GEOLOGY AND ENVIRONMENTAL SCIENCE DEPARTMENT ASSESSMENT PLAN DOCUMENTS

Prologue: Department Mission Statement

A basic understanding of our earthly home should be an essential component of all Christian education. Wheaton College's Geology Department provides coursework at levels from introductory general-education through advanced majors' classes. The various aspects of the geology curriculum are intended to contribute to the college's
preparation of Christians for effective living and service throughout the world.

As a result of the Geology curriculum and interactions among members of the departmental community, graduates should be prepared for graduate-level studies as well as entry-level employment in geological fields, related areas in environmental management, resource development, or missions/community development. These individuals should also be well grounded with an integrated educational background, such that they may make constructive contributions to dialog concerning science and faith in Church and society.

The understanding and practice of geological science is presented (where appropriate) across the curriculum in the context of applied biblical ethics. This establishes a foundation for critical thought and particularly the criteria for solution of problems involving human interaction with the environment.

The department offers courses for general education in the Studies of Nature Cluster and courses leading to BS and BA majors in geology and earth science teaching, or a minor in geology.

1. Key Learning Objectives for Geology Majors

The following skills and comprehensions comprise the educational goal of instruction for the B.S. and B.A degree programs. Each objective is set in accord with the Wheaton College Geology Department's mission of preparing Christians for careers, for further professional education and for life as "global citizens".

I. **Skills:**
A. Analytical- Geology majors should be able to conduct certain methods in the collection and processing of scientific data.
B. Communications- Geology majors should be able to effectively communicate the technical details and significance of geological studies. Competency should be demonstrated for 1) oral as well as 2) written communication.
C. Integration-Synthesis- Geology majors should be able to integrate various forms of knowledge and synthesize these in the solution of problems. In the more scientific sense, 1) technical modeling and mapping skills are essential attributes. In the more value-oriented sense, majors need to 2) devise theological/ethical evaluations.

II. **Comprehensions (including terminology and working concepts):**
A. Geological Materials- Geology majors should have a basic understanding of the origin and utility of minerals, rocks, soil and other non-biological earth materials/resources.
B. Geological Time- Geology majors should be familiar with the concept of geologic time, its subdivisions, measurement, and the overall progression of events in earth history.

C. Earth Processes- Geology majors should be familiar with the important processes, both 1) physical/mechanical and 2) chemical, that constitute Earth's main lithospheric and hydrologic systems.
D. Operational Paradigm- Geology majors should be familiar with the basic concept, historical development , and implications of plate tectonics in all subdisciplines of geology.
E. Regional Geology- Geology majors should understand the fundamental reconstruction of historical geology for the USA, with particular detail for the Black Hills of South Dakota.

II. Outline of Assessment Strategy (Sept. 2004)

1. Learning objectives are tied to (explained in the context of) the college's mission statement.

2. The basic assessment philosophy is to collect key information from assessment instruments each year and use for program evaluation (of effectiveness, need for changes, etc.)

3. Specific objectives are assessed for the majors' curriculum via certain classes and certain instruments. In particular the required courses, GEOL 433 (*Structural Geology*, GEOL 494 (*Senior Capstone Seminar*) and GEOL 412 (*Field Geology*) provide critical measures for evaluation.

4. Information collected each year from the assessment instruments is interpreted and forms part of the consideration for changes in the department curriculum and culture.

5. General Education assessment in Geology is one component of the larger strategy practiced for the Natural Sciences as a division. The use of specific instruments is portrayed through use of the matrix charting 200- or 300-level gen. ed. class versus its mode of evaluating particular objectives (as specified for the entire division and tied to the college's intention for general education).

III. Assessing Instructional Outcomes (Submitted Spring 2003, Revised, Spring 2004)

Background
In the early 1990s, Wheaton College made a priority of specifying methods of assessing learning in each academic program. There is very little agreement among professional theorists as to the best vehicles for this type of evaluation. However, various forms of assessment can be applied to obtain at least a qualitative summary of learning as a value added through education. Fortunately for the Department of Geology and Environmental Science, many diverse means are available to achieve an assessment of our educational goals. Most of the following forms of assessment have been in long-term use. Only the most ambitious, the maintenance of student portfolios, is now considered to be ineffective. The reason for this is that faculty made the portfolios a voluntary project for departmental majors. The students are/were to place important papers, exams, reflections, etc. into their file as evidence of learning and growth in learning (see List 1). Unfortunately, only a few individuals took the initiative to keep their file up to date. For those who were diligent, the portfolio was a most impressive measure. Faculty tried for two to three years to facilitate the portfolio maintenance but without much cooperation.

Basis of Assessment
The standard for assessing the success of the Geology Program is initially found in the mission statement of Wheaton College (p.4 in the 2004-2005 catalogue). The introductory paragraph for the Geology Program (p. 81 " ") is primarily descriptive but implies objectives that tie directly to the college's foundational objectives on Page 4. Of particular importance are the goals to "help build the

church and improve society worldwide by promoting the development of whole and effective Christians…" The vehicle of goal attainment is "through excellence in programs of Christian higher education." The term "excellence" is not considered to be an existing condition but a general goal itself that implies continual assessment and improvement.

Forms of Assessment

What particularly are the goals of assessment? A brief outline of departmental educational goals is a good statement of expectations for each student (see List 2). While it is hoped that every G&ES major (as well as general education student) will truly learn what they are presented, much depends on the individual. Assessment is always susceptible to confusing what is taught or offered with what is actually learned. Is the department effective in facilitating learning or is the student an effective learner? The separation is not a clear-cut one. This ambiguity can never be fully resolved, but multiple assessment instruments do improve our chances of making judgments.

A) General Instruments:

These include exams, quizzes, papers, lab exercises, maps, and other class projects with written and oral presentation (these are specified in individual course syllabi). Faculty members keep records of student performance in each course. The material evidence, kept either by faculty or given back to students, are quite useful in determining learning, especially growth in learning/expertise as more advanced courses are completed.

B) Progressive Curricular Systematic Evaluation:

For two years in the past, first-year students who declared G&ES majors began study at Wheaton with a *Freshman Experience* course designed to introduce them to the realm of science for Christians. In this course they produce reflection essays on readings and discussions. These early efforts serve for later comparison with similar essays done after at least five semesters of academic and personal maturing. Unfortunately, the concept of such a freshman course is inactive at Wheaton College.

In other majors' courses, such as GEOL 443, *Structural Geology*, students are provided a realistic, synthetic exercise in which they are to apply many of the skills and aptitudes gained from many sources. Their final product includes a map, geological cross sections, a report of investigation and interpretation of complex relationships. This term project is described in the paper, ***Indoor Field Study for Structural Geology Course*** **(Greenberg, 2002)**, attached as **Appendix 1**. The assessment value of the project is clearly stated in the paper. In addition, as of Spring 2004, students in this class produce a **pre- and post-course instrument** to gauge their change in ability to interpret macroscopic geologic structures (**Appendix 2**).

The G&ES majors' *Senior Seminar*, capstone course, revisits some of the issues that would have been first encountered in the *Freshman Experience* class. Papers are produced, presentations are made to the class, and a synoptic project is completed. Particular skills assessed in the project appear in **List 3**. This seminar course in particular serves to represent how much students have grown in understanding over their four years.

A unique opportunity for Geology majors is the required summer field course offered at Wheaton's Science Station in the South Dakota Black Hills. Here is the venue to draw on all geological knowledge and expertise in a wonderful practicum. Students apply their education in solving real problems in the real laboratory of nature. Each class participant produces several maps as interpretations of the geology of diverse areas. The map areas themselves vary in complexity and

types of geological features. Students also write reports of their observations and defend their interpretations before classmates and instructors. No other experience has such a grand effect of stretching the majors into the role of creative investigator. Assessment of their summer experience is probably the best instrument available (see **List 4**).

C) Other Accomplishments:

The department no longer requires or even recommends majors to take the subject-area GRE exam for Geology. That particular exam was always a poor indicator of learning, especially by liberal-arts students without extensive geological coursework. Better measures of accomplishment are found in the increasing number of original research projects completed, usually in cooperation with G&ES faculty. Research is now typically recorded in reports and by oral and poster presentations, both at Wheaton and professional meetings. Many students are also finding time to serve as interns in appropriate situations, such as Wheaton's HNGR Program in international context (see description of specific internships in **Appendix 3**), or with environmental consulting firms, as examples. The practical service work is considered an activity with great assessment value. In most cases, the student intern produces reports of their work. It is obvious that success depends in large part on the educational skills gained prior to their internship placement.

Department faculty learn of post-graduation accomplishments through our alumni. Many of these our former students stay in close touch. Through anecdotal means, they let us know how well the education here has enabled them to continue on into impressive graduate programs (and succeed), to enter the work force as scientists, or to otherwise apply their education (alumni testimonials were collected for the G&ES departmental Ten-year Review and are available upon request).

Value of Assessment and its Influence

From the many varieties of evaluation, there has come a continual examination and revision of G&ES curriculum. Modifications have included the way that lab material is presented (amount of realism), an increase in field trips (still quite limited by the number of department staff), and an increase in majors involved in teaching parts of general education lab sections. The department is currently undergoing significant change in response to student needs. Although the dual disciplines of Geology and Environmental Science will remain closely allied at Wheaton College, Environmental Science is being "upgraded" and given more individual attention. This comes as a direct result of program assessment and the realization that students in ES require more specialized curricular opportunities than existed.

Use of Assessment Instruments (results)

Over the last three years, as an example, the different indicators of student performance have yielded the following information.

- The *Structural Geology* (GEOL 443) project was successfully completed by nine majors in one year and by four majors the next time the class was taught (it is on a two-year cycle). "Success" is standardized as an 80% score on the project map, cross section and narrative report. The bottom line is that 100% of the majors demonstrated proficiency in essential geological skills (rock and mineral interpretation, structural analysis, tectonic reconstruction, and graphic modeling).
- The summer field practicum, GEOL 412 includes seven projects, five maps in addition to a stratigraphic section and a report of regional geology. Over the last three years, twelve students completed the course assignment with overall scores above 85%. Scores on some individual projects did fall below the 80% proficiency level, but these were compensated by satisfactory efforts in all other work. Note that the average score total for GEOL 412 was over 90%.

- Seven majors took the *Senior Seminar*, GEOL 494 during the last three years. All participants finished with a grade of 'B' or better. Each student produced a personal-reflection essay on his or her educational experience at Wheaton College. Part of the essay included a required evaluation of academic, emotional, and spiritual growth. Individual and teamwork projects contributed to the greatest portion of the course score. Successful completion of these indicates that the senior students involved all met the standard level of proficiency required (see **List 3**).

It should be noted that over the most recent three years, one student (a double major with Archeology) did not complete the Geology degree because of below standard performance in more than one required class.

IV. General Guidelines for Implementing Program Modifications Resulting from Assessment of Learning Objectives (submitted Nov. 2004)

Data collected each year according to the specified indicators/instruments of program assessment will be compared to rubric standards of performance. In cases where performance is below standards, department faculty will discuss obvious or potential problems and propose actions for improvement. This main discussion of assessment activities should occur during the first or second departmental faculty meeting each fall. Ongoing attention to assessment concerns, including suggestions for program changes can and should occur regularly (each month) as concerns arise.

The overall strategy for departmental assessment itself is considered to be under constant review. For example, if cause can be shown to change rubric standards, the established levels of performance at 2/3 correct answers for general education exam questions, 80% scores for most majors' assessment instruments, or the 85% scores for majors' capstone instruments may be moved. The current standards are not arbitrary but represent levels the department deems as appropriate indications of performance.

V. Capstone Course GEOL494 Assessment Characteristics

Refer to the recent syllabus for documentation of the statements below.

The Geology capstone is specifically designed to assess the degree to which majors can demonstrate educational objectives of the department as well as those embedded from the general education curriculum. Particular objectives are met according to specific assignments.

- CRITICAL THOUGHT AND USE OF EVIDENCE:

An integrative project, involving data collation and interpretation results in a written report with oral presentation before the class. Three such projects are described on the attached "List #3". The subjective nature of this project does not allow quantitative evaluation other than a grade awarded for effort and evidence of creative integration. Copies of project reports are kept as data by instructors.

- INTEGRATION OF FAITH AND LEARNING AND BROADER INTEGRATION:

Students prepare a personal reflection paper on the integration of faith and science (see syllabus). They are to indicate areas of growth in understanding. Reflections are discussed in class.

- ORAL COMMUNICATION SKILLS:

The principal integrative project and the faith-science reflection are presented to the class. In addition, each student will lead class discussion of a topic chosen by the instructor. There is no grade

specifically assigned for speaking performance. However, the organization and content of presentations are evaluated as part of the overall activity. Also note that the class typically visits a nearby university to attend one or more professional presentations. The opportunity offers a model of presentation quality (good, bad or between).

- WRITTEN COMMUNICATION SKILLS:

There are no fewer than four assignments in writing to be completed each participant in the seminar. Evaluations of the writing include the usual concern for content accuracy and clarity but each effort is also considered in how it compares to expectations of sophistication. Senior students having completed Wheaton's general education requirements and a departmental major should be capable of demonstrating expertise at least at a level considered adequate.

Geology faculty consider it most important that the seminar course is constructed such that it can give students several venues to demonstrate their educational and spiritual growth. Our primary concern is over that which we can control and not student performance; that is ultimately their responsibility. If in evaluating student performance any systemic weakness is discovered, then assessment demands that modifications be made to improve what we offer. It should be noted that this is exactly how Geology has responded to previous experiences with the capstone seminar. In one particular instance, it was recognized that the integration project covered some topics not previously addressed, while others of significance were being neglected. Since that time (1994), two different improved permutations have been introduced with more emphases on multidisciplinary relationships (in the spirit of general education).

It may perhaps be that Geology majors are in a very advantageous situation, because of a distinctive requirement. The capstone seminar is not the only opportunity for a summative departmental experience. The two summer field courses now taken by all majors, serve as practica and excellent mechanisms for departmental assessment.

With respect to the three particular general education goals described in Scott Moreau's memo of July 28, 2005, these are assessed by way of the mechanisms listed above, specifically:

1) **Faith issues and Christian worldview-** via position paper and personal growth reflection.

2) **Connections between Geology and other disciplines-**via synoptic projects which integrate the other natural sciences with geoscience. The position paper in #1 also incorporates theological understanding. Depending on the projects selected, political science-law, economics, and cultural geography are also shown in relationship to geology.

3) **Professional aspects of Geology-**via preparation of a resume, discussion of the Hearn book.

VI. Additional Geology Department Assessment Instruments

Two activities are conducted by the department in addition to the specific course-centered instruments for the assessment of learning objectives. Each of these is considered an instrument for measuring the effectiveness of the Geology Majors' Program. Each is considered a measure of conformity with "best practices" for geology programs offering undergraduate degrees.

A) <u>"Value-added" exercise of growth in comprehension:</u>

A hand-specimen descriptive/interpretive exercise is administered at the beginning of GEOL 433 *Structural Geology.* The same exact exercise is re-administered near the end of the course. The two efforts are evaluated for evidence of student growth in understanding of skills and concepts (including terminology and hypotheses on observed rock interactions). A qualitative expectation of growth is utilized for assessment. Improvements in curriculum may be suggested if one-third or more of the majors fail to demonstrate an advance in ability a) to describe features or b) to interpret relationships.

B) Survey of Geology Department Alumni:

Graduates of the department will be randomly surveyed five or more years after graduation. They will be asked a set of questions regarding their opinion of the Wheaton College Geology Program, including the curriculum and its value in preparation for future directions in vocation. Data from the surveys are helpful in making modifications, particularly as suggested by alumni in professional geology positions.

VII. Table of Objectives, Assessment Instruments and Rubrics for Geology Major

LEARNING OBJECTIVE	ASSESSMENT INSTRUMENT(S)	MEASUREMENT RUBRIC
Skill A Analytic Data Collection	**GEOL 336 exercise** **GEOL 344 lab** **GEOL 412 project(s)**	**80% score or better** **“ “ “** **“ “ “**
Skill B1 Oral **Communication**	***GEOL 494 presentation***	**85% score or better**
Skill B2 Written **Communication**	***GEOL 433 report*** **GEOL 412 report** **GEOL 494 papers**	**80% score or better** **“ “ “** **85% “ “**
Skill C1 Integrat./Synth. Technical Modeling, Mapping	***GEOL 344 exercise*** **GEOL 336 “** **GEOL 412 maps**	**80% score or better** **“ “ “** **80% “ “**
Skill C2 Integrat./Synth. Theological/Ethical Eval.	**GEOL 221 exam quest.** **GEOL 494 essay**	**80% of majors correct** **85% score or better**
Comprehension A **Geological Materials**	**GEOL 343 exam quest.** **GEOL 344 “ “**	**80% correct responses** **“ “ “**
Comprehension B **Geological Time**	**GEOL 221 exam quest.** **GEOL 321 lab or essay**	**80% of majors correct** **80% score or better**
Comprehension C **Earth Processes** **1) Phys./Mech. 2) Chem.**	**1) GEOL 336, 433 labs** **2) GEOL 342, 343 labs**	**80% score or better** **“ “ “**
Comprehensions D&E **D-Operational Paradigm** **E-Regional Geology**	***D-GEOL 321, 494 rpts.*** **E-GEOL 321, 412 projs.**	**80%, 85% score or better** **80% score or better**

VIII. Objectives, Assessment Instruments and Rubrics for Geology General Education Courses

A. Goals of the General Education Studies in Nature Cluster Curriculum:

200-1. develop a basic vocabulary and understanding of the content/process relationship in sciences as a matter of scientific literacy

200-2. perceive the conceptual nature of science, including some history of development of thought and the relationship of concept to worldview

200-3. comprehend and participate in the discovery role of science, including some reflection on the validity of this way of knowing

200-4. understand the method of science with emphasis on its experimental nature and the functions of quantification, measurement, statistics, and critical thinking

200-5. begin to participate in the integrative and interdisciplinary nature of science from the focus of a particular discipline and its application to problem solving, including problems in society

300-1. master appropriate levels of content and method necessary to raising and solving integrative problems characteristic of specific area(s) of a discipline

300-2. develop a sense of biblical relationship to the application of science particularly, but not entirely, as an ethical matter

300-3. develop and exercise understanding of both theology and other academic disciplines (in this case, science) as ways of knowing

B. GEOL 211 Physical Geology

Question/Goal	Assessment Instrument	Rubric
A. Knows and understands vocabulary of scientific discipline	Test questions given each semester	2/3s correct responses
B. Can explain history and development of scientific thought and relation to world view	Test questions given each semester	2/3s correct responses
C. Understands the means and methods of scientific discovery	Mineral identification labs	80% scores
D. Understands and experiences the interdisciplinary nature of science	Test questions given each semester	2/3s correct responses

C. GEOL 205 Natural Disasters
1, 4. Goals: (1) Develop a basic vocabulary and understanding of the content/process relationship in science as a matter of scientific literacy. (4) Understand the method of science with emphasis on its experimental nature and the functions of quantification, measurement, statistics and critical thinking.

Instrument: Exams contain questions that require knowledge of specific terms and concepts in earth sciences (geology, geophysics, meteorology, fire ecology, astronomy).
Criteria: At least 70% of questions on exams will be answered correctly by at least 70% of the class.

2. Goal: Perceive the conceptual nature of science, including some history of development of thought and relationship of concept to worldview.
Instrument: Integrative assignment: Theological implications of natural disasters (class discussion with theologian and reflective paper from discussion and selected readings).
Criteria: Student writes a reflective paper (3-4) pages on the matter of God's purposes for natural disasters in Biblical and post-biblical history.

3, 5. Goals: (3) Comprehend and participate in the discovery role of science, including some reflaction on the validity of this way of knowing. (5) Begin to participate in the integrative and interdisciplinary nature of sciencer from the focus of a particular discipline and its application to problem solving, including problems in society.
Instruments: Hazards at Home Project: poster presentation and written summary of hazards where students call home, covering scientific explanations, case studies including recovery and community response. Disasters in the News Assignment: report in style of news article on a disaster and recovery for some event in the past year, excluding US events.
Criteria: Students follow rubrics used to score performance on these assignments.

D. GEOL 208 General Oceanography
1. Goal: Develop a basic vocabulary and understanding of the content/process relationship in science as a matter of scientific literacy.
Instrument: Exams contain questions that require knowledge of specific terms and concepts in marine science (marine geology, climate, physical oceanography, marine biology and ecology, environmental issues).
Criteria: At least 70% of questions on exams will be answered correctly by at least 70% of the class.

3. Goals: Comprehend and participate in the discovery role of science, including some reflection on the validity of this way of knowing.
Instrument: Students visit Shedd Aquarium in Chicago and study exhibits and programs. Students complete a worksheet for fact finding ane personal observation of marine life. A makeup assignment involves watching two videos with a similar worksheet for fact finding and observation.
Criteria: Worksheet is checked for completeness.

4, 5. Goals: (4) Understand the method of science with emphasis on its experimental nature and the functions of quantification, measurement, statistics and critical thinking. (5) Begin to participate in the integrative and interdisciplinary nature of sciencer from the focus of a particular discipline and its application to problem solving, including problems in society.
Instrument: Students investigate a specific place in the ocean and prepare a poster in the style of results presented at a scientific meeting. (4) Topics include physical characteristics and ecology. Exploration vehicles and experiments are designed as well as real data evaluated. (5) Posters must include environmental issues, resources and cultural factors in the region of study.
Criteria: Students follow rubric used to score performance on these assignments.

E. GEOL 311 Geology of National Parks

1, 2. Goals: (1) Develop a basic vocabulary and understanding of the content/process relationship inscience as a matter of scientific literacy, (2) Perceive the conceptual nature of science, including some history of development of thought and relationship of concept to worldview.
Instrument: Exams test for development of: (1) basic geologic vocabulary and knowledge of earth processes as applied to featured national parks, (2) content presented in the context of basic geological concepts such as the rock cycle, plate tectonics, geologic time, and history of life, with reference to the historical development of these ideas and history of US national park system.
Criteria: At least 70% of questions on exams will be answered correctly by at least 70% of the class.

3. Goal: Comprehend and participate in the discovery role of science, including some reflection on the validity of this way of knowing.
Instrument: Student designs and produces a mock interpretive sign that park visitors would see to describe and interpret a natural object in a national park.
Criteria: Projects are graded following a rubric with specific expectations for accomplishments.

5. Goal: Begin to participate in the integrative and interdisciplinary nature of science from the focus of a particular discipline and its application to problem solving, including problems in society.
Instrument: Student develops an illustrated field guide with itinerary for a 2 day field trip through a national park, highlighting geological phenomena, description and interpretation.
Criteria: Projects are graded following a rubric with specific expectations for accomplishments.

6, 7, 8. Goals: (6) master appropriate levels of content and method necessary to raising and solving integrative problems characteristic of specific areas of a discipline. (7) Develop a sense of biblical relationship to the application of science particularly, but not entirely, as an ethical matter. (8) Develop and exercise understanding of both theology and other academic disciplines (in this case, science) as ways of knowing
Instrument: Students read an essay by Wendell Berry (The Gift of Good Land) as the starting point for class discussion and a reflective essay to (a) consider social, government policy, and environmental management implications of wilderness and natural areas, (b) develop a biblical theology of creation stewardship as related to conservation of wilderness and natural areas.
Criteria: Projects are graded following a rubric with specific expectations for accomplishments.