# EDUCATION FOR PROFESSIONAL PRACTICE

**Report with Recommendations**
**of the**

## American Institute of Professional Geologists

### Ad Hoc Committee on Curriculum

**Revised 2007**

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# EDUCATION FOR PROFESSIONAL PRACTICE
**Ad Hoc Committee on Revision**
**FINAL REPORT**

**Acknowledgements**

We have revised Education for Professional Practice, first published in 1991. The original was developed by three committees of AIPG.

The Committee for Cooperative Evaluation of Geology Departments included Robert G. Corbett, Chairman, Bruce E. Archinal, Arthur E. Burford, Gary T. Dannemiller, and Edward B. Nuhfer.

The National Screening Committee was composed of Robert A. Northcutt, Chairman, Travis H. Hughes, Harold H. Sullwold, and Robert H. Fakundiny.

The Ad Hoc Committee on Curriculum brought together Hayden H. Murray, Robert A. Northcutt, Robert G. Corbett, Lee C. Gerhard, Charles G. Groat, and William V. Knight.

The current committee responsible for the revision of 2007 includes David M. Abbott, R David Asti, Robert G. Corbett, Gary T. Dannemiller, John T Howard, Matt Leone, Robert S. Nelson, Richard M. Powers, Jonathon G. Price, Daniel J. St Germaine, William J. Siok, Mark B. Sweatmen, Andrews L. Tolman, and Lawrence B. Weber.

**Introduction**

The premier level of individual membership within the Institute is “Certified Professional Geologist”. We set forth the curricular expectations for the profession of geology in this document, and they apply to all seeking this premier status.

Several other categories of membership in AIPG have their own curricular requirements. One may become a member in AIPG with or without meeting the curricular expectations listed in this document. Please note that “Members shall normally hold a baccalaureate or higher degree in a geological science” (AIPG 2006 Bylaws, Section 2.2.3). Some persons receive their degrees from colleges and universities with curricula that lack one or more of the learning outcomes and/or courses outlined here. Although this lack constitutes a deficiency of preparation for professional practice, AIPG believes that attempting to remedy such deficiencies through an accreditation program for departments is inappropriate.

However, Education for Professional Practice serves as 1) a guide to Academia, 2) the AIPG Screening Committee, 3) the AIPG Academic Education Committee, and 4) individual students. Students may use specific standards disclosed here as a basis through which to evaluate their own programs and advice received.

## Education for Professional Practice

### The Problem

Some Geology Departments are not offering the courses required to provide the education and skills that students will need when they graduate and move into the workforce. Many causes can be cited for this situation. Among them are: budgetary constraints on campus, absence of industry or agency experience by faculty, and competition for funds, equipment money, and space. Some departments lack the required balanced distribution of faculty expertise to educate students for professional practice. This is compounded by some colleges doing away with a degree in geology and instead offering a diluted degree involving components for the major other than expected courses in geology.

Accreditation of programs works only when it is generally welcomed. A recent and broad survey of departments indicates that accreditation is not favored for a number of good reasons. Therefore, an alternate method to a checklist of courses for evaluating programs is needed.

### Suggested Solutions

Today's students graduate into a world of geology in which data use and manipulation has grown to great importance. Employers expect Geology graduates to work with a variety of such data. Collecting and utilizing information may range from downloading and printing topographic and geologic maps in a Geographic Information Systems format to modern remote sensing and surveying. Water wells, test borings, oil wells, mineral prospect cores, potential fields, and reflection seismic surveys are also common sources of information. All students should be prepared to use modern interpretative methods, regardless of the type of data. They should be trained to synthesize data and concepts, preferably through a capstone geology course containing elements of question definition, hypothesis testing, data acquisition, analysis, and conceptual integration. Whenever possible, such projects should involve real questions and real data.

Rigor within subject matter is of greater importance than organization of courses. Achieving such rigor involves incorporation of new technology and also in introducing technology in the lower level courses, as appropriate. Mathematics courses need to be taken early in the plan of study. Also, new concepts must be brought into the undergraduate curriculum at all levels as early as possible. Computer usage must be a tool incorporated throughout these efforts.

We have identified abilities, attributes, characteristics, and skills that are found in well prepared undergraduates. They are attributable to one or more of the following learning activities, most situations being available to undergraduates

- Classroom courses
- Field camp, field courses, field trips

- Extracurricular and co-curricular activities
- Journals and reports
- Museum & other collections
- Mentoring
- Internships and on-the-job training
- Professional short courses
- Professional meetings
- Learning by doing on the job
- Other

Here is what defines a well trained undergraduate, upon completion of the program. The recent graduate in geology should be able to

1. Identify fossils, minerals, sediments, and rocks and how they form.
2. Recognize and map consolidated and unconsolidated geologic formations, disturbed ground and made ground, using imagery, outcrops, and borehole data.
3. Interpret data to determine geologic structure, age sequences, geologic histories, and conditions of formation.
4. Collect and analyze information needed to evaluate sites for resource extraction, suitability for land use, and susceptibility to environmental damage.
5. Assess effects of human activity on geologic systems, including ground and surface waters.
6. Apply current technologies and theories.
7. Use sources of geologic information.

Less identifiable to specific courses are these:

8. Think critically, define problems, quantify parameters, understand limitations, and define solutions
9. Communicate effectively to a variety of audiences
10. Recognize career opportunities
11. Appreciate obligations and responsibilities to an employer and to society
12. Respect other disciplines and their professionals.
13. Establish self-esteem and personal and career development.
14. Be able to work in a team, have interpersonal and negotiating skills.
15. Be highly motivated; exercise both leadership and organizational effectiveness.
16. Understand the organization of geology as a science and a profession.

There is no single curriculum through which all these can be best developed. While each institution will approach the task in its own way, the results must be comparable. But there are desirable courses that encompass the body of knowledge and experience considered essential. AIPG looks to how these attributes are nurtured in its evaluation of the qualifications of both individuals and institutions. In the words of a recent GeoVentures ™ promotion, “the best geologists have seen the most rocks.”

Remember that a geologist throughout a professional career further develops competence in these listed attributes.

## Coursework

The intent of presenting a curriculum in the final part of Education for Professional Practice is to guide how the recent graduate can acquire many of the 16 abilities previously presented. The remaining section is divided into Core Courses in Geology, Additional courses in Geology, and Other Courses.
Field study and/or laboratory exercises are crucial in the training of geologists, and each course elected for the minimum of 36 semester hours must include such activities. Furthermore, students should gain experience in writing and oral presentation and in application of mathematical skills to solve problems in many of the courses. Some campuses have formalized these activities in programs of writing across the curriculum or mathematics across the curriculum. A capstone experience involving problem definition, hypothesis testing, data acquisition, analysis, and conceptual integration is expected in every program, and may take the form of a special problem, undergraduate thesis, or be a major part of a course, such as those designated by an asterisk in the section, Additional Courses in Geology.

## Geology Courses

A block of thirty-six semester hours in Geology courses is the minimum considered necessary for professional training. In some cases these may be offered in related departments, such as civil engineering or soil science. AIPG also recommends additional requirements for the student training for Geology in mathematics and other sciences, and encourages provision for a liberal education. All students should understand that a Masters degree with thesis is the primary professional degree in Geology. Ideally, geology students will attend two institutions (undergraduate and graduate) to obtain breadth and experience in adapting to new ideas and colleagues.

## Core Courses in Geology

AIPG recognizes a core of required Geology courses (descriptions appear in the Appendix) common to most curricula, and essential to the training of geologists.

| | |
|---|---|
| Physical Geology | 4 sem. hrs. or equiv. |
| Historical Geology | 4 sem. hrs |
| Earth Materials (Rocks and Minerals) | 4 sem. hrs. |
| Structural Geology | 3 sem. hrs. |
| Stratigraphy | 3 sem. hrs. |
| Field Geology | 6 sem. hrs. |
| | **24 sem. hrs. or equiv.** |

### Additional Courses in Geology

AIPG recognizes legitimate regional differences and needs in a curriculum, and therefore the remaining 12 semester hours in Geology courses may be chosen from the following, and must include one course that is a capstone course (indicated by an asterisk and having the opportunities for synthesis) or a senior thesis.

Geomorphology
Invertebrate Paleontology
Petrology, or
  Petrography, or
  Sedimentary Petrology, or
  Igneous & Metamorphic Petrology, or
  Optical Mineralogy
Sedimentology
*Groundwater Hydrology, or
  Hydrogeology, or
  Hydrogeochemistry
*Environ/ Engineering Problems
*Applied Geophysics
*Economic Geology
*Petroleum Geology

## Other Courses

### Mathematics and Statistics

Proficiency in quantification and numerical solutions of geologic problems may be achieved in several ways. A mere passing grade in one or two courses in calculus or statistics or computer applications does not assure such proficiency. Students should be taught calculus through integration and practical problem-solving in at least one of the geology courses that has the mathematics course(s) as prerequisite(s). Such training would provide better assurance that the student will be properly trained in this area. Computer literacy is also essential.

### Physics

Two courses (8 semester hours) of college level physics with laboratory, preferably calculus-based, are recommended.

### Chemistry

Two courses (8 semester hours) of college level chemistry with laboratory are recommended.

### Effective Communication

A formal course in technical writing, a program of writing across the curriculum, of inclusion of writing assignments graded for clarity, style, and grammar as well as technical content, in one or more major courses is recommended. A course in oral communication (speech) or formal oral presentations in required geology courses is also expected. Team teaching between geology and communications instructors is encouraged.

Additional Elective Courses

Other courses outside of those mentioned above that have proven useful to practicing geologists include the following:

Accounting
Applied Economics (Engineering Econ)
Modern Language(s)
Descriptive Geometry
Statistics
Differential Equations
Quantitative (Instrumental) Chemical
Analysis
Physical Chemistry
Organic Chemistry

Soil Science and Soil Mechanics
Rock Mechanics
Fluid Mechanics
Strength of Materials
Surveying
Geographic Information Systems
*Geographic Information Systems may take on greater importance in the undergraduate core curriculum, given the need to obtain topographic maps and geologic maps and selected data layers from the U.S. Geologic Survey.*

**Note on Graduate Curricula**

All students, before acceptance as an undergraduate major, should be appraised that an M.S. is the primary working degree in geology. Courses in geophysics, advanced courses in Structural Geology, Stratigraphy, Petrology, and specialized courses in an identified field of practice need to be included. A thesis should be required.

# APPENDIX

**Descriptions of Core Courses**

## Physical Geology with Laboratory

Introduction to processes within and at the surface of the earth. Description, classification, and origin of minerals and rocks. The rock cycle. Internal processes: volcanism, earthquakes, crustal deformation, mountain building, and plate tectonics. External processes: weathering, mass wasting, streams, glaciers, ground water, deserts, coasts.
Modern theory and concepts. Application of geosciences to relevant resources and environmental problems. Laboratory to include basic minerals and rocks, topographic maps, aerial photographs, and landform identification and analysis.

## Historical Geology with Laboratory

Basic principles of earth history including geologic time, basic rock types, reconstructing past environments. Physical development of the earth: its interior, mountain formation, plate tectonics. Origin and development of life including: evolution, the fossil record. Laboratory to include fossils, geologic maps, cross-sections, historical interpretation of the rock record, including unconformity interpretation.

## Earth Materials (Rocks and Minerals) with Laboratory

Identification of common rocks and rock-forming minerals, study of mineral assemblages and occurrences, and introduction to optical mineralogy and X-ray methods. Laboratory includes some economically important rocks and minerals, and environmental and commercial applications.

## Structural Geology with Laboratory

Classification, criteria for recognition, and mechanics of formation of crustal structural features. Introduction to rock mechanics, stress and strain, failure criteria, fault analysis, rheologic properties of geologic materials, and fold analysis, map interpretation, standard graphical techniques, and use of stereographic projections, and algebraic and graphical solutions of structural problems.

## Stratigraphy with Laboratory

Interpretation of depositional environments. Sedimentary facies and interpretation of stratigraphic record from outcrop, core sequence, and remote sensing. Laboratory problems in subsurface interpretation, including seismic data and well logs. Introduction of practical and commercial applications.

## Field Geology

Five or six weeks at field sites. Interpretation and mapping of sedimentary, igneous, and metamorphic terrain using air photos, topographic maps and other methods such as geophysics and hydrology. Site visits to active mines, quarries, and drilling rigs, as possible.

## Description of Recommended Elective Geology Courses (*Capstone)

### Geomorphology with laboratory

Physical and chemical processes operating at the earth's surface, the effects on geologic materials,
and the formation and evolution of landforms. Surface expressions of structural and stratigraphic features. Practical and commercial applications.

### Invertebrate Paleontology with laboratory

Identification of fossils and uses of paleontological data in paleocology, stratigraphy, and biogeography, with emphasis on ecosystems. Practical and commercial applications.

### Petrology with laboratory

Identification, association, origin, composition, and uses of rocks.
Students must be able to identify mineral assemblages using a hand lens, and/or microscope. Introduce practical and commercial applications.

### Sedimentology with laboratory

Processes which form sedimentary rocks, including sediment transport, sedimentary structures and bed forms, fluid/sediment depositional models, and post-depositional events.

***Groundwater Hydrology (Hydrogeology) with laboratory**

Groundwater occurrence and movement, water chemistry and quality, exploration, evaluation, development, management, and protection. Quantitative methods, modeling, and field methods for determination of aquifer characteristics.

***Environmental/Engineering Geology with laboratory**

Application of geology to civil engineering practice, site suitability, and/or remediation of existing problems. Geologic hazards and other case histories using quantitative methods. Introduction to soil and rock mechanics, engineering properties, and investigative methods. Field trips are essential.

***Applied Geophysics with laboratory**

Seismic, gravity, magnetic, electrical, or borehole methods applied to engineering, petroleum prospecting, well field development, or minerals exploration or development. Collection, analysis, and interpretation of data. Research paper.

***Economic Geology with laboratory**

Origin, classification, distribution of mineral resources (ores, industrial minerals, and energy resources). Tectonic and stratigraphic relationships, exploration and development policy and methods. Case studies, problems using real data. Detailed coursework in any individual resource should be at the graduate level. Research paper.

***Petroleum Geology with laboratory**

Study of the occurrence, properties, origin, migration, and entrapment of hydrocarbons. Study of typical producing provinces and fields throughout the world. Introduction to methods of hydrocarbon exploration, development, drilling, well completion, production, and property evaluation. Laboratory work with geophysical well logs, cuttings, cores, subsurface maps, and cross-sections. Research paper.