

Geology Gets Discovered at NAU

1) INTRODUCTION/BACKGROUND

What is geology about?

Geology

- Investigates volcanic eruptions, earthquakes, landslides, floods, dinosaurs, water, and mineral and energy resources
- Seeks to understand the composition, structure, evolution and other physical aspects of Earth
- Uses information about Earth's past to make predictions about its future

Why is geology so important in today's world?

- Geologists determine the location, frequency, and severity of potential hazards associated with volcanic eruptions, earthquakes, flood, and landslides
- Geologists discover and help develop groundwater supplies, construction materials, mineral ores, and fossil fuels
- Geologists improve our understanding of the natural world, from the highest peaks to Earth's core and from the origin of life to the demise of the dinosaurs
- Geologists are scientific consultants on policy decisions concerning energy resources and management and the potential effects of climate change
- Geologists consult and advise on issues of environmental preservation, remediation of ecologically damaged areas, and the environmental impact of land development

What do geologists do (<http://www.earthscienceworld.org/careers/>)?

Geologists

- Work in the field, examining rocks and surface materials, conducting geological surveys, constructing geologic maps, and using sophisticated instruments to analyze earth structure and processes
- Work in the laboratory, examining the chemical and physical properties of earth materials, studying fossil remains, analyzing information collected by remote sensing instruments, or experimenting with minerals, rocks, and fluids
- Work with computers, modeling the location of earthquakes and subsurface structures, and simulating geological processes
- Work with colleagues in other fields such physics, chemistry, and biology to understand the interplay between the physical, chemical, and biological aspects of Earth
- Communicate their results in writing, illustrations, oral presentations, and professional workshops

What skills do geologists use?

- Geologists routinely employ quantitative and technologically innovative techniques in research, teaching/learning, and exploration and management of resources
- Geologists are skilled in problem solving, analytical thinking, and communication
- Geologists develop high level 2-, 3- and 4-dimensional thinking, visualization, and mapping skills

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Why is NAU Geology important?

- NAU Geology trains students for the Arizona and national workforce, in water management and conservation, mineral exploration, environmental protection, fossil fuel exploration and production, and education
- Geology informs economic, political, and practical decisions made by Arizona citizens
- Geology educates the public about the processes that formed many of the natural landmarks for which Arizona is famous, such as the Grand Canyon, the Petrified Forest, and Meteor Crater
- NAU Geology serves as an interdisciplinary link among the natural sciences

What jobs await our majors on graduation?

- Our graduates pursue careers in education, mineral and energy exploration, environmental consulting, and in government agencies such as the National Park Service, and U.S. Geological Survey
- Most of our graduates seeking employment find it in Arizona
- Many enroll in graduate or advanced graduate degree programs
- Alumni have become prominent in teaching, writing, and industry careers

Why is NAU ideally situated for its vibrant Geology program?

- Cornerstones of the department are
 - its combined strengths in field and analytical techniques, and
 - its interdisciplinary approaches to learning about the interactions among geological, biological, physical and chemical components of the Earth
- The department builds on a long tradition of geologic discovery on the Colorado Plateau
- Students learn about Earth in an unsurpassed geologic setting, one that is located at the doorstep of a rich variety of world-renowned geologic features for field studies
- NAU's geology research program is strengthened by the department's adjunct faculty at the Flagstaff Field Office of the U.S. Geological Survey and the Museum of Northern Arizona
- The department has recently expanded its laboratories for teaching and research to bolster student training in modern analytical techniques

2) DEPARTMENTAL PROFILE

Where is NAU?

- NAU is in Flagstaff, Arizona, at about 7000' elevation on the southern Colorado Plateau
- The climate is "four seasons", with an average of about 100" of snow in the winter and summertime temperatures that are typically in the low to mid 80's, with frequent thunderstorms
- The southern Colorado Plateau is a geologic wonderland, with the Grand Canyon, Painted Desert, Monument Valley, and many other spectacular geologic features within a day's reach

What is the Geology Department's "place" in the university?

- The department is an important part of the College of Engineering and Natural Sciences
- Geology courses are taken by about a third of NAU's undergraduate students

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- The department has strong teaching and research interactions with the departments of biology, chemistry, environmental sciences, forestry, and engineering

How big is the department?

- Sixteen full-time tenured faculty; four of whom share joint positions with other units
- 14.45 FTE faculty
- 5 FTE research staff and 2 FTE support staff
- 4 adjunct and emeriti faculty actively involved in directing student research
- Teaching and research capacity is enhanced by earth scientists affiliated with other scientific institutions in Flagstaff (e.g., U.S. Geological Survey, Museum of Northern Arizona)

Where is the Geology Department?

- Faculty and most teaching classrooms are in Buildings 12 and 13, adjacent buildings on the north part of the NAU Mountain Campus
- Introductory laboratories are taught in building 19
- Research laboratories are in buildings 19, 20, 24, and 52

What analytical equipment does the Geology Department have?

- The department has modern analytical equipment, including
 - Scanning electron microscope
 - Electron microprobe
 - X-ray diffraction spectrometer
 - Nine-collector inductively coupled plasma mass spectrometer, with laser ablation unit, shared by Chemistry with Geology
 - Amino acid geochronology laboratory
 - Lake core analysis laboratory
 - Paleomagnetism laboratory
 - Geothermal laboratory
 - Microanalysis preparation laboratory
 - Granulometry laboratory, with sieves and particle size analyzer
 - Isotope preparation clean laboratory
 - Arizona Earthquake Information Center
 - Geophysical equipment, including a proton precession magnetometer, LaCoste Romberg gravimeter, 6 portable field earthquake seismographs, 12 channel refraction/reflection field seismograph, and a permanent network of 8 earthquake seismograph stations in northern Arizona
 - Hydrogeological equipment including a time domain reflectometer, a multi-parameter water quality meter, pressure transducers/data loggers, flow meters, and EarthVision 3-D GIS

What degree programs are offered?

- **BS, Geology**
 - 8 emphasis areas, including general geology, engineering geology, environmental geology, geochemistry, geophysics, hydrogeology, paleontology, geographical information systems
 - This program produces entry-level professional geologists

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- **BS Ed., Earth Science**
 - This program produces qualified middle and high school geology teachers
- **Minor, Geology**
 - This program provides a clear understanding of geology to people who will be going into non-geological careers
- **MS, Geology**
 - The MS in geology is the “union card” for the profession
 - This program produces graduates well prepared to lead in industry as well as prepare students for doctoral programs
- **MS, Earth Sciences**
 - This program trains in-service professionals in earth science, with the majority of the courses offered during the summer.
- Active participating department in **MA in Science Teaching (MAST)** program
 - We provide courses that give in-service science teachers the confidence to teach advanced concepts in geology
 - Faculty advisor for the MAST program is in Geology Department

3) EDUCATIONAL PROFILE

What is the overall mission of the department’s research activities?

- Train professional geoscientists through outstanding instruction in the field, laboratory, and classroom.
- Contribute to the general education of NAU students through critical evaluation, quantitative analysis, and effective communication about Earth's features, processes, and resources

How many students do we teach?

- Non-majors: 700 students per semester; many classes fill to capacity
- Undergraduate Majors: Typically 35-50 students at any one time, with about 15-20 graduating each year
- Graduate Students: Typically 25-30 students at any time, with about 8-12 graduating each year
- We anticipate that the increasing demand for greater and wiser use of earth resources will spur an increase in Geology majors in the coming years

What are some of the strengths of the undergraduate program?

- Senior-year capstone course – a field-based course that integrates the entire curriculum into a real-world series of geologic problems
- Field experiences in most courses, including trips to the Colorado River and Grand Canyon, Colorado Rockies, Death Valley, and Mexico
- Integration of modern technology into instruction
- Undergraduate students are integrated into the department’s research programs
- Opportunities for personalized study and research
- Many students go on to graduate schools, including U Arizona Tucson, U California Berkeley, U Minnesota Minneapolis, U New Mexico Albuquerque, U Texas Austin, U Wisconsin Madison, and Yale

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Do undergraduates do research?

- Many research projects lead to senior theses
- Many undergraduates fund their research projects through Hooper and NASA Space grants
- In 2005, a quarter of our graduating seniors presented posters at the college's Undergraduate Research Celebration

Where do our undergraduates get jobs after they finish?

- Many of our students find entry-level jobs in environmental consulting, hydrogeology, mining, and energy production
- Many students get paid to continue their education in graduate school
- Private firms actively recruit at NAU for our graduates

How are the department's teaching innovations recognized outside the department?

- Four of the department's current faculty members have received teaching awards, three of them as college-wide Distinguished Professor of the Year
- The department has acquired external funds to pioneer the use of technology for visualization in the classroom (e.g., the pen-assisted computer tablets, Geowall, imaging by scanning electron microscopy)
- Participation in Learner-Centered Education symposia and workshops

How are we incorporating teaching innovations into the classroom?

- Pen-tabs are incorporated into the field mapping courses, allowing students to map in digital format, using aerial photos and satellite images as well as topographic maps, and then return to the computer lab and work on the final maps and products using industry-standard programs such as ARC-INFO
- Portable computers and a local area wireless network are used in lecture classes to do in-class activities such as researching recent geologic disasters
- Geowall is a three-dimensional interactive virtual reality projection system that allows us to demonstrate important geological models and processes

What are some of the strengths of the graduate program?

- Strong record of placement in geosciences jobs and PhD programs
- Graduate students authored and coauthored 19 publications in refereed journals from 2003 to 2005
- Most graduate students receive money from extramural grants

How competitive is the MS program in Geology?

- Applications are received from around the country and foreign countries
- Only one in five applicants are admitted (about 10 per year)

4) RESEARCH PROFILE

What is the overall mission of the department's research activities?

- To advance scientific understanding of the Earth through rigorous field-based study of Earth's features and processes, coupled with quantitative analyses generated by state-of-the-art laboratories and equipment

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- To engage undergraduate and graduate students in the excitement of discovery at the cutting edge of science

Where do faculty and students conduct their research?

- Colorado Plateau
- Western US, including: Arizona, Utah, Nevada, California, Oregon, and Alaska
- Internationally, including: Andes, Australia, Baltic States, Canada, Indonesia, Ireland, Italy, Mexico, Russia, Spain, and Turkey

What analytical facilities do geologists have at NAU?

- Major analytical capabilities include:
 - amino acid geochronology
 - aqueous geochemistry
 - major and trace element analyses and mineral and fossil imaging facilities
 - radiogenic and stable isotope facilities (shared with chemistry and biology) equipped for microscale analyses
- Research centers include:
 - Arizona Earthquake Information Center, including the North American seismic network
 - Grand Canyon sandbar studies

How active is the faculty in publishing and external funding?

- Generated over \$8M in grants from 2001-2005 (average of >\$1.6M/year)
- Published 77 peer-reviewed articles from 2003-2005 (average of 1.6/year/faculty)

Where are the research results reported?

- Published in the most widely circulated geoscience journals
- Reported at regional, national, and international meetings:
 - Delivered an average of 22 abstracts/year at Geological Society of America meetings from 2003-2005
 - Delivered papers at international conferences in Australia, Denmark, France, and Russia from 2003-2005

5) OUTREACH AND SERVICE

What are some of the faculty's contributions at NAU?

- Participation in the Grand Canyon Semester
- Participation in the Colorado Plateau Cooperative Ecosystem Studies Unit
- Participation in Quaternary Sciences Program and the Center for Environmental Studies and Education
- Very active in university committees

What are some of the faculty's professional service contributions?

- Editors, Associate Editors, and reviewers of internationally recognized journals
- Professional Society Committees and Chairs
- National Science Foundation Program Panels and Chairs
- NSF and other funding organization proposal reviews

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- NAU Coordinator of the Arizona Water Institute

What are some of the faculty's contributions outside NAU?

- Science consulting and advising
 - Education about ancient habitats in Arizona
 - Consultations on earthquake hazards
 - Fossil identification for public
 - Geothermal Outreach and Education to State of Arizona
 - Meteoritics, meteorite and meteo-“wrong” identification for public
 - NASA Mars probe
- Geologic evaluation and investigations of natural resources
 - Evaluation of national resources of National Parks (U.S. and Canada)
 - Participation in the Grand Canyon Monitoring and Research Center
 - Participation in the Fossil Creek Watershed and Riparian Restoration Project
- Professional and popular geologic outreach
 - Paleogeography, global geologic history, and Colorado Plateau history maps
 - Conference organization
 - Frequent field trip leadership at national and regional geoscience conferences, as well as for visiting classes from other universities
- Educators in lifelong learning
 - Distance education
 - Elderhostel
 - Chautauqua Summer course
 - Summer courses and content workshops for Arizona kindergarten through 12th grade teachers
- City outreach
 - City Water Board
 - Flagstaff Festival of Science
 - Science fair judging at local schools (and nationally)
 - Geology presentations at local schools

What are some popular departmental websites?

- See “Popular Departmental Links” at <http://www4.nau.edu/geology/>