipients will have a clearer idea of the position expectations.]

"The Department of Biology has provided out-of-department graduate committee members, as well as opportunities for graduate teaching assistantships for paleontology graduate students."

[The Biology Department should directly support the Paleontology Program through joint appointments of biologists who have expertise in biology and paleontology; such as was done with Dr. Morton Green in the 1960’s. Partnering with Biologists on
Campus and at nearby institutions should be explored and are encouraged.)

“Changes in Program Objectives - The fundamental objectives of the program have remained constant since the program was initiated. Changes that occur largely reflect interests of students and faculty as they apply to specific research problems and how problems are approached.”

“Anticipated Changes in Program Objectives - No major changes are anticipated in the program objectives, although this stance may change when the new director is hired. Cooperative interactions with appropriate educational institutions and resource managers will play an increasingly important role in the program.”

PROGRAM STRUCTURE

“Program Rationale - The basis for the Paleontology program rests primarily in the opportunity to provide students with first hand experience in the practice of the science in South Dakota. The paleontological resources of South Dakota and adjoining states have world-wide significance. Students participate in the extension of understanding that was initiated by these early workers. The program is part of a very strong geology curriculum in the Department of Geology and Geological Engineering, with emphasis in the geology of the Black Hills region. For 76 years the Museum of Geology has systematically conducted collecting expeditions which have yielded significant documentation of the fossil history of the region with specimens forming the basis for teaching and providing focus on paleontological problems. The primary mission of the program is to preserve, develop, and disseminate an understanding of the fossil record.”

“Breadth of Program - Although the Paleontology program seemingly has a narrow focus in vertebrate paleontology, it includes vertebrate paleogeography, tectonics, catastrophic extinction, discoveries of dinosaurs and human fossils. The expansion of knowledge of taphonomy allows a clearer understanding of fossil preservation. New conservation techniques and the technology to disseminate data via computers have made fossil resources available on an enhanced scale. Study of the relationships among organisms is approached with a rigor that has revitalized the study of all vertebrate groups.”

“The program in paleontology is based on the premise that students should have experience in collection, preparation, curation, research, and education of the public. This real-world approach is built on a core of academic course work that provides the intellectual framework for the hands-on activity. That core curriculum includes six semester hours of vertebrate paleontology, four semester hours of comparative osteology/odontology, six semester hours of vertebrate biostratigraphy, two semesters of museum methods, a summer field paleontology course, and one semester of sedimentation. Students are also encouraged to take advanced field methods to hone their observational skills and report-writing capabilities and are required to participate in seminars. Additional course work reflects interests of the student. Each potential Ph.D. student
is encouraged to conduct research on a problem that is not directly related to his/her thesis problem. This effort demonstrates diversification, making the student more likely to be accepted into a doctoral program.”

[Students applying for admission to the Paleontology Program should be advised to remediate any deficiencies before entering the Program to shorten their tenure at SDSMT.]

“External Relationships of Program - Because the program is woven into the fabric of the Museum of Geology, the alliances that the Museum enjoys then become woven into the Paleontology program. Associations with federal agencies including the Badlands National Park, the Corps of Engineers, the Bureau of Reclamation, the Bureau of Land Management, and the Forest Service, and with state agencies including the Office of the Commissioner of School and Public Lands, the State Archaeological Research Center, and the South Dakota Geological Survey are in place. The Museum collaborates with faculty at Black Hills State University and nonresident teachers and researchers from Argentina, France, New Zealand, California, Nebraska, New Jersey, New York, North Dakota, Oregon, Texas, Washington, Wyoming, and the District of Columbia. The Crow Creek and Oglala Indian Tribes have supported Museum efforts along the Missouri River and on the Pine Ridge Indian Reservation, respectively. The Wyoming Department of Transportation has collaborated on an important collecting project in the Black Hills. The Museum of Geology is assisting the Journey Museum in Rapid City and development of visitor centers in Chamberlain and Ft. Thompson, SD, as well as Crawford, NE. All of these relationships are important for the success of the program in Paleontology. Linkages with resource managers are essential to provide students with experience in working with a variety of agency cultures where they are part of a team that reacts to discoveries in diverse settings. The program supports resource managers, tribal governments, and colleagues and their resources help students learn in a synergistic relationship.”

PROGRAM NEEDS

“Increasing interest in the conservation of paleontologic resources coupled with unprecedented public awareness of paleontology places the paleontology program in a very positive public position. The level of awareness of federal resource managers takes on two important aspects: 1) the assessment of paleontological resources for which they are responsible and 2) the preservation of threatened specimens.”

“Researchers from around the world visit the collections. In 1998, the Curator of Vertebrate Paleontology of the Museum of Geology became involved in expeditions to Antarctica, Argentina, and in 2000 in Australia. This drew international attention and permitted the participation of students as well as faculty in the programs, enriching education in the paleontology program.”

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“The program derives its primary justification from interest in fossil vertebrates, as well as the geographical location of the university within the midst of one of the world’s richest and most diverse fossil locales. This long-standing interest has been most recently rekindled by the overwhelming success of the movies, "Jurassic Park" and "Lost World." Interest is sufficient to attract a number of qualified students to the program. In fact, currently the paleontology program has the largest graduate student enrollment of any such program in the United States. The need for qualified paleontologists to provide land and resource managers with relevant data regarding the preservation of resources is a growing need. With continuing visibility of paleontology many museums are looking to increase the exhibit and public education activities in this area. Smaller museums also find that paleontologists are versatile enough to fill a variety of roles when they are short of staff. Many SDSMT students pursue the doctoral degree after completing this program. The paleontology program has significant role in research, public education, and resource management in the future.”

“Relationship with Other Programs - The program is well integrated into the Geology graduate program, and students in past years have contributed to the vitality of the Geology graduate student environment. The paleontology students bring a very broad perspective to the department and are especially suited for assisting with the instruction of Historical Geology. They are also often qualified to assist in the instruction of undergraduate courses in the Department of Biology.”

5.0 STUDENT DEMAND

“Pool of Applicants - Currently three applications are in hand for the paleontology program for the fall of 2000. We have been very successful in obtaining external funding; at least four student stipends with tuition remission should be available in the fall of 2000, as well as hourly positions funded through external funding and the Museum of Geology.”

“Enrollment Statistics - The staff has tried to maintain a small program in keeping with limited resources. Recent growth has stretched our capabilities to produce quality education. We have lost students with a great deal of potential to other schools, primarily in response to recent decisions concerning costs for nonresident students and the small institutional stipends compared to those of peer universities. However, the reputation of the Program and uniqueness as the only Master’s degree in paleontology have helped maintained numbers of students. Four students matriculated to pursue the doctoral program in geology with emphasis in paleontology; one finished, one left due to lack of support, and two are currently enrolled.”

[The chart below indicates a developmental stage followed by a strong implementation which has shown some erosion due to personnel problems over the last two years. As the Program proceeds it will be necessary to either increase support through dedicated assistantships and internal and external funding. The Museum Staff has done a]
remarkable job in supporting students in the Paleontology Program. The Department of Geology has strongly supported students in many ways in the degree progress. The SDSMT Administration should take a hard look at Institutional support levels and determine if the myriad benefits being derived from the Paleontology Program and the Museum of Geology might support an increase in Institutional funding levels to capitalize on this center of excellence (which deserves to be one of the Institution's premiere programs).]

![Graph showing applications, acceptances, entering, and graduating numbers over time.]

Degrees Granted in Paleontology - The Paleontology program offers an M. S. degree

"Student Placement in Paleontology - Past students in the Paleontology program have included: 1988, Craig A. DeTample, Director, Children's Science Center, Rapid City, SD; 1988, Dennis A. Robertson, Geologist, Prospector Mining Corporation, Denver, CO; 1988, Janet L. Whitmore, Collections Manager, Northern Arizona University, Flagstaff, AZ; 1989, Jane P. Abbott, Research Assistant, State Archaeological Research Center, Rapid City, SD; 1990, Tammie R. Keeler-Bouchard, Geologist, Geraghty & Miller; 1991, Rachel C. Benton, Ph.D. from University of Iowa, Park Paleontologist, Badlands National Park, Interior, SD; 1993, John R. Foster, Ph.D. from University of Colorado, Collections Manager, University of Wyoming, Laramie, WY; 1996, Kimberly Stevens, Instructor, Sierra College, CA; 1997, Janet L. Bertog, pursuing Ph.D., University of Cincinnati, OH; 1997, Heather C. Finlayson, Education Assistant, Children's Science Center, Rapid City, SD; 1998, David Cicimurri, Collections Manager, Clemson University, AL; 1999, Darrin C.
Pagnac, pursuing Ph.D., University of California, Riverside; 1999, Christian M. Cicimurri, recently applied for the Education Coordinator at Clemson University; application pending

Degress to to be granted in 2000 include those to Joseph N. Dibenedetto, Barbara L. Rowe, and Kathleen M. Stokosa."

"Program Enrollment Capacity - The Paleontology program is one of the largest in the country, a situation which should continue with continued interest in paleontology and with students entering the doctoral program in geology with interests in paleontology. Two professors, the collections manager/preparator, and a post-doctoral fellow have formed the core of the faculty. The program requires very dedicated students who realize the job potential is not so great as that of some other disciplines. We therefore attract excellent students more interested in education and research than later financial rewards."

[The growth in Paleontology and the illness of the Director has caused inordinate work loads to be placed on current staff. The descriptions of each staff member's job roles needs to be clearly defined in terms of institutional expectations and compensation when a new Director is hired.]

"Anticipated Changes in Enrollment - We do not wish to enlarge the program greatly, and maintenance of a high-quality educational program is our goal. We wish to attract those students with the greatest potential. It may be noted from the table that our applications for the paleontology program have increased over the past five years. This is due, in part, to being the only degree-granting program in paleontology, our reputation, proximity to the source of fossils, and the current "dinosaur craze." From these applicants, we wish to accept students of merit, and attracting high-caliber students requires competitive assistantships."

[Unless the staff can come to grips with the workload generated by 16 students, it will be necessary to increase staff in some manner or decrease the number of students. This workload can be shared across the Program by creating a dual management system for students, assigning Thesis and Dissertation Committees with a research supervisor (from the Museum, Geology, or Biology area) and a thesis/dissertation progress supervisor (from Geology or Biology) to assure rapid progress in both research and course programs.]

PERSONNEL

"Faculty in Direct Participation in Program - Currently, the Curator and Collections Manager/Preparator are most directly involved in the program. Most graduate students who obtained a Master's degree in paleontology during the last ten years have had either the Director or Curator as a thesis advisor. Dr. Gordon Bell, the former Haslem Fellow undertook the primary advising of one graduate student who graduated in 1998; the Director advised one
student who graduated in 1996; otherwise, all students have chosen the Curator as their thesis advisor. We anticipate that the new director will also aid in advising graduate students in paleontology."

[The support from Geology in immediately (Year 2000-2001) hiring a Vertebrate Paleontologist will go a long way toward sharing professional loads with the Museum. The reviewer strongly recommends this position be placed at the top of Institutional objectives for the new academic year and the position be filled as rapidly as possible. Such a position could be the key to rapid improvement in the Program.]

"Support and Advisory Faculty - Many members of the faculty of the School of Mines have been extremely helpful in adding depth to the program, advising students, in critical review of theses, and supporting the program in many intangible regards. The expertise and help of Dr. James Fox is especially essential to this process."

[The support from Geology delivered in so many ways is often overlooked. The professional competency and expertise of the Geology staff has been so well integrated that I think it often becomes “invisible.”]

"Current Support Staff - Michael T. Greenwald with an M.S., South Dakota School of Mines and Technology has a temporary appoint as Research Scientist II and is responsible for much of the curation. His areas of expertise include Late Cretaceous vertebrate faunas; curation of vertebrate fossils; and public outreach. Katherine McCarrville with a M.Sc., Colorado School of Mines and holding the position as SDSMT Director, Instructional Technology Services brings to the Program her technology expertise and her interests in Avian taxa of Pleistocene Fossil Lake; evolution of birds; application of scientific visualization and simulation techniques to paleontology; curation of vertebrate fossils; paleontological data management."

[The staff of the Paleontology Program has developed a close working relationship through an exciting teaming effort. The efforts of Museum and Departmental staff have become supportive of the Paleontology Program and this trend needs to be nurtured by opening communication during the near future.]

"Special Competencies of Existing Faculty - The competencies of the major faculty members in paleontology fit closely with the academic and research opportunities offered by the overall technical orientation of the School of Mines and its unique geological/paleontological setting in the midst of the Badlands and dinosaur-bearing strata."

"Philip R. Bjork has extensive field experience and published articles on the mammalian fauna from the White River Badlands. Most recently, the excavation and analysis of a Pliocene site in the northern Black Hills. and the wealth of dinosaur remains in northwestern South Dakota. He studies their evolution, biostratigraphy, functional morphology, paleoecology, and taphonomy."

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"James E. Martin studies Jurassic mammals of eastern Wyoming, Late Cretaceous marine fish and reptiles from Antarctica and South Dakota, Late Cretaceous dinosaurs and mammals from eastern Wyoming, Miocene mammals from South Dakota and the Pacific Northwest, and vertebrates associated with Ice Age sites. He has had a very strong working relationship with students in paleontology and was a primary force in the initiation of the paleontology undergraduate track. He collaborates with the Bureau of Land Management in Oregon on resource management policies and has also developed the most extensive collection of Pleistocene vertebrates from the Fossil Lake localities in Oregon. His collaboration with federal entities is also evidenced by an extensive paleontological survey of the Missouri River shorelines for the US Corps of Engineers. Dr. Martin has also been instrumental in the revision of the state geological map, conducted excavations in Antarctica (for which he received the 1999 Discovery Award from the Royal Geographical Society of London and the Discovery Channel-Europe). Students are now becoming involved in these projects. Two students will accompany Martin in an upcoming expedition to Australia in June, 2000."

"Carrie Herbel has been assisting Badlands National Park in the preservation of a unique bone bed (the Pig Dig site) in the Scenic Member of the Brule Formation. In addition to this excavation and curation, she is involved in examining other bonebeds at the same stratigraphic level in many areas within Badlands National Park. Several students are working directly with Ms. Herbel in the analysis of the Pig Dig site and its correlation. Ms. Herbel has been conducting research on adhesives and their qualities in the conservation of vertebrate fossil material and is working closely with other collection managers in the Society for the Preservation of Natural History Collections. She maintains up-to-date information pertaining to collections and laboratory procedures, and her focus on fossil conservation (from the field to the lab) and curation is shared with undergraduate and graduate students through two courses in museum methods. These courses provide much of the experience for collection management and fossil preparation duties that some of our graduates may require with certain positions. Educational outreach and exhibit designs are also a major portion of a student’s education in this program, and Ms. Herbel oversees this aspect of the program while providing students with hands-on opportunities."

"Julia Sankey has current research interests in the Late Cretaceous vertebrate faunas of western North America between Texas and Alberta, especially on the mammals and theropod dinosaurs, and the paleoenvironmental effects on the K/T (Cretaceous/Tertiary) extinctions. She has collaborated with paleontologists at the Royal Tyrrell Museum of Paleontology in Drumheller, Alberta, and other museums. Her research includes the Late Cretaceous vertebrate paleontology and magnetostratigraphy in Big Bend National Park, Texas supported by Earthwatch’s Durfee Student Challenge Awards and will include eight high school student volunteer assistants during summer, 2000. Her future research will focus on the Latest Cretaceous vertebrates, especially from the Hell Creek Formation of the Dakotas, in order to explore the diversity patterns of the theropods leading up to the K/T boundary. She has also done extensive research on late Pliocene-Pleistocene vertebrates from Idaho and uses magnetostratigraphy to help constrain the age of
vertebrate faunas and collaborates with paleomagnetist, Dr. Wulf Gose, at the University of Texas at Austin. Another of her research interests has been to use ancient pack rat middens to reconstruct past environments, which she did with a Holocene midden from Baja California, Mexico."

"Michael Greenwald is doing paleontological survey and salvage for the Mini Wiconi water-pipeline project with the Oglala Sioux Tribe and Badlands National Park and directly involved with all vertebrate curation for Badlands National Park, resulting in a great addition of cataloged specimens to be utilized for research and education. He has been instrumental in public outreach and interfacing with both undergraduate and graduate students. His interests include both Late Cretaceous terrestrial faunas and vertebrate fossils from the White River Group."

"Specialties not Currently Existing in Faculty - Although the majority of vertebrate paleontological subfields are covered by the current faculty, two major additions are envisioned. The first would be the addition of a faculty member who specializes in evolutionary biology, particularly with a strong interest in vertebrate systematics. This individual could be added to the biology faculty, but this is a non-degree granting program. The second addition is to meet the need for expertise in data management. A major focus of museum collections is now toward computerization for ease in entry and retrieval of pertinent information for education and research. This goal may be achieved by training of existing faculty/staff members. However, funds must be procured for release time for this undertaking as primary paleontological instructors are over-committed. The best solution would be the addition of an expert in computer data management. Such a person with a strong interest in paleontology is currently the director of ITS."

[Partnering opportunities abound within the SDSMT community, including formal and informal arrangements between and amongst Departments to expedite the mission of SDSMT and its units. One of the new directions the Program may take will be integration with other Campus and off-Campus programs to capitalize on the popularity of paleontology in our society.]

"Anticipated Staff Changes - We are fortunate to have capable faculty and support staff. The replacement of the Director's position should provide additional expertise. Also, the addition of at least one full-time position to accelerate the preparation of specimens for teaching and research is desperately needed. This has a real impact on our program because it limits the samples available for students. The preparator would also be expected to aid in the teaching of the laboratory portion of the museum methods courses."

**CURRICULUM**

"Degree Requirements - The degree requires: 1) A program of at least 30 semester credit hours
of course work, including 6 hours of thesis research credit; 2) At least 18 credit hours of graduate course work; 3) Passing an oral examination on general knowledge following course work; 4) Satisfaction of academic standards prescribed in the school catalog; 5) Production of a thesis based upon individual research; the non-thesis option is not available for the paleontology program; 6) Successful completion of reading examination in a foreign language; 7) Successful completion of oral defense of thesis. and 8) A minimum of two semesters in residence.”

“A program of study is suggested including undergraduate prerequisites, undergraduate courses which may be taken for degree credit, and graduate courses, the first eight of which are required. The Program suggests prospective student in paleontology should have completed as part of his/her undergraduate training a minimum of one year of chemistry, and one semester each of physics, statistics, and calculus. No graduate credit is granted for making up these deficiencies. The candidate is required to pass a reading examination in one of the following languages: French, German, Spanish, Russian, or Chinese.”

[The program of study may have to be streamlined to encourage more rapid progress in degree programs. Selection of students from geology or biology tracks ought to be placed in equivalency, as both are professional fields with strong degree requirements. I wonder if all biology students have to “be made over” into geologists; or visa versa? Certainly there has to be a “core” of geology AND a “core” of biology content necessary for the degree, but maybe that core can be better defined and delivered through a more efficient mechanism than taking so many courses. With many students coming out of biology, maybe some relief in remedial work in geology can be worked out?]

“Undergraduate Prerequisites

Course:
Physical Geology
Mineralogy and Crystallography
Historical Geology
Stratigraphy and Sedimentation
Structural Geology
Elementary Petrology
Field Paleontology
Invertebrate Paleontology
Introduction to Statistical Analysis
Calculus I
Physics I
Chemistry I
Chemistry II”
[The implication here is that the Paleontologist is essentially a Geologist, the Reviewer wonders if the same assumption could be applied to a Biology track, i.e. that a Paleontologist ought to be essentially a Biologist and have had the core requirements of a B.S. in Biology. It certainly would be a lot of remedial work from either side of the track.]

"Undergraduate Courses for Graduate Degree Credit"

Geol. 400 Field Geology 6
Pale. 396 Vert. Paleont. Techniques & Exhibit Design 3
Pale. 496 Museum Conservation & Curation 3

Graduate Courses

Pale. 673 Comparative Osteology 4
Pale. 776 Vertebrate Paleontology 6
Pale. 774 Stratigraphic Paleontology of the Continental Mesozoic and Paleogene 3
Pale. 775 Stratigraphic Paleontology of the Continental Neogene 3
Pale. 770 Seminar in Vertebrate Paleontology 1-3
Pale. 793 Graduate Seminar 1
Pale. 700 Geological Research 5

Geol. 633 Sedimentation 3
Pale. 684 Paleoenvironments 3
Geol. 631 Rocky Mountain Stratigraphy I 3
Geol. 632 Rocky Mountain Stratigraphy II 3
Geol. 672 Micropaleontology 3
Geol. 704 Advanced Field Geology 3

In a two-year program (for students without any deficiencies), a program of study would include minimally the two museum methods courses and the first eight graduate courses. However, many students come to the School of Mines with some math or physical science deficiencies which when coupled with the requirement of a thesis, normally involving extensive field work, often causes a student to be in residence for longer than two years."

[The number of courses and their credit might be examined. Would it be possible to combine content in some courses by creative team teaching (i.e. Paleo. 774 and Geol. 632 and Paleo. 775 and Geol. 634) to provide both the rock framework and the paleontological framework as a single content unit which would be team taught by a Stratigrapher and a Paleontologist? Such a course might provide more integrated]
content for students, open lines of communication across campus, and also be “saleable” on an International basis over distance learning networks.

“Unique Features and Strengths of the Program - The degree offered in paleontology with an emphasis in vertebrate paleontology is the only such program in the nation. Similar programs are available at other universities, including all those neighboring states except North Dakota. However, in each case, the degree is a subdiscipline of geology or zoology. The program at South Dakota School of Mines and Technology is unique.”

“The strength of the program is its faculty, facilities, and current field activity in the acquisition of outstanding teaching and research specimens by the Museum of Geology. The proximity to world-renowned fossil beds is one of our greatest assets and collections made over the last century now rival many in the world, providing a superb resource for instruction and unduplicated research opportunities. Paleontology courses taught by Museum staff includes use of these collections to illustrate course material. Few regions in the world are so well suited for a program in vertebrate paleontology, and the Museum facilities contribute greatly to the success of the program.”

“In addition to the Museum support, the university supports the program through computer technology, partnering on campus, and an international reputation for delivery of educational programs. Technology in the field of paleontology provides the opportunity for leadership in the capture, dissemination, and replication of fossil data and content. Program-related research important to the citizens of South Dakota and assists them in understanding the land on which they live. Degree candidates associate with people at every level from children to senior citizens and interfaces with many other scientific organizations and agencies, resulting in mutual benefits. The program provides students who have a strong, lifetime research orientation to blend with those who are industry-oriented, providing a mixture of philosophical outlooks is beneficial to both types of students and adds dimension to overall education at the SD School of Mines.”

“Program Deficiencies and Planned Remedies - The significant and rapid increase of the program with from two to five students to twelve to fifteen students, along with advances in technologies has resulted in greater program deficiencies than in the past; including space for students and specimens, particularly for lay-out and study of larger specimens; requirement for additional equipment, space, and software. A current need is to acquire at least two workstations and licenses for the Rediscovery data management program, as required by federal agencies and to interface this program with the SDSMT High Priority Connection network (HPCNet). The program requires additional computer capability, visual capture capability including three-dimensional digital capture of specimens, as well as CT-scan capability at both macro and microscopic scales, and training so students become proficient utilizing this equipment and programs.”
[The use of computer technology in the Museum needs to be placed in top priority with data acquisition, imaging, and data base management on LAN and over Internet 2 using HPCNet where appropriate. Web site development should receive high priority as this is a very effective educational and recruiting tool.]

"Conservation of specimens is an important facet of the paleontology program, and ability of students in this important field is essential for employment. The program needs increased space for a conservation laboratory."

[The laboratory facilities support most necessary preparation. Space for visiting scientists and students to study specimens is in short supply. Collections storage is currently impinging on quality office space. The Reviewer strongly recommends assigning the entire gym floor to secure collections and exhibit storage, freeing up several office spaces and allowing for layout of specimens. The relocation of "outside" storage to the buildings of origin and relocation of some offices to other open campus space should be strongly considered by the Administration. A comprehensive space utilization plan would direct these actions. The "Western Fossil Repository" concept should be placed high on the Institution's priority list and be used as the keystone of the Campus Master Plan development.]

"Safety and ventilation must be upgraded for the laboratories. Modern equipment is required for the preparation laboratory including a new abrasion unit, as well as sand-blasting capability."

[The current space utilization is as safe as it can be made, except for storage of outside materials on the Old Gym floor. The exhibit facilities have been made accessible to the disabled, the collections storage and laboratories probably have a way to go to meet current codes.]

"Graduate assistantships are always a major consideration, especially with the great increase in student numbers. The curator and collections manager/preparator spend inordinate amounts of time generating funds for both summer field work and academic stipends. The Dean of Graduate Studies, Dr. Sherry Farwell, has been very supportive during this year, providing monies for five students, but this level of funding may be a one-time occurrence. When the graduate program in paleontology was originally formulated in the early 1960s, two graduate assistants were promised to the Museum of Geology in exchange for teaching responsibilities carried out by the Museum staff. These have evaporated over the years, placing greater demand on the Museum."

[The number of graduate assistantships might be stabilized to allow the staff to adequately plan the developmental level supportable by this part of their Institutional support.]

"Another original understanding concerning support of the paleontology program appears to be
changing. Those members of the Museum staff who were overloading their time in order to teach were awarded with faculty rank as a courtesy. Recent decisions have stated that because the Museum staff members have faculty rank, their teaching is mandatory or at least expected. This decision appears to bring the concept of teaching full circle, with no apparent compensation to the Museum. The Museum staff is already overwhelmed, and efforts should be made to add a faculty member who specializes in paleontology to the Museum or Geology program.”

[The arrival of a new Director would be the perfect time to establish the job descriptions of each staff member, including those with faculty appointments. If teaching duties are not part of the mix, then a mechanism to transfer released time funds from the academic budget to the support budget must be found. As the Program has evolved, the job descriptions also have evolved. By defining each person’s job role with a current job description, it should be possible to make all staff member feel good about their role and valuable contributions to the Program.]

“Although not truly a deficiency, in order to maintain the program, fossil specimens must continually be accumulated for research and teaching purposes. Some time intervals such as the Paleocene and Eocene, are not well represented in the Museum collections, and efforts should be expended to acquire specimens from these intervals. Also to maintain standards, collections should continue from those intervals already represented in the Museum collection.”

“Expansion of the comparative collection of living vertebrates is a major deficiency. Theses and research projects require comparative osteological specimens, especially those concerning Quaternary vertebrates. Also, expansion of preparation of fossil specimens remains a major stumbling block to the program. Only a half-time preparator with a full slate of duties is available to get all specimens for 12-15 students prepared. A full-time preparation position is needed to maintain preparation of annual specimen acquisitions and aid with specimen backlogs.”

“Finally, the biology program, which is not a degree-granting program and combined with chemistry, could be oriented to aid the paleontology program. The department could be enlarged, course offerings expanded, and staffed with teachers and research scientists who could advise and teach paleontology students.”

[The Biology Program? Well that’s not part of this, or is it? Maybe the Administration might want to look at the differing roles of Engineering and Science Departments and define a structure bringing the sciences more closely together as a coherent unit capable of supporting common goals. Certainly linking Engineering and Science in a discipline makes sense (i.e. Geology and Geological Engineering), but maybe a second linkage of sciences together and engineering together could be defined without disarticulating the current structure.]

“Overall, additional faculty, student stipends, support staff, space, and equipment are required
to maintain the expanded program.”

**Instructional Methods**

“Historically, the paleontology program was small enough that the best methods of teaching were applied. With only two or three students in the graduate paleontology courses at a time, tutorial methods were utilized. This method of teaching has long been considered to provide the best results, and we felt fortunate to utilize this method, rather than large-class lectures. The benefit was to our students, many of whom have been employed in important positions or have continued successfully in Ph.D. programs elsewhere. Now, due to some pressure to maintain seven students in a course and because of the great interest in paleontology, our courses are larger. Coupled with other duties, time for faculty to interface with students is limited. Although the primary vehicle for class presentation is lecture, much use is made of actual specimens. This is particularly the case for museum methods courses and is an integral part of Pale. 673, 776, 774, and 775. All of these courses have required laboratories which are based upon Museum collections. Lecture, one-on-one communication, and hands-on approach to laboratories characterize most courses taught during the academic year. Also offered during this period are seminars that provide students with specialized projects. These too are enhanced by the small size of classes and close cooperation between students and faculty.”

“Besides classroom instruction, the museum methods courses require actual preparation, casting, collection, and preservation of fossil vertebrates. These courses provide practical experience and diversification that broadens the students’ employment opportunities. Further practical experience is gained when the students collect and curate specimens for thesis research; experience in locality and specimen cataloging is required for most positions in paleontology.”

“Another important area of instruction is in the natural laboratory. Summer expeditions and field courses involve students who learn complete documentation of vertebrate occurrences and how to collect vertebrate specimens without damage in a variety of field situations. Such practical experience is also a great asset for future employment.”

“Overall, the combination of lecture, laboratory, museum, and field experience provides our students with a strong, diversified background, enabling the student to either enter the work force or continue in a doctoral program.”

[If space were to become available, a small computerized classroom in the Old Gym ought to be established for teaching specimen oriented classes. Again, synchronous and asynchronous teaching over the web and distance learning network could import and export expertise and increase efficiency of the the Program.]

**Interrelationships with Other Programs** - The program interfaces with other SD School of
Mines programs such as geology and independent studies. The paleontology program may be considered an advanced or cap-stone course in historical geology, which is a core subdiscipline of geology. Students in stratigraphy, invertebrate paleontology, and sedimentation take paleontology courses to expand and consolidate their knowledge of historical geology, and conversely, many paleontology students undertake corresponding geology courses to better understand the context of fossils. All collections made through the efforts of summer Field Paleontology are deposited in the Museum, and some collections thus gained have been used for thesis research. Many graduate students of paleontology have been hired as teaching assistants for such field courses. This is also the case in the biology department, where paleontology graduate students have often instructed laboratories in the human anatomy and physiology courses."

"Anticipated Changes in Curriculum - Within the last two years, we have revised the curriculum at both the graduate and undergraduate levels; therefore, few major changes are anticipated in the near future. Normal upgrade of courses is required, and we wish to devote greater attention to data base management."

INFORMATION RESOURCES

"Library Resources - Two reprint libraries containing scholarly papers and associated books, as well as the School of Mines Devereaux Library, are available to students and researchers. Dr. J.E. Martin has a private reprint library that totals over 5,000 titles. The James D. Bump Memorial Library, which is essentially the Museum library, contained 5,500 entries. However, donations have increased this number almost two-fold. The donation of the Ted and Marian Galusha reprint library added 1,200 titles and the donation of the Dr. J.R. Macdonald library added nearly 4,000 titles for a total of 10,700 titles. Therefore, these libraries coupled with the Devereaux Library, which contains information on more general topics of geology and paleontology, provides an important data base for the program. The efficiency of interlibrary loan is increasing each year to the point that materials required for research are often available in a timely manner. Crucial references for courses or term papers must be ordered early in the semester.”

"The Museum has not been awarded a formal annual budget for library needs. However, requests for purchases are normally made through the Department of Geology and Geological Engineering by the Devereaux Library."

[The significant library resources in Paleontology need to be consolidated and entered on a computerized data base to make them easily available to students and faculty on campus and across the region. The consolidation of the many libraries in the Museum should be a highly fundable project if presented as a “library project” with strong Museum and Departmental support. Perhaps these unique collections could be consolidated into a “Western Regional Paleontology Library” housed in a secure area]
in the Devereaux Library as part of the "Western Paleontology Repository (when built),... maybe a renovated fourth floor of the library until the new Repository is finished?, AND then be linked into the world as an electronic resource with requested papers to be scanned and distributed via emerging electronic technologies over Internet 2 or HPCNet. This would allow SDSMT to share this significant resource and provide possible "trading value" across the internet."

"Special Informational Resources - Most instructional information comes through direct interaction with museum specimens and. the Collection does have casts of unusual specimens and the capability for producing such casts. All Museum computers are connected to the campus file server for use in data management and for word-processing. One personal computer is available for student use. In addition, binocular microscopes are often utilized in teaching and research; some have measuring capabilities. A camera lucida binocular attachment is available for scientific illustration of small specimens. We also have access to the School of Mines electron microscope and the analytical equipment housed in EMES. Computer aided drafting laboratory, word-processing, and statistical packages are available through the campus Local Area Network."

[The growth in electronic technologies is being integrated into the Museum and it is expected that this trend will continue. Computers linked across the Campus and across Internet 2 will allow for rapid dissemination of data and images. SDSMT should be one of the leaders in computer applications in paleontology and in outreach through the Internet.]

"Anticipated Changes in Information Resources - As computer technologies have emerged, the paleontology program has attempted to respond, primarily through the efforts of the Museum. Attempts are underway to automate the Museum collection, making it more accessible for students and researchers alike. This automation will take some years to complete, and additional software and hardware are required for completion. In addition, we envision capture not only of textual data, but visual as well. Therefore, three-dimensional and CT-scan technologies are being investigated to enhance student abilities for research and education. We plan to provide such information through advanced Internet 2 capabilities and link with other museums and universities. Thereby, we hope to have the availability of more specimens required for research projects with reduced travel."

FACILITIES AND EQUIPMENT

"Current Facilities - Most of the program operations are conducted in the Museum of Geology, where laboratories, collections, and student offices are combined. Since 1944, the Museum has been housed in the O’Harra Building, a facility also utilized by the Administration and Foundation and The Geology Department until about 1962. Over the years the administrative and service functions increased tremendously and encroached on Museum storage
space until the collections and laboratory had become almost inaccessible. The situation was remedied when a portion of the Old Gym was designated to house the systematic collections and for the preparation laboratory, storage area for field casts, bulk matrix, field equipment, and some oversized specimens. Everything but the offices of the secretary and director and the exhibit areas are now located in the Old Gym. Total Museum space is 16,750 square feet, of which 2,395 square feet are utilized for teaching and research collections and graduate student offices. Finally, because not enough space was available for very large field jackets of dinosaurs and marine reptiles, off-campus storage is currently rented.”

“In addition to the physical space, the Museum is equipped with a preparation laboratory under the direction of Carrie L. Herbel. The laboratory contains a ventilation system, hood that requires installation, pneumatic preparation tools, antiquated power abrasion unit, and facilities for washing and screening of bulk matrix samples. Some equipment to assemble a sandblasting unit has been purchased. This augments the standard preparation tools, drills, saws, grinders, etc. We also maintain field equipment, including gasoline-powered rock saw, jack-hammer, winches, camping gear, etc., for summer excursions, many of which are geared toward thesis research. A boat and ATV are also available for field work. The Museum lost all four-wheel drive vehicles when the state consolidated all vehicles into a single fleet. Now, we cannot always be sure which vehicles will be available for field work. Sometimes this works well, but when only very old, poorly maintained vehicles are assigned, safety concerns arise when traveling in remote field areas.”

"**Capital Equipment** - Because the program is intimately related with the Museum, much of the equipment on the Museum inventory may be applied to the paleontology program.

<table>
<thead>
<tr>
<th>Collection Storage Cases (Metal)</th>
<th>62</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999 ATV</td>
<td>1</td>
</tr>
<tr>
<td>1998 Flat-bottomed Boat, Motor, Trailer</td>
<td>1</td>
</tr>
<tr>
<td>IBM Selectric Typewriter</td>
<td>3</td>
</tr>
<tr>
<td>Calculators</td>
<td>2</td>
</tr>
<tr>
<td>35 mm Camera (Canon) and Attachments</td>
<td>1</td>
</tr>
<tr>
<td>Polaroid Camera (Fits microscope)</td>
<td>1</td>
</tr>
<tr>
<td>Anthropomorphic Measuring Set</td>
<td>1</td>
</tr>
<tr>
<td>Collection of Casts</td>
<td>1</td>
</tr>
<tr>
<td>Collection of Vertebrate Fossils</td>
<td>1</td>
</tr>
<tr>
<td>Collection of Invertebrate Fossils</td>
<td>1</td>
</tr>
<tr>
<td>Collection of Recent Vertebrates</td>
<td>1</td>
</tr>
<tr>
<td>Collection of Fossil Plants</td>
<td>1</td>
</tr>
<tr>
<td>Fume Hood (not connected to system at this time)</td>
<td>1</td>
</tr>
<tr>
<td>Slide Projector</td>
<td>1</td>
</tr>
<tr>
<td>Leica Copy Equipment (Camera lucida)</td>
<td>1</td>
</tr>
<tr>
<td>Map Files</td>
<td>2</td>
</tr>
<tr>
<td>Item</td>
<td>Quantity</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Binocular Microscopes</td>
<td>10</td>
</tr>
<tr>
<td>Measuring Microscopes</td>
<td>3</td>
</tr>
<tr>
<td>Microscope Video Attachment</td>
<td>1</td>
</tr>
<tr>
<td>GPS Instruments</td>
<td>3</td>
</tr>
<tr>
<td>Power Rock Saw</td>
<td>2</td>
</tr>
<tr>
<td>Jack Hammer</td>
<td>1</td>
</tr>
<tr>
<td>Personal Computers on campus network</td>
<td>6</td>
</tr>
<tr>
<td>Sandblaster Tank</td>
<td>1</td>
</tr>
<tr>
<td>Ultrasonic Cleaner</td>
<td>1</td>
</tr>
<tr>
<td>Chest Freezer (Recent vertebrate storage)</td>
<td>1</td>
</tr>
<tr>
<td>Automatic Leroy Lettering Machine</td>
<td>1</td>
</tr>
<tr>
<td>Total Station Surveying Instrument</td>
<td>1&quot;</td>
</tr>
</tbody>
</table>

"Needed Additional Facilities" - The major facility needs revolve around space needs. Even with the addition of space in the Old Gym, the few student offices are extremely crowded, all of the collection storage space is filled, especially with the acquisition of many large dinosaur specimens, several of which have necessarily been stored in off-campus rental space. Storage problems could be remedied if the long-planned new museum were to materialize. Many of the large specimens could be put on display, thus freeing storage space for research and teaching collections. In addition, a new collections and research facility which could house the Museum collections and perhaps those of the Archaeological Research Center has been proposed. The facility is estimated at $12,000,000 for the Museum part of the facility."

"Needed Additional Materials and Equipment" - For the classroom and laboratory, the following materials and equipment are required: additional collections to maintain current standards, storage cases for these collections (two are requested each year for a total of $3,200 per year); curatorial and laboratory supplies; a computerized device for precise, replicable measurements; ventilation for fume hood; completion of sandblaster; new abrasion unit; development of data base management, including acquisition of two workstations and licenses for Rediscovery software, digital cameras, CT-scan capability, and three-dimensional digital data capture.

FINANCING OF PROGRAM

"Financial Support Currently Available" - In discussions with Dr. Fox, Head, Department of Geology and Geological Engineering, he stated that departmental funds budgeted for the paleontology program are intended for copying charges and student travel.

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copying Charges</td>
<td>$ 500</td>
</tr>
<tr>
<td>Travel for Students since 1995</td>
<td>$ 2240</td>
</tr>
</tbody>
</table>

22
Monies available from granting agencies through the efforts of the Curator of Vertebrate Paleontology and the Collections Manager/Preparator aid in helping students. The following represents an estimate of monies for students from various sources. These are not guaranteed from year to year.

National Park Service: $40,000
US Forest Service: $2,500
Bureau of Land Management: $5,000
US Corps of Engineers: $10,000
National Science Foundation: $5,000

[Budgets were not examined in this review. However, observation indicates the Museum Staff is overextended by the constant efforts to raise support to support the students. This situation should be remediated by hiring a new Director and the recommended addition of an Associate Museum Director. A comprehensive look at the history of Institutional budgetary support may be in order to be sure Institutional resources have kept pace with Program growth.]

"Future Financial Support - The program will continue with the present funding; however, the program would flourish under reinstatement of two full-time graduate research assistantships which would help address a pressing need in the museum for preparation and provide valuable experience for the students, as well as the addition of a full-time faculty member whose responsibility is directed entirely to teaching and advising. Hopefully, financial support will be garnered for the construction of a new museum repository facility, which will greatly enhance student educational opportunities."

"Principal publications of the last five years include numerous peer reviewed papers, an indication of relevance and significance of the research being done in Paleontology at SDSMT."