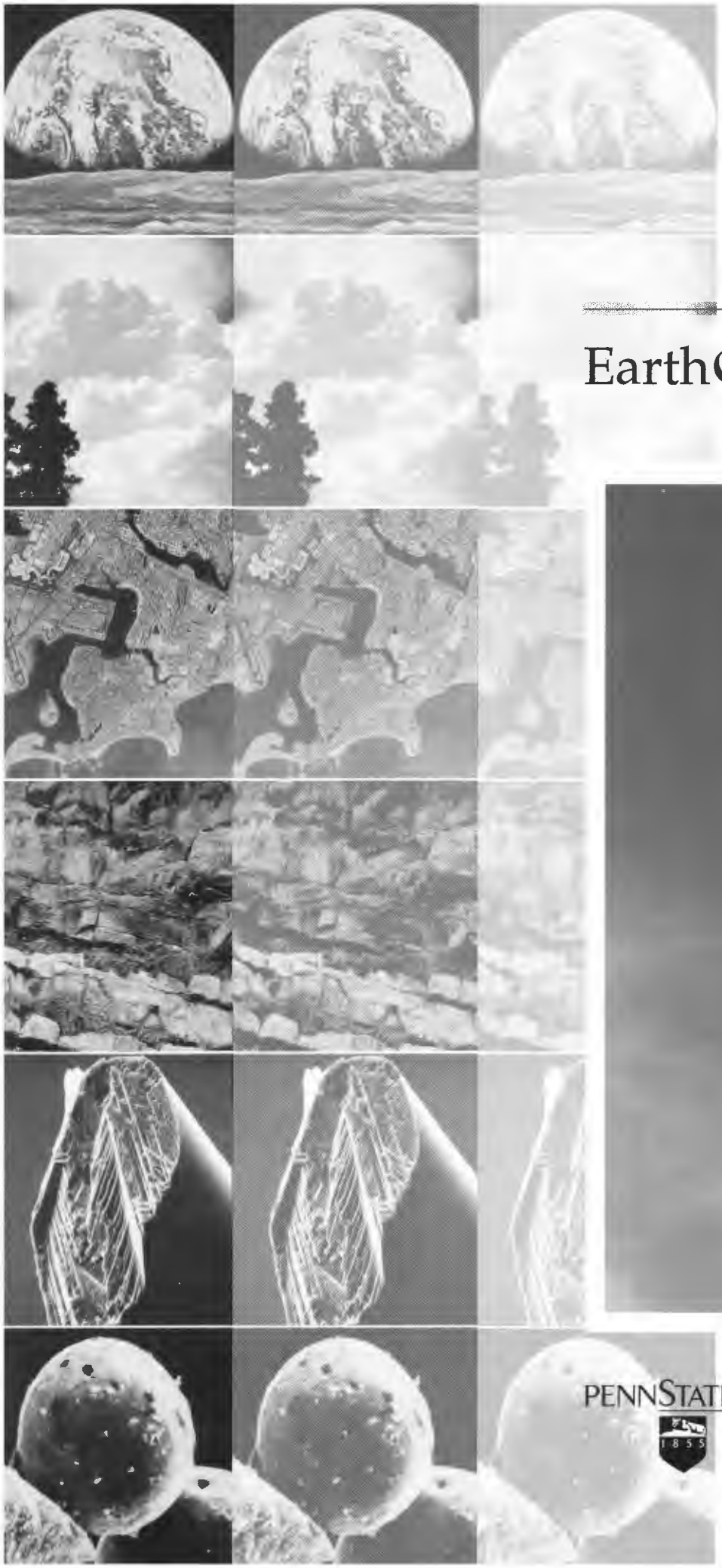

Special Issue

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Contents

This bulletin is a publication of the Penn State College of Earth and Mineral Sciences, representing the Departments of Geography, Geosciences, Materials Science and Engineering, Meteorology, Mineral Engineering, and Energy Environmental and Mineral Economics together with the interdisciplinary research centers: Center for Advanced Materials, the Environmental Institute, the Energy Institute, and the Center for Energy and Environmental Risk Analysis.

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Cover:
A research balloon with instrument payload rises toward the stratosphere.

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EDITORIAL

This special issue of *Earth and Mineral Sciences* provides a glimpse of how EMS is taking advantage of the information revolution to explore new approaches to research and teaching. With a few examples, we show how advancing computer and communications capabilities are transforming the way we work and learn. All EMS disciplines and the everyday operation of the College have been profoundly affected by the information revolution. Thus this issue can only provide samples, not a comprehensive survey.

The force of today's technological change poses critical challenge to academic institutions. We share problems encountered in the private sector: we must provide adequate and increasingly expensive equipment, we must train our faculty and staff in new approaches, and in the face of already scarce resources we must find ways to support critical needs that did not even exist years ago. But most significantly, both business and academic institutions must rethink carefully and creatively whether their basic business model must be revised or created anew.

There are many questions for academe that are far from resolution. We cannot yet perceive the full role that advancing computers and the Internet will play in education in the years ahead. Some observers say that the university as we know it will become an anachronism in a new age and disappear. Indeed, there are real concerns about the implications of the information revolution in how we will learn and acquire new understanding. And there are real concerns about what fraction of resources should be invested in these new approaches. How large and how rapid a commitment should we make?

In the private sector, we see examples of fundamental change in the relationship between companies and customers. We can go on-line and buy a computer or an automobile to be manufactured to our specifications, we can plan and order tickets for a trip around the world, or we can structure an investment portfolio. In all these cases, there is a direct interaction between provider and customer. Is that where we are going in education? Or are the subtle and stimulating interactions between professor and student, or among students in a challenging class, too unique and valuable to abandon to computer learning, however advanced it might be? Presumably both life and learning are deeper and more complex than the interactions between mind, keyboard, and monitor screen, even though they may in fact illuminate our understanding of the environment in which we find ourselves.

As we show in the special section, the new technological capabilities are enabling and stimulating new views of our world. The examples demonstrate that a major transformation is underway. They make it clear that we must change in fundamental and dramatic ways to maintain academic relevance and leadership. So we find ourselves setting forth on a long and daunting journey without knowing what the destination will be. Nevertheless, as this issue shows, we are on the way.

John A. Dutton, *Dean of the College*

ENVIRONMENTAL IMPACTS OF PROPOSED SUPERSONIC PASSENGER AIRCRAFT

William Brune, Professor of Meteorology

International air travel could soon get much faster. By the year 2020, aircraft manufacturers want to build a fleet of 500 new supersonic airplanes. These would fly at twice the speed of sound in the ozone layer. Who wouldn't want to get to Europe or Asia in half the time that it now takes?

The problem is that these aircraft will spew 500,000 tons of ozone-destroying pollutants directly into the ozone layer each year. Fortunately, ten years of study tell us that as long as the pollutants stay in the lowermost ozone layer, they may have only small effect on ozone. However, if enough of these pollutants drift upwards into the heart of the ozone layer, they will destroy ozone, allowing more dangerous ultraviolet light to reach Earth's surface. Our task as atmospheric scientists is to determine if enough pollutants will drift upwards.

Getting the answer to this question is not easy. Stratospheric wind measurements are not accurate enough. We already know that air from the lower atmosphere enters the stratosphere in the tropics and then in a few years spreads out towards the poles, eventually settling back into the lower atmosphere. What we don't know is the mixing of air from the lower stratosphere, where the aircraft will fly, into the rest of the stratosphere. Fortunately, measurements of some gases can tell us how air moves through the stratosphere.

Consider carbon dioxide. It has a well-known increasing trend and a seasonal cycle in the lower atmosphere. Thus, when air ascends into the tropical stratosphere, the carbon dioxide trend and seasonal cycle is carried up into the stratosphere. Higher in the stratosphere the air contains carbon dioxide characteristic of the lower atmosphere at some earlier time. In this way gases like carbon dioxide tell us the motion of stratospheric air and the length of time that it spends in the stratosphere.

The only way to get this information with enough precision is with instruments carried into the stratosphere by a large helium-filled balloon. The balloon-borne instrument measures carbon dioxide in the air as the balloon first ascends, reaches a peak altitude above 32 km, and then descends. Each flight yields two vertical profiles of carbon dioxide and other gases, but only at a latitude near the balloon launch site. To get measurements at other latitudes, we must launch the payload from sites at other latitudes. This we did between June 1996 and November 1997, when we had an unprecedented six launches: two from New Mexico, one from Alaska, and three from Brazil.

What we find is that air ascending in the lower tropical stratosphere is readily mixed with about an equal amount of older air from higher altitudes. Above this, the mixing of older air into the tropics decreases and the seasonal signal persists to above 27 km. The altitude separation of carbon dioxide's peaks gives the ascent rate. As the air moves to higher latitudes, carbon dioxide's seasonal signal is washed out by mixing of different air masses. But carbon dioxide's amount indicates that the air is much older, as old as six years at the highest latitudes.

This information is used directly and is compared with global-scale models to determine if the pollutants from a future supersonic aircraft fleet will ascend into the ozone layer in large enough amounts to significantly destroy ozone. We do not know the answer to this question with much certainty yet, but a preliminary analysis suggests that significant future ozone loss is a possibility. Further analyses and perhaps additional information from a few more balloon launches will give us a better estimate.

Bill Brune is Project Scientist for NASA's Mission: Observations from the Middle Stratosphere.

BUILDING ON TRADITION: THE GEOSCIENCE SUMMER FIELD PROGRAM

Donald M. Fisher, Associate Professor of Geosciences

Last July, a banquet was held in Alta, Utah, to honor Dr. David P. Gold and his 30 years as the director of the summer field program. The celebration attracted field camp alumni from all around the country, with collections of stories that spanned the years of Duff's service. I was very impressed with the positive impact that Duff Gold and this course have had on the careers of Geoscience graduates at Penn State. Given the strong feelings expressed by alumni about the importance of the field camp, I think it is appropriate as the incoming director to talk briefly about the program and my future plans for it.

The main purpose of field camp has traditionally been for undergraduate Geoscience majors to gain experience in geologic field techniques and geologic mapping. Some programs at other universities use field school as a recruiting program for freshmen and sophomores but at Penn State, field camp is usually taken after the junior year as a capstone course that integrates the disciplines covered within the core courses of our Geosciences major. The intention is to study a diverse array of geologic problems after students have the background necessary to think analytically in the field. Under these circumstances, they can make first-hand observations relevant to the internal and surface processes that shape the Earth. The itinerary is built around some of the important tectonic and stratigraphic events in the history of North America that incorporate sedimentary, metamorphic, volcanic and intrusive rocks ranging in age from more than a billion years to thousands of years. Within this context, we focus on fundamental skills such as rock and mineral identification, geologic mapping, and cross-section construction—skills that are necessary for the characterization and interpretation of field data. Ultimately, we expect students to use the landscape and the surface geology to describe the three-dimensional geometry of geologic features and the spatial and temporal variations in geologic processes.

For the near future, we will continue to maintain bases of operation at the Yellowstone-Bighorn Research Association Campus near Red Lodge, Montana (June) and the Alta Peruvian Lodge in Alta, Utah (July). At Red Lodge, students complete maps of glacial deposits and relatively simple structures, whereas the Alta area offers a more advanced exercise in structural mapping, with Sevier fold-and-thrust structures overprinted by Tertiary normal faults and intrusions. We also map the Alta stock and associated contact metamorphic aureole. Both Red Lodge and Alta offer excellent facilities for lecturing, drafting maps, and writing reports.

The itinerary for 1998 will differ from past years mainly in the interval between the Red Lodge and Alta base camps. After observing the hydrothermal activity associated with the Yellowstone hot spot, we will drive west along the hot spot trace in the Snake River plain to Craters of the Moon National Park, where we will examine the cinder cones and lava tubes associated with hot spot volcanism. We will then head north along a valley that marks the hanging wall of a regional listric normal fault that forms the western boundary of the Lost River Range. This active fault is characteristic of Tertiary basin and range extension and was the site of a magnitude 7.0 earthquake in 1983 (the Borah Peak earthquake). We will examine the scarp that marks the surface rupture in several places and also drive across the valley to examine sand boils that formed where a seismic ground water wave passing through the permeable alluvial fan sediments encountered the less permeable basement. These sand boil pits existed prior to the earthquake and were filled with garbage that was fired 10's of meters into the air during the most recent seismic event. The Borah Peak area provides a nice example of how individual seismic events relate to the more protracted history associated with the landscape and regional subsurface structure.

A transect across the footwall of the Lost River fault will give us a complete section of the Paleozoic stratigraphy, with the Cambrian-Ordovician quartzites and sand-shale sequences, the major carbonate bank environments of the Devonian and Mississippian, the intervening Lower Mississippian influx of distal turbidites from the Antler orogeny to the west, and the carbonate cemented aeolian sands of the early Pennsylvanian. These strata are spectacularly exposed within regional Sevier-age fault-related folds that are not dissected by Tertiary normal faults. A new four-day mapping exercise will be completed to the west of this area, where Sevier thrust faults are intricately related with conglomerate units.

These changes in the itinerary are part of a larger effort to incrementally bring new mapping projects into the summer field program while preserving the diversity of processes and geological environments that were covered in the past. The localities may change, but there remains a commitment to teaching basic field skills and providing a course where students are exposed to the practical aspects as well as the intellectual rewards related to field studies.

"We hope to bring in new mapping projects while preserving the diversity of processes and geological environments that were covered in the past... ."

Geoscience alumni also see:
http://wave.sheridan.wy.us/~doc/index.htm

EMS NEWS

Penn State Ceramics 75

On October 15-17, at its 53rd Annual Ceramic Forum, the Pennsylvania Ceramics Association will present a three-day event celebrating the 75th anniversary of the Penn State Ceramics Program. The event will take place at the Penn Stater Conference Center Hotel at University Park.

Information is available from John Hellmann, 201 Steidle Building, Penn State; phone (814)865-4992; email jrh3@ems.psu.edu

HIGHLIGHTS:

- address by president of American Ceramics Society
- *Thursday*—Penn State Facilities and Capabilities
- *Friday*—Advances in Ceramic Technology by range of high-power academic and industry speakers who are alumni of the program or have strong connections with it—includes Bell Labs, Alcoa, AVX, and GE
- inaugural address by Bob Newnham as recipient of the new Alumni Achievement Award in Ceramics
- social events include banquet, tailgate, Homecoming Football Game (PSU vs. Purdue)

New EMS Department Being Developed

The faculties of the Fuel Science Program (MatSE) and the Department of Mineral Engineering voted recently to merge into a single department. Although the department is still un-named, Alan W. Scaroni, professor of fuel science, has been appointed department head and Turgay Ertekin, professor of petroleum and natural gas engineering, has been appointed associate head.

Pending University approval, the new department will commence operations on July 1, 1998. The merger will integrate into a single department the College's educational offerings in the extraction, processing and utilization of energy and mineral resources and their related geoenvironmental aspects. Existing degree programs will be maintained, although graduate degrees in Fuel Science will replace the Fuel Science Option in Materials Science and Engineering. Significant synergy in research is anticipated.

The new department involves about 30 faculty members, 100 graduate students, and 250 undergraduate students. In addition to offering degree programs in Mining Engineering, Mineral Processing, Petroleum and Natural Gas Engineering, Fuel Science, and Mineral Engineering Management, the department will administer the interdisciplinary undergraduate programs in GeoEnvironmental Engineering and Industrial Health and Safety.

The Environment Institute

A new Environment Institute has been created in the College to foster interdisciplinary research across physical and social sciences. Eric J. Barron, director of the Earth System Science Center, will serve as Institute director.

The Environment Institute consists initially of two existing centers: the Earth System Science Center (ESSC) which focuses on climate change and its hydrologic impacts, particularly at a regional scale, and the Center for Integrated Regional Assessment (CIRA) which is interested in the impact of climate change on people's lives and activities.

In addition, two new initiatives are being developed under the guidance of the Institute: first, a group involved in natural hazard research will examine their common interests in assessing the science and impacts of storms, earthquakes, volcanoes and other hazards; and second, a land use analysis project using satellite data and computer modeling to help urban planners prepare for future change. The natural hazard initiative will be guided by Kevin Furlong, professor of geosciences; the land use initiative will be developed by Toby Carlson, professor of meteorology.

The Center for Natural Hazards has been initiated by a collaborative team from the departments of Geography, Geosciences, Meteorology, and EEME to foster study of hazard evaluation, forecasting, and mitigation and establish an undergraduate minor in Natural Hazard studies. The center's research will focus on Pacific Rim Hazards, such as the synergies among active tectonics, severe weather and developing economies; and Mid-Atlantic Hazards, including hazard planning and impact, global climate change and coastal damage. The center's members expect to establish a speaker's program, encourage visiting scientists, and maintain an active relationship with regional agencies. Faculty members involved in the initial planning for the center include: Kevin P. Furlong and Douglas Burbank (Geosciences); Jenni Evans, Greg Forbes, and William Frank (Meteorology); Brent Yarnal and Robert Crane (Geography); and Adam Rose (ECEEM).

Hellmann Heads Ceramics, Electronics

John R. Hellmann, associate professor of ceramic science and engineering, has been appointed as chair of the Ceramic Science and Engineering Program and the Electronic and Photonic Materials Program in the Department of Materials Science and Engineering, succeeding David J. Green who has returned to full-time teaching and research after six years as program chairman.

Dr. Hellmann teaches graduate and undergraduate courses on thermal and mechanical properties of ceramics, composites and refractories, and coordinates the program's recruiting and summer internship activities. He is also a member of the faculty of the Intercollege Graduate Program in Materials and the Center for Advanced Materials. His research focuses on processing and thermomechanical behavior of structural ceramics and composites.

He has been a member of the American Ceramic Society since 1974 and serves on the president's faculty advisory board of the American Ceramic Society. He is also president-elect of the Ceramic Educational Council, couselor for the Central Pennsylvania Section of ACerS, and technical program co-chair of the Pennsylvania Ceramics Association.

Ohmoto Heads NASA Initiative at Penn State

Penn State has been selected as one of eleven institutions invited to form a new NASA Astrobiology Institute, an electronic 'virtual' institute that will conduct interdisciplinary research on the issue of life in the universe and its cosmic implications, as part of NASA's Origins Program.

The initiative here will be organized around a new Penn State Astrobiology Research Center, directed by Geosciences Professor Hiroshi Ohmoto. It will probably involve faculty members in Geosciences, Chemistry, Biochemistry and Molecular Biology, and Biology and the Institute of Molecular Evolutionary Genetics. Geoscientists James F. Kasting and Lee Kump are expected to be active participants.

Penn State scientists will join colleagues at Harvard, Arizona State, and the universities of California (Los Angeles) and Colorado (Boulder), together with the Carnegie Institution, Washington D.C., the Scripps Research Institute, CA; and Woods Hole Marine Biological Laboratory, MA. NASA's Ames Research Center, Johnson Space Center, and Jet Propulsion Laboratory will also be involved.

Given Lecture Series in Coal Science

The eighth annual Peter H. Given Lectureship in Coal Science was presented by Dalway J. Swaine of the University of Sydney, Australia, who visited Penn State from May 18 to May 22. During his visit, he gave a series of three lectures about trace elements in coal.

In addition to his position at the University of Sydney, Swaine is an Honorary Research Fellow of CSIRO and a senior science advisor at the Energy and Environmental Research Center at the University of North Dakota. He is a graduate of Melbourne University and the University of Aberdeen, and joined CSIRO in 1959.

The Given Lecture series has been presented by some of the world's most distinguished coal scientists. The event honors the memory of Peter H. Given, a member of Penn State's fuel science faculty from 1961 to 1985, whose research into the geochemistry, molecular structure and organic reactions of coal gained international recognition.

SME Awards

The AIME/SME annual meeting in Orlando, Florida witnessed one EMS alumnus step down as SME president and another take his place. Richard Klimpel '84 M.S., '88 Ph.D. mineral processing served as 1997 SME president and Ihor A. Kunasz '68 M.S., '70 Ph.D. geology is now serving as 1998 SME president. Additional Penn State representatives on the SME board of directors are Christopher Bise, centennial professor of mining engineering, and Sukumar Bandopadhyay, professor of mining engineering, University of Alaska.

In the SME Coal Division, Distinguished Professor Emeritus Frank F. Aplan received the Percy Nicholls Award; Professor Emeritus Robert L. Frantz received the Howard N. Eavenson Award; and Stanley C. Suboleski '63, '78 Ph.D. received the Distinguished Member Award. Suboleski was recently named head of the Department of Mineral Engineering at the Virginia Poytechnic Institute and University. Former faculty member Lee W. Saperstein received the President's Citation for his work with ABET and education; Saperstein is Dean of Engineering at the University of Missouri–Rolla.

Greskovich Wins 1998 Hosler Medal

Charles D. Greskovich '64, '66 M.S., '68 Ph.D. ceramic science received the 1998 Charles L. Hosler Alumni Scholar Medal, the College's highest award for distinguished scientific achievement. Greskovich has been with General Electric Corporation throughout his career. He is known especially for the development of polycrystalline ceramics used as scintillators in CT x-ray scanners and high-intensity arc lamps, and was co-inventor of the first efficient ceramic scintillator composed of multicomponent rare earth oxides. GE's Dushman Award and the Real Advances in Materials Award of NASTS are among the honors he has received.

John R. Hellmann

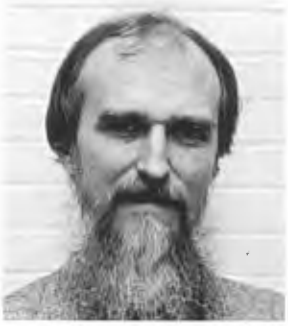
Hiroshi Ohmoto

Charles D. Greskovich

Professor Alan Scaroni presented the 1997 Given Lecture Award (Fuel Science program) to D. Swaine (left).

Amy Glasmeier

Clive Randall



Alan MacEachren

Mike Chung

1998 Wilson Awards

The Wilson Award for Outstanding Teaching

Amy Glasmeier, professor of geography and regional planning, was presented the 1998 Wilson Award for Outstanding Teaching. Of her economic geography course, students wrote: "Her class is one....you don't ever miss...not because of attendance policy, but because you enjoy going to it.... "another said: "....no other professor in the department puts more energy and enthusiasm into teaching." Their admiration extends beyond teaching—one female undergraduate said: "Wow, if I could only be like her when I graduate. She is truly amazing . . ." Glasmeier has been in the College since 1992 and last year served as interim head while Department Head Roger Downs was away on sabbatical leave. Since 1996 she has served as the Appalachian Regional Commission's John D. Whisman Appalachian Regional Scholar.

Clive Randall, associate professor of materials science and engineering, received the 1998 Wilson Award for Outstanding Teaching. Randall is a specialist in advanced electroceramic materials and currently serves as director of the Center for Dielectric Studies at the Materials Research Laboratory. He receives the award for his teaching of MATSE 201 which has a large enrollment from several disciplines. The students from this introductory course to materials science and engineering were emphatic in their praise of Randall's clear concise teaching style and his focus on practical applications. One student said: "to me an excellent teacher . . .accomplishes two things: first the teacher should present information to the class in an enthusiastic and understandable manner; second, the teacher should be available and helpful to the student. In my four-year Penn State career I have had professors who fit the first characteristic and I have also had teachers who fit the second——Dr. Randall's teaching is a combination of the two criteria and therefore he is deserving of the Wilson Teaching Award."

The Wilson Award for Achievement in Research

Alan MacEachren, professor of geography, received the 1998 Wilson Award for Research Achievement for his analysis of cartographic representation, presented in his book *How Maps Work*, and for his pioneering studies of geographic visualization. His highly acclaimed book documents the transformation of cartography from an art to an empirically-based science that is joining with GIS and geographic visualization to become the rapidly developing method of geographic information science. MacEachren joined the faculty in 1985 to direct the newly created Deasy GeoGraphics Laboratory. He has established an eminent reputation for his work on the representation of data and reality in maps and was instrumental in building the research team that has made the Geography Department one of the leading academic centers for cartography in the United States.

T.C. "Mike" Chung, professor of materials science and engineering received the 1998 Wilson Award for Research Achievement for his innovative use of boron to engineer new polyolefin materials. Mike Chung's work is acclaimed for its creativity and its rare combination of elegance and practicality. He has devised an ingenious method for copolymerization through the use of boron chemistry that allows polyolefins to be invested with a wide range of desirable functional attributes. Since polyolefins are among the most widely used commodity polymers, his work has attracted widespread interest in industry and shows substantial potential for future production. His innovative chemistry has been developed in a cohesive and integrated body of work that is being increasingly recognized by the academic community. Chung is author of 100 technical papers and 24 patents and has been a member of the EMS faculty since 1989.

Weyl Glass Science Award

The Pennsylvania State University and the International Commission on Glass announce the presentation of the 1998 Woldemar A. Weyl International Glass Science Award to Dr. Sabyasachi Sen of the University of Wales, Aberystwyth, UK. He received the award and presented the Weyl Lecture at the XVIII International Congress on Glass in San Francisco in July. Dr. Sen has carried out innovative work involving molecular and ionic dynamics of oxide glasses, crystals and silica melts. He is a native of India and received his doctorate in geology from Stanford University in 1996.

The Weyl Award recognizes a young glass scientist whose work has shown creativity and ingenuity. The award honors the memory of Woldemar A. Weyl, Evan Pugh Research Professor of physical science and professor in the School of Mineral Industries from 1938 to his death in 1975, whose pioneering studies of colored glass formed the basis of later research into the constitution of glass.

MatSE Celebrates McFarland Award Anniversary

In celebration of the Golden Anniversary of the David Ford McFarland Award for Achievement in Metallurgy, ASM International and the Metals Science and Engineering Program hosted a full day symposium on Friday, April 24, featuring Penn State alumni and focusing on *Metals Into the 21st Century*.

In addition to providing a forum for interesting ideas, the symposium resembled a family reunion in that it provided an opportunity for many of the previous McFarland winners, alumni, former faculty, current faculty, students and staff to meet for the first time in many years.

The symposium covered the economics of today's metals industry, trends in metals processing technology, applications for metallic materials, and the environment and the metals industry. Materials science and engineering department head, Richard Tressler, commented on the appropriateness of the symposium as a guide for the department as it structures its educational and research agendas in response to the future needs of industry.

The recipient of the Golden Anniversary McFarland Award was Dr. Richard Shultz who received his Ph.D. in metallurgy from Penn State in 1970. Shultz is presently the vice president of technology for Cleveland Cliffs Reduced Iron Corp. and director of ironmaking technology for Cleveland Cliffs, Inc. Prior to joining Cleveland Cliffs, Shultz spent 24 years with Armco Steel Corp—first in research and development and later as general manager of technical services for the Corporate Business Development Group. Shultz is active in several professional societies and is a recipient of the prestigious Ironmaking Merit Award from the Ironmaking Division of ISS. He is an EMS Centennial Fellow and has been an active member of his community.

The 50th Anniversary McFarland Weekend concluded with Schultz's presentation of the Annual McFarland Lecture titled "Raw Material Challenges of the Dynamic New Steel Industry, Will They Be Met?" and the annual McFarland Banquet.

Laws Memorial Lectures

In Spring Semester 1998 the Department of Geography presented the Glenda Laws Memorial Lecture Series to honor Associate Professor Laws who was struck down by a brain hemorrhage two years ago. In the series, six national experts presented lectures on topics related to Laws' research, which had focused on issues of urban social geography and social justice, specifically among marginalized groups such as poor women, the homeless, the mentally ill, and the elderly.

Lorraine Dowler, assistant professor of geography received the 1998 Wilson Research Initiation Grant to study aspects of gender and politics in Belfast, Northern Ireland and Philadelphia.

Elburt F. Osborn 1912 -1998

Elburt F. Osborn, former Dean of the College, died at his home in State College on January 19, 1998 at the age of 86. His wife Jean Osborn passed away a week later.

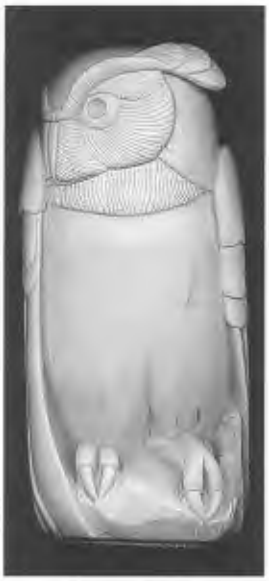
Dr. Osborn received a B.A. from DePauw University in 1932, M.S. from Northwestern University, and Ph.D. from the California Institute of Technology. After war service with the National Defense Research Committee, he came to Penn State from Eastman Kodak Co. in 1946 to lead the Earth Sciences Division (geology, mineralogy, geophysics, geochemistry), and was subsequently the first academic to hold the title 'professor of geochemistry'. E.F. Osborn pioneered experimental petrology as a university discipline, strengthened the earth sciences graduate program and established an interdisciplinary research group in high-temperature/high-pressure research and oxide systems that gained worldwide eminence. He was well-known for his work on the phase relations of silicate systems and the petrogenesis of igneous rocks.

He served as Dean of the College of Mineral Industries from 1953 to 1958 and was instrumental in the growth of both research and graduate programs. He was then appointed University Vice President for Research and over the next 12 years supervised a fourfold increase in research funding at Penn State. Under his direction a range of interdisciplinary research programs and facilities were established, notably the Computer Center, the Materials Research Laboratory, the Pennsylvania Transportation Institute, and the Institute for Research on Land and Water Resources. In 1970 he left the University to become director of the U.S. Bureau of Mines. Following his resignation from the Bureau three years later, he was named the first distinguished professor of the Carnegie Institution, Washington, D.C., where he remained until his retirement in 1987.

Dr. Osborn was an elected member of the National Academy of Engineering and served as president of the American Ceramic Society, the Geochemical Society, the Mineralogical Society of America, and the Society of Economic Geologists. His awards included: AAAS Fellow, the Roebling Medal (Mineralogical Society of America), the John Jeppson Award and Bleininger Award (American Ceramic Society) and Hal Williams Hardinge Award (AIME). He was awarded honorary doctor of science degrees by Alfred University (1965), Northwestern University (1972), DePauw University (1972), and Ohio State University (1972).

DEVELOPMENT NEWS

John L. Dietz, director, EMS Development



The EMS Museum received two soapstone owls from Clarence P. Cameron, a sculptor and gallery owner in Madison, Wisconsin. One of them is shown here.

During this past fiscal year, many alumni, corporatations and friends have made generous contributions to the College. Our records indicate an increase in both the number of gifts and dollars raised. **Thank you!** Your generosity makes a big difference to our students and programs.

These are a few of the gifts we received in the past fiscal year. They have been selected to show the different ways contributions can be designated.

Richard E. and Susan Alexander Tressler Centennial Scholarship in Materials Science and Engineering

Richard Tressler, '63, '67 Ph.D. Ceramic Science, Head of the Department of Materials Science and Engineering, and his wife Sue understand the importance of scholarships to students. So much so, they have contributed substantial funds toward a scholarship endowment in the department. Their fund will provide recognition and financial assistance to full-time undergraduate students who have achieved outstanding academic records and have a proven financial need.

Core Laboratories

For the second year in a row Core Laboratories funded a Penn State Alumni Reception during the American Association of Petroleum Geologists (AAPG) annual conference. This year's conference was held in Salt Lake City and approximately 45 people were able to attend the reception. Core Laboratories provides analytical and consulting services and related manufactured products to the energy and environmental sectors. The President, David M. Demshur, is a '77 Geological Sciences graduate.

George L Ellis Scholarship

The college received a distribution ($369,242.11) from a trust established by the late George L. Ellis, '17 Geology. Mr. Ellis directed that the trust be used to provide scholarships for students who enroll in the Geology program or the Petroleum and Natural Gas Engineering Program. He was a petroleum geologist in Oklahoma and Texas.

Richard Robert Brown College of Earth and Mineral Sciences Arts Appreciation Endowment

Richard Robert Brown, '60 Metallurgy, makes annual contributions toward a fund he is establishing which will provide EMS undergraduate students with experiences with the Arts. Mr. Brown who is a Manager with Ford Motor Company fondly remembers his experiences at Penn State and hopes he can help to enrich the experiences of EMS students who otherwise may not be exposed to the Arts.

Texaco representatives Ken Rhinehart (far left), Richard Biddle '61 PNGE (presenting check) and Richard Andre '83 Geosc. (far right) are happy to present Dean Dutton and Rudy Slingerland, geosciences department head a $25,000 check for the department's new Applied Geophysics Instructional Facility (AGIF). The AGIF is a great addition to the department which strengthens the applied geophysics effort and allows students to be trained in modern exploration/extraction technologies.

In the February snows, product line manager Rick Keeney and Allie Waldron, president and CEO of Systems Management Incorporated (left) met at Rock Springs Research Facility with Penn State meteorologists John A. Dutton, Charles L. Hosler, and Dennis Thomson (right). The ribbons and bows, and the smiles, recorded the generous gift of an Automated Surface Observing System (ASOS), donated to the Department of Meteorology by SMI. The new equipment includes continuous monitors of wind speed and direction, temperature, dewpoint, barometric pressure, et al. and will provide a significant improvement over the old system on the roof of Walker Building. According to Dr. Thomson; ".....this is the most exciting development that has occurred in industrial resource support to the Penn State Meteorology Program in 20 years."

1998 SHOEMAKER LECTURE

The New Age of Electric Energy

E. Linn Draper, Jr.

A Dramatically Changing Industry

I've looked forward to talking with you about the new age of energy. This is an incredibly exciting time to be in the energy business—as well as the important disciplines and businesses that are allied with or integral to energy services. The latter would include the critical technological disciplines and those who teach them, most certainly. And "king coal" as Jay Pifer (West Penn Power) recognized it when he was your lecturer four years ago. He said and I agree that, simply stated, coal *is* electricity. We know too that exciting times are almost always challenging times. And notice I have spoken broadly of the new age of energy—not just electric energy. I will argue to you that we have not seen anything like the interdependence and interaction of energy forms and sources we are going to witness as the future unfolds.

The electric company of the future will be the energy company of the future. It's already happening. Electric utilities and the entire energy industry are in the midst of very basic changes. Companies are redefining and redesigning themselves. Some are consolidating. Some are divesting assets to focus on some segment of the business. Others are expanding. Just about all are rethinking and re-enforcing their marketing strategies. The trade news is filled with acquisitions, mergers, new developments, strategic alliances, and global outreach. Electricity and gas are converging as companies move to offer complete energy packages. Companies including AEP are getting into telecommunications and other services. New suppliers of all kinds are entering or looking at the electricity marketplace. They are the power marketers and brokers, merchant plants, independent power producers, distributed generation entities, and the list will continue to grow.

AEP is greatly expanding both its U.S. activities and global span. We are pressing to complete our historic merger with the Central and South West Corporation of Dallas. We're excited that this combination will make AEP the preeminent, low-cost electric utility here in the U.S.—stretching from Canada to Mexico. AEP has a number of international interests, with holdings in the U.S., the United Kingdom, China, and Australia. We have offices now in Canada, Australia, Singapore, Beijing, and London. We are eager to get on with creating the competitive market here in the U.S., and we are working hard to push it forward.

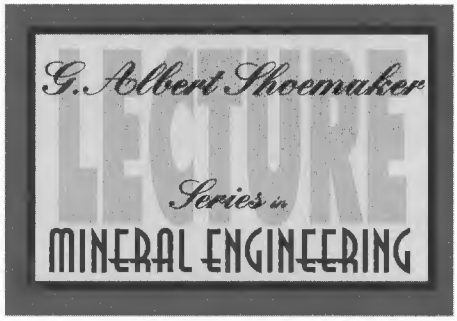
Restructuring Progress

The next question is: When will that happen? Federal legislation to restructure electric utilities has simmered but not boiled in the Congress, and does not appear that it will make front burner again this year. Last month, the Presidential Administration brought forth its electric restructuring plan—30 pages of "principles." There is a great deal of restructuring activity in the states—Pennsylvania has certainly been in the forefront and the thick of it. Overall, so far, states with about 44 percent of the U.S. population have adopted or are adopting restructuring plans. All 50 states are considering electricity reforms. AEP continues to believe that Congress can best promote competition by facilitating the states' activities. The AEP concept of the ultimate competitive market is one that supports the careful development of independent market institutions for generation, and competition that leads to the lowest cost for customers.

Technology Driving Change

Critical technological disciplines? Technology is the enabler and driver on our way to the new age of energy—and really will be the determinant of our success in that new age. Many kinds of generation as well as energy delivery technologies will hold critical importance as we create the new–competitive–age of energy. On the delivery side, we must certainly plan and devise a safe and reliable electricity superhighway for this very different future. Assuring the transmission flexibility to meet new and less predictable supply and demand conditions in the competitive marketplace will be a considerable challenge.

The future of electric power delivery lies very much in the expanding of capacity and flexibility through a widening use of power electronics. In 1997, AEP added a truly historic technical advancement to our energy delivery capabilities. It is the world's first Unified Power Flow Control system which was a team effort among AEP, the Electric Power Research Institute, and Westinghouse. This system will allow the control of power transmission to a degree that was only imagined in the fairly recent past. It effectively, efficiently—and reli-



The Shoemaker Lecture Series was established in 1992 to honor the memory of G. Albert Shoemaker, a distinguished alumnus of Penn State, former Penn State trustee, and president of the Board of Trustees from 1970 to 1972. The series was administered by the Department of Mineral Engineering from 1992 to 1998.

Dr. Draper is chairman, president, and chief executive officer of the American Electric Power Company (AEP) and the American Electric Power Service Corporation, an investor-owned utility that provides energy to 2.9 million residential, commercial and industrial customers in seven states, primarily in the midwest. Some ninety percent of its power generation is fueled by coal. The company is based in Columbus, Ohio, and has holdings in the United States, United Kingdom, and China. Dr. Draper has been AEP's chief executive since 1993. Earlier, he was a member of the faculty of the University of Texas and director of its Nuclear Engineering Program. He is a past president of the American Nuclear Society, and in 1992 was elected as a member of the National Academy of Engineering.

"The electric company of the future will be the energy company of the future....
The trade news is filled with acquisitions, mergers, new developments, strategic alliances, and global outreach. Electricity and gas are converging as companies move to offer complete energy packages."

ably—steers electricity throughout the transmission network—much the way the valves and pumps in a piping system direct water flow. This is just one example of how communications, computers, power electronics, and fundamental power systems engineering will be blended to make the new age of energy work for people as it must.

Other new power system technologies involve devices like STATCOMS and dynamic voltage restorers. They use power electronics and microprocessors to correct minor imperfections in the flow of power that once were tolerable, but will not be as we move deeper into the digital world that cannot stand even momentary glitches in its smooth supply of electricity.

Environmental Challenges

As for fuel supply and technologies, we must continue to develop, to economically yet acceptably generate electricity in the future—again, king coal *is* a mighty old soul. King coal is also mighty set upon as we look to the future. There are big-time questions of how we will sustain its viability as an energy source into the next century. The impact of climate change and other environmental issues on the coal industry holds ample excitement for us all in the category of challenge. The issues are emotionally-charged and the coal and electricity industries have been spotlighted as prominent villains.

There are those among our electric industry observers who see the environmental and climate questions as "train wreck issues" on the way to restructuring and competition. They see a collision course between competition and the major costs of new environmental regulations. Governmental and environmental groups as well as some utilities advocate the inclusion of significant environmental requirements in federal and state legislation to change the way energy is produced in this country. The various interests want policy actions addressing a range of concerns, particularly those associated with coal-burning power plants:

- urban and regional smog
- fine particles
- acid deposition
- excessive nutrient loads to important bodies of water
- toxic impacts on health and ecosystems from mercury emissions
- nitrogen saturation of sensitive forest ecosystems
- regional haze
- and climate change

They want mandated electricity generation performance standards for sharp reductions in carbon dioxide, N_{ox}, and sulfur dioxide emissions, and caps on these emissions for the future. For some, the ultimate goal is to eliminate coal combustion for the production of electricity or anything else.

And then we must also think about climate change issues. I was greatly disappointed by the outcome of last December's global climate change conference in Kyoto, Japan. The Kyoto treaty, which the U.S. Senate will probably never ratify as it came out, is a bad deal for our country. The emission reduction requirements exceed the President's proposal. They are unreasonable and almost certainly unattainable. The lack of commitment by developing countries raises serious concerns about trade competitiveness, and ensures this treaty will not be ratified in its current form. If there are dire predictions of what may result from global warming—whatever the real nature of it is—there are equally dire projections of what may result from the Kyoto treaty. The economic forecasters at DRI-McGraw Hill, for example, have estimated it could mean the loss of 1.5 million American jobs, a 43 percent increase in gasoline costs, and a 94 percent increase in electricity costs. It would result in a reduction in global average temperature of zero-point-one-eight degrees centigrade, assuming full compliance by all industrialized nations.

Our AEP position on global climate change remains unchanged after Kyoto. We want to do our part, but we want actions that are sensible. Universality and flexibility are the keys. The treaty falls short on both counts. It's important to emphasize also that the electric utility industry has already been a leader in reducing greenhouse gas emissions. Through the voluntary Climate Challenge program, for example, U.S. utilities will reduce by more than 180 million tons of carbon dioxide equivalent emissions in the year 2000. At AEP– and in a growing number of utilities and other companies—our environmental commitment is a corporate

business goal with specific performance measures. They are measures that start with strict legal compliance, and go beyond compliance to an aggressive list of environmental and pollution prevention initiatives. We pledge and work "to find the most effective ways to protect and enhance the environment while providing reliable electricity at a competitive cost."

Sustaining Coal

Some say we can get along as a nation without burning coal to make electricity. The truth is we're going to need all sources of energy—natural gas, wind, solar, nuclear, *and* coal—as our country uses more electricity. We won't get there without coal. Government sources predict that electricity, which provided 32 percent of energy used in the U.S. in 1970, will be up to 63 percent by the year 2010. U.S. electricity generation which is now about 3.2 trillion kilowatt-hours will grow 25 percent by 2010 (to 4 trillion). Coal will continue to be the workhorse. This means among other things that advanced clean coal technologies will be increasingly critical. Development work has shown promise in pilot projects and will need to continue at full commercial scale on such technologies as low emission boiler systems, high performance power systems, pressurized fluidized bed combustion, and integrated gasification combined cycle generation. These are advances that can cut carbon dioxide emissions by a third or more, and significantly reduce sulfur dioxide and N_{ox} emissions as well. These are technologies now ready for full-scale evaluation and development. The challenge is to make them competitive. The use of coal to fuel our nation's electric infrastructure is more than just an option. It is an absolute necessity. Our economy and lifestyle depend on coal now, and will continue to depend on it well into the future. And so the development and use of coal technology will be critical to retain this abundant source of energy.

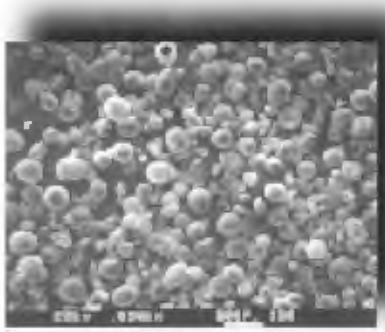
I strongly suggest to you, in closing, that there are exciting times ahead. Not easy—but definitely exciting. And they will be very, very interesting times. We are all privileged to be on the forward edge in helping to shape them.

STUDENTS SPONSOR EMEX 98

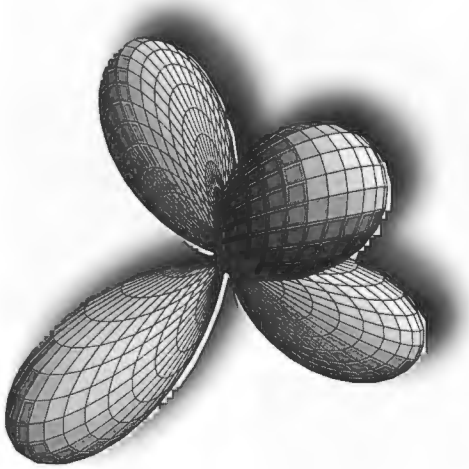
EMEX 98 was held on April 4. The event, sponsored by EMS Student Council, focused on recruiting prospective students, and invitations were sent to high schools and Penn State campuses around the Commonwealth, and a web page was developed to advertise and answer questions. Though the primary intent of EMEX is to interest others in the College, the cameraderie among EMS students working together on the project may well be its most significant asset.

New Views of Our World

John A. Dutton, Dean of the College



Students and faculty members of the College of Earth and Mineral Sciences are riding the crest of the wave of new capabilities made possible by rapid advancing information technology. Throughout the College, they are developing new approaches to research and learning, enjoying new scientific discoveries, and developing new understanding–all made possible by increasingly powerful instruments and computers. But at the same time, they struggle to keep pace with the rapid rate of technological change and the consequent changes in scientific strategies and concepts.



It is all part of the information revolution, now sweeping through business, research, and education, that began decades ago with the invention of the transistor and the creation of microprocessors. Commonly called computer chips, these devices are a triumph of materials science and computer engineering. They contain millions of transistors linked together on a silicon wafer. They are the heart of the smallest desktop and laptop computers, the largest super-computer, and every contemporary electronic device. The Internet connects microprocessors around the globe and allows them to exchange information through the protocols of the World Wide Web.

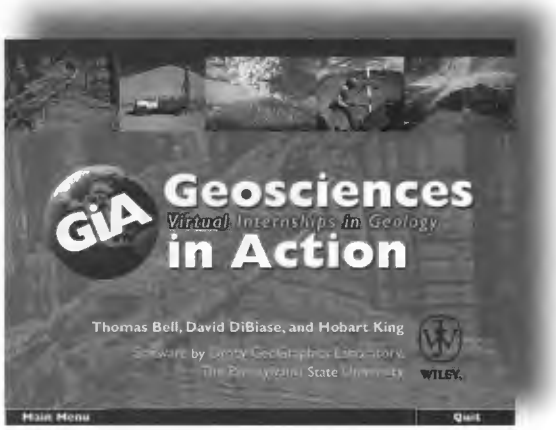
In science, the microprocessor makes possible new views of our world. On the large scale, we gain high-resolution images of terrestrial patterns and processes, with satellite observations made possible by microprocessors and advanced materials. On the smallest scales, we explore the amazing structures we see in natural and manufactured materials as we zoom in to nearly molecular scales with instruments utilizing, and controlled by, microprocessors.

But the new views extend far beyond the direct observations. Contemporary computers and new concepts for the effective use of information allow us to analyze, display, and visualize the data contained in these observations more effectively. These synthetic views stimulate improvements in modeling and theory, and that in turn leads to more reliable simulations of complex processes ranging from climate change, through multiphase flow in pipes to the evolution of molecular structure in materials. And thus our computers, too, produce new views of our world.

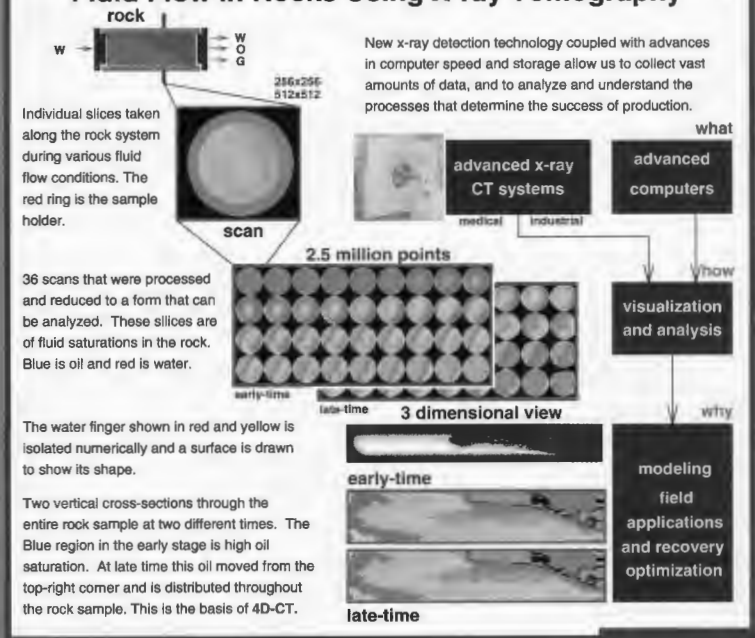
All these views can be shared among scientists through the capabilities of the Internet and the World Wide Web. And they can be shared between teacher and student, too, both in the classroom and through individual computers connected by the Web.

Thus modern technological advances in computation and communications, largely the consequence of the microprocessor, is changing research and education at an accelerating rate. And that will create a new as yet undefined academic world.

The following special section of *Earth and Mineral Sciences* presents some examples of the diverse advances in research and teaching made possible in EMS by new information technologies.



Fluid Flow in Rocks Using X-ray Tomography



Information science and technology techniques are allowing scientists to obtain new information, gain new understanding of phenomena, and share information more widely than ever before. In Petroleum and Natural Gas Engineering, Avrami Grader and Phillip Halleck are learning more about fluid flow in rocks by using computer assisted x-ray tomography and image analysis techniques. Moreover they are able to share their insights and work on common projects on-line with colleagues worldwide. Imaging data collected in Italy can be examined at PSU within minutes. The combination of new measurement systems and high speed networked computers provide us the opportunity to find and understand new fluid flow mechanisms.

www.pnge.psu.edu

In the Earth System Science Center, soil scientist Douglas Miller is creating an on-line database of soil characteristics tailored for easy and versatile use by environmental scientists and managers. Though still in early stages of development this Internet-accessible database promises to be an invaluable resource and gain widespread use.

Soil Information for Environmental Modeling and Ecosystem Management

Soil Info Home | ESSC Home | Links

Soil Landscapes | Soil Climates | Soil Datasets | What's New | Personnel

Soil is an integral component of the Earth System. Few natural processes involving water, energy, and mass fluxes on the Earth's land surface escape the influence of the soil environment. Scientists from many disciplines now seek information on the physical, chemical, and biological nature of soils. A research effort now underway in the Earth System Science Center is aimed at transforming existing soil information resources into understandable forms. Information architecture shapes these products using advanced spatial information technology and exploits the power of hypermedia, such as the World Wide Web, to deliver soil information resources suitable for the environmental modeling and ecosystem management communities.

www.essc.psu.edu/soil_info/

Earth System Science Center research on global, regional and local change revolves around the computer simulation of alternative scenarios for global climate regimes in the past, present and future. Considerable research has been conducted on possible climate change and its impact in the Susquehanna Basin of Pennsylvania.

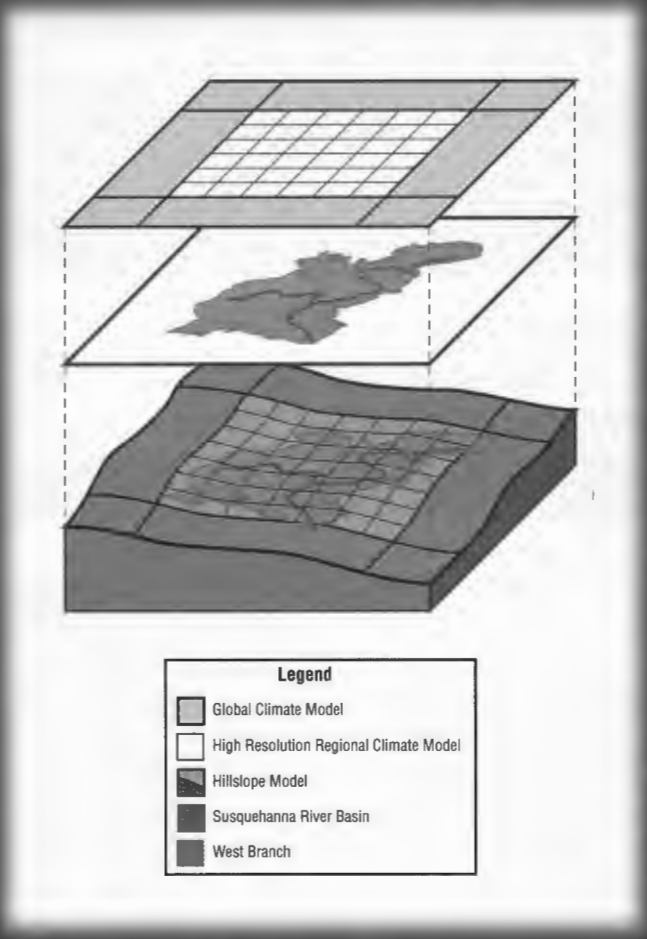
www.essc.psu.edu/

Global Water Cycle: Extension Across the Earth Sciences

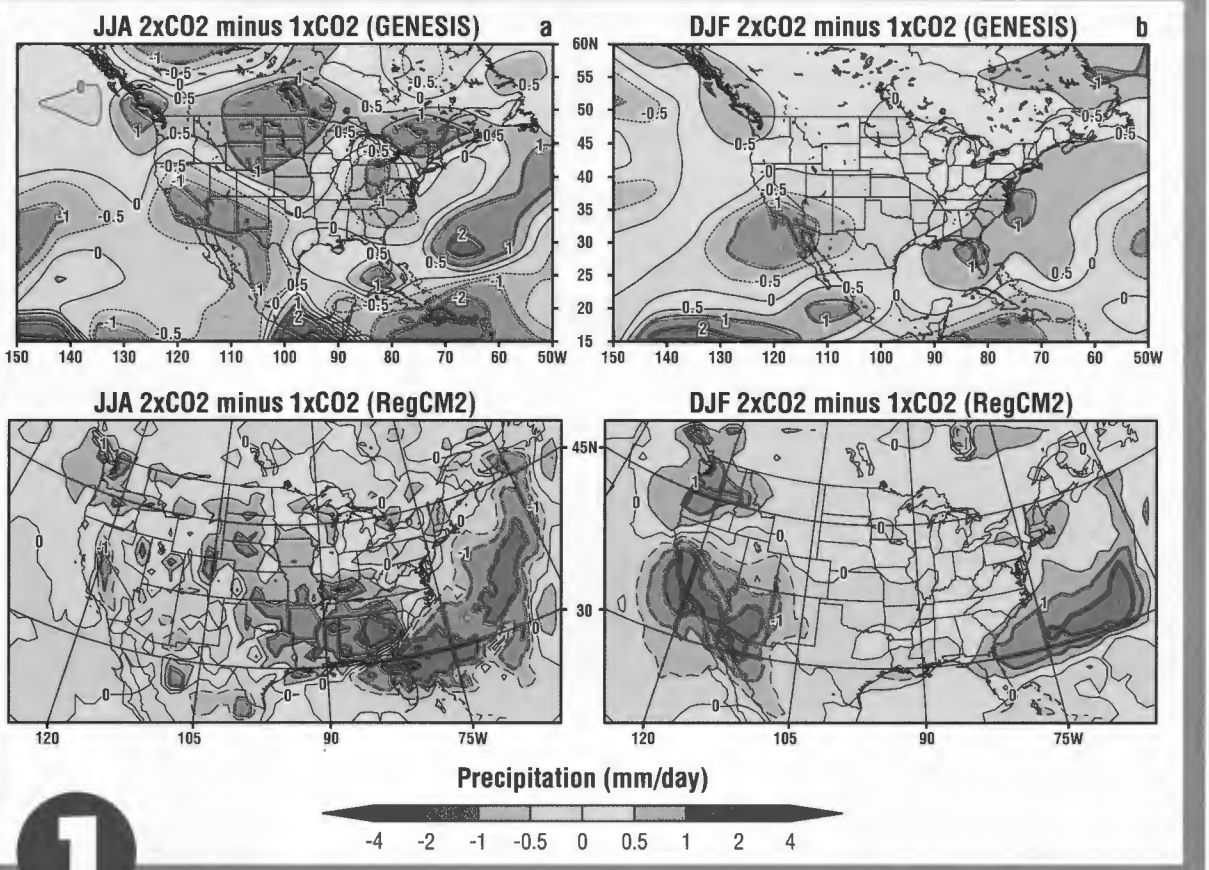
A NASA Earth Observing System Interdisciplinary Science Investigation

As part of a NASA Earth Observing System (EOS) grant, the Earth System Science Center is developing methodologies and modeling capabilities to describe quantitatively the presently uncertain rates associated with the sources, sinks, and fluxes of the global water cycle at a range of spatial and temporal scales.

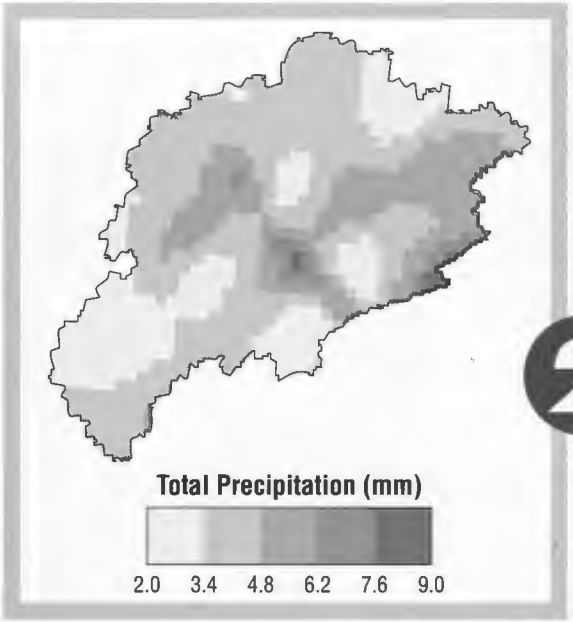
The primary focus of the investigation centers on nesting or coupling coarse resolution global circulation models, with high resolution climate models, and models including soil moisture, vegetation, and surface and groundwater hydrology at the watershed scale. A key element of our nested modeling strategy is the development of a strong framework which links models with information analysis and visualization tools to study global change in regional and local contexts. This hierarchical approach also provides a context for understanding the human dimensions of global change, which is the focus of the Center for Integrated Regional Assessment (CIRA) that was founded in 1996. A detailed study of social and economic impacts in the Susquehanna River Basin, directly linked to the climate and hydrology modeling research described above, is among the first major projects of this new center.



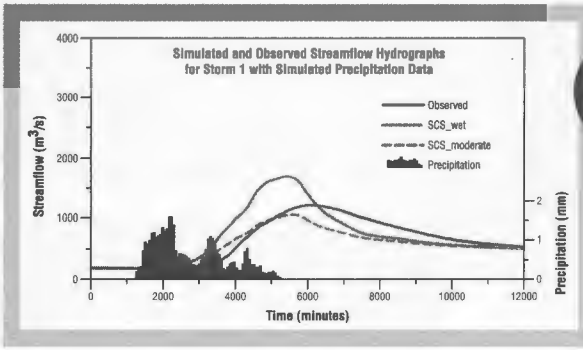
Additionally, new research emphases in the areas of land use planning and natural hazards will benefit from a multiscale framework which addresses physical processes and anthropogenic impacts from global to local scales in an interdisciplinary research and teaching environment.



1 compares precipitation estimates from the GCM model (GENESIS) with the high resolution model (RegCM2) for 2xCO2 and 1xCO2 for (a) June-July-August and (b) December-January-February. The high resolution climate model indicates significant differences in summer dryness centered over the Ohio River valley and the Southwest. Much of the Northern US has slightly wetter winters with the Southeast having substantially wetter winters. These simulations also provide a basis for comparison with other down-scaling methods used in this study.



2 modeled total precipitation from an April 11-17, 1986 storm over the upper portion of the West Branch of the Susquehanna River Basin (SRB). The Penn State-NCAR Mesocale Model (MM5), using nested grids with 4-, 12-, and 36-km resolution, was used to simulate this storm event over the SRB. The precipitation fields generated by MM5 were used as input to a hydrological model which, in turn, was used to generate runoff estimates.



3 shows the simulated and observed stream flow hydrographs for the Upper West Branch, near Williamsport PA, during the April 11-17 storm. The simulated stream flow hydrograph was generated in a hydrologic model which accepts MM5-generated precipitation.

Information Science and Visualization in Geography

Research endeavors in the earth and mineral sciences are almost invariably linked to a set of observations for which location on, in, or above the earth is an integral component. Such *georeferenced* information is the focus of *Geographic Information Science* (GISci), a rapidly developing field in geography and information science. GISci has links to fields as diverse as scientific visualization, high performance computing, statistics, and cognitive psychology. From within geography, GISci integrates research traditions from cartography, remote sensing, geographic information systems (GIS), environmental cognition, and spatial analysis.

By searching for effective ways to model, manage, and analyze georeferenced information, GISci spans a range from the theoretical (associated with the representation of space and space-time) to the applied (particularly design of geographic information and mapping systems and their user interfaces). GISci research has proven useful in a vast array of applications both within and outside the earth sciences, from regional planning, decision support, hazards management, marketing, international development, epidemiology and health care delivery, to science education, intelligent transportation systems, facility location, and many others.

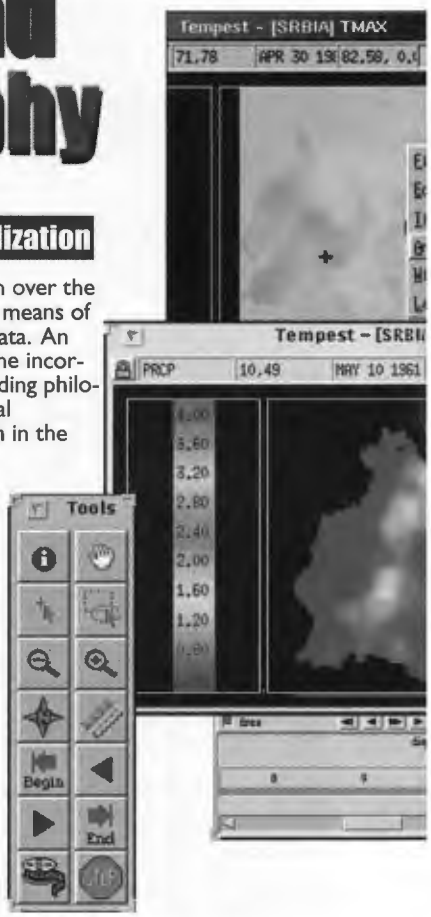
Building on a strong GISci base that involves several faculty with related research and teaching interests, the Department of Geography has just begun a major new GISci initiative in Geographic Visualization (GVis). One current GISci research project with a substantial GVis focus is featured here: the *Apoala Project* (co-led by Donna Peuquet and Alan MacEachren and funded for three years by the U.S. Environmental Protection Agency), which seeks to design and implement a prototype system that integrates Temporal Geographic Information Systems (T-GIS) and Geographic Visualization (GVis) concepts and methods for application in environmental science and policy contexts.

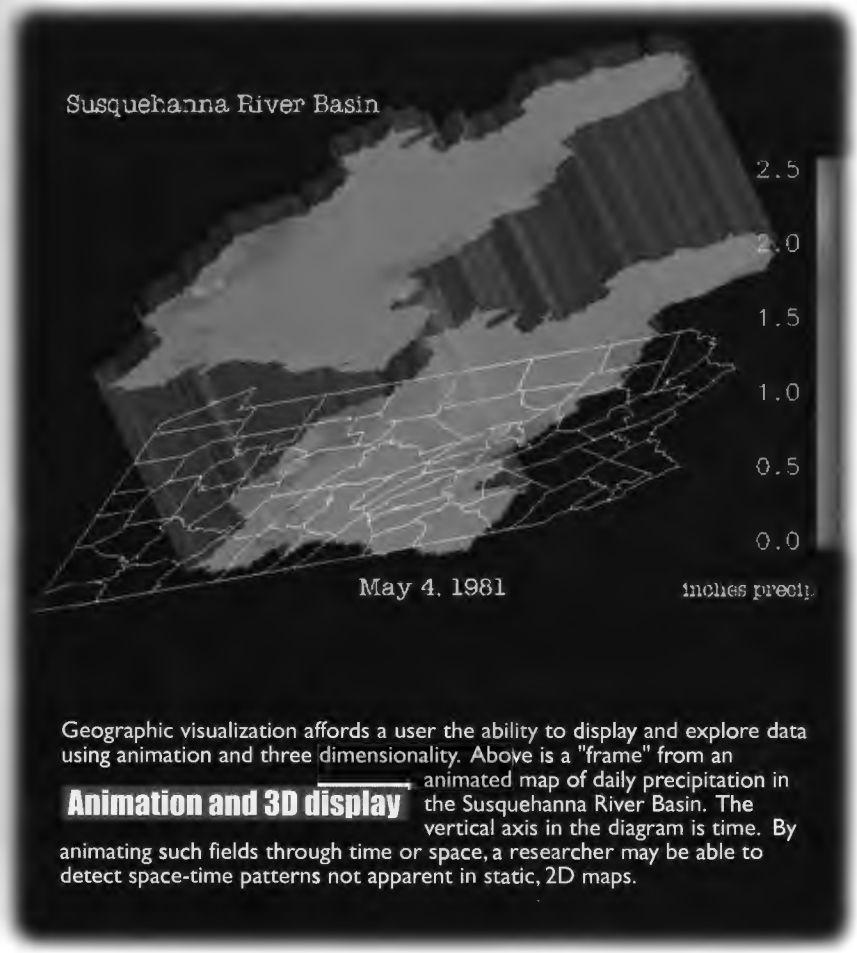
For more details about the Apoala Project see:
`www.geog.psu.edu/apoala/.`

For more on the GVis initiative, visit:
`www.geog.psu.edu/GeoVISTA/.`

Spatiotemporal GIS and visualization

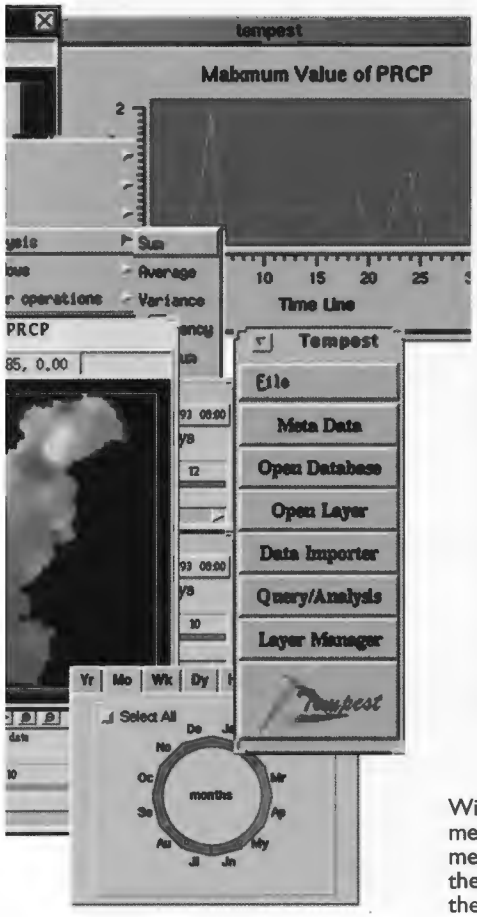
Geographic Information Science research over the past thirty years has focused on efficient means of storing, accessing, and displaying spatial data. An important extension of this research is the incorporation of temporal data into GIS, including philosophical issues concerning the fundmental differences between time and space, both in the "external" display and in the "internal" database representation. Graphical spatiotemporal representation in GIS is one of the most promising applications of geographic visualization. Creative ways of exploring space-time data sets have been integrated into TEMPEST, a prototype temporal geographic information system. In the multi-window TEMPEST interface (right), linked interface elements, from timelines and timewheels to plots, and scaleable maps allow easy access to space, time, and attribute characteristics of the data.





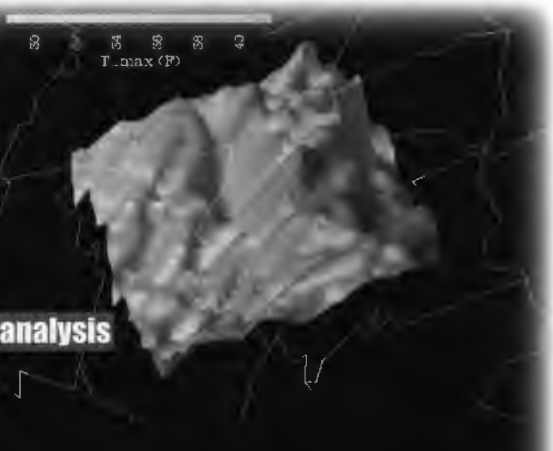
Animation and 3D display

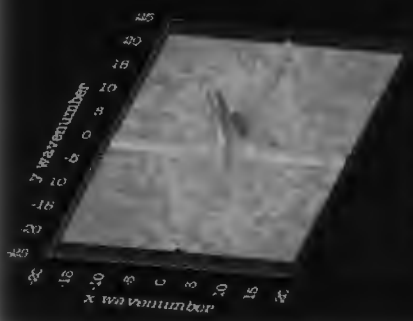
Geographic visualization affords a user the ability to display and explore data using animation and three dimensionality. Above is a "frame" from an animated map of daily precipitation in the Susquehanna River Basin. The vertical axis in the diagram is time. By animating such fields through time or space, a researcher may be able to detect space-time patterns not apparent in static, 2D maps.



Visualization in spatial analysis

Scientific visualization can be used to explore physical or statistical spaces. The image at right uses a technique which drapes a "surface" over a field of attribute values. A surface of early spring temperature maxima in central Pennsylvania is the result, with "peaks" and "valleys" corresponding to high and low values of the attribute.

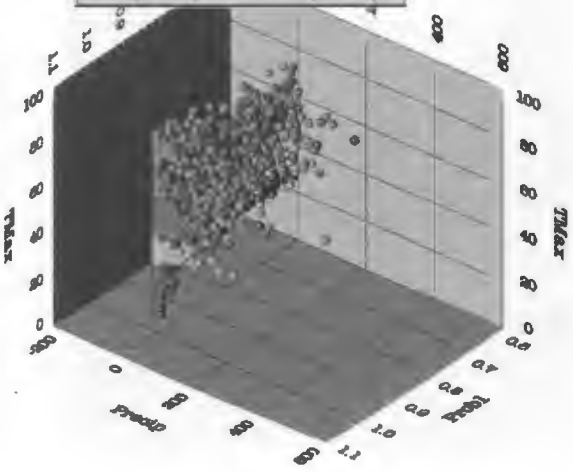




At left is the two-dimensional spectral transformation of the same temperature data, mapped in abstract "wavenumber" space. This representation gives a researcher information about the directional periodicity of the temperature field.

Visualization of large databases

With databases in the earth sciences now being measured in petabytes (one million million megabytes), developing methods for exploring these huge databases has become a priority for their understanding. Containing detailed observational data over both time and space, the database itself has become a virtual world. *Data mining*, a statistical method for "knowledge discovery in large databases," has been used to classify observations in massive databases according to the relative value of all variables recorded for the observations. User-manipulable graphical statistical plots and multidimensional scatterplots (below left) help researchers to look for patterns and confirm or revise hypotheses. The data mining classification is displayed in the scatterplot as varying colors of the points. Statistical graphics such as these may be dynamically linked to maps or 3D space-time displays to reveal temporal and geographical interactions.



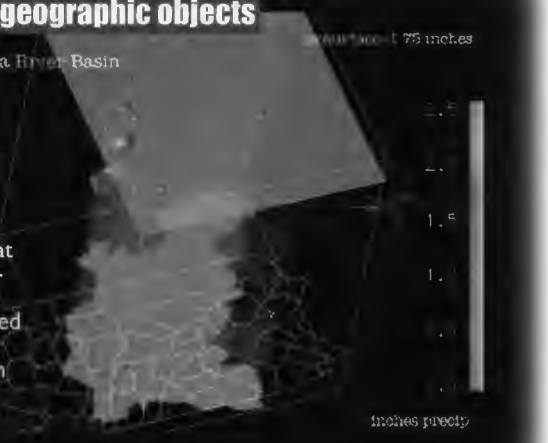
Visualization of simulation results

In this image, a three-dimensional visualization technique called *isosurfacing* enables researchers to discern structures and patterns in space-time.

Here, isosurfacing is used to visualize a simulation of the diffusion of rabies in Pennsylvania through time. Using these techniques, researchers can observe the behavior of a contagion or other agent as it spreads over space and time.

Detection of coherent geographic objects

Three-dimensional visualization enables researchers to detect entities that share common properties or attributes. When the third display dimension represents time, events can be discerned. The blue objects in the image at right represent periods of relatively heavy rain; it can be seen that, during the days represented above, most of the heavy rain events occurred in the western part of the Susquehanna River Basin.



The Department of Meteorology depends on advanced communications technology for making observations of the atmosphere, collecting and disseminating atmospheric information, and simulating and modeling physical phenomena. Weather information is provided for scientists, students and the general public in a variety of formats: raw data, mapped observations, charts, animations, and output from its own numerical weather prediction model:

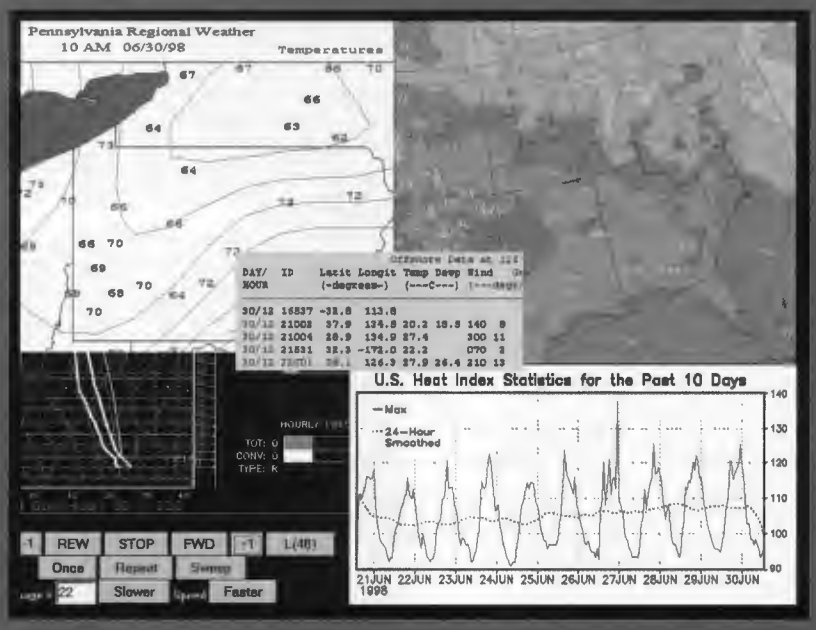
www.met.psu.edu/new/weather

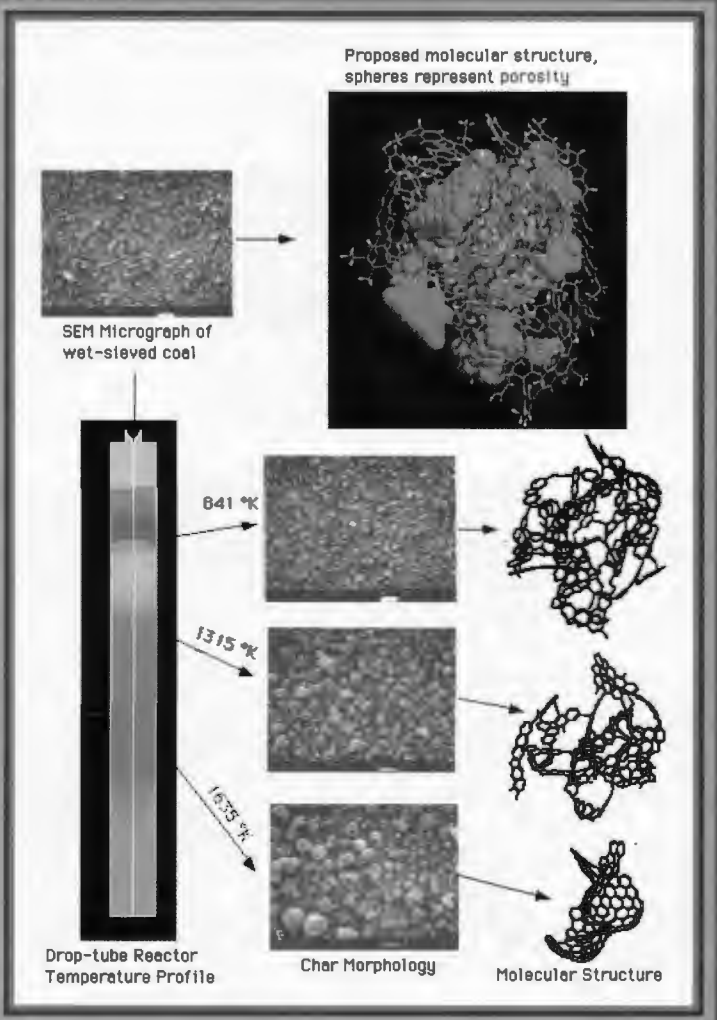
See also

www.ems.psu.edu/WeatherWorld/

Useful and interesting information is provided at the site of the Pennsylvania State Climatologist Paul Knight at:

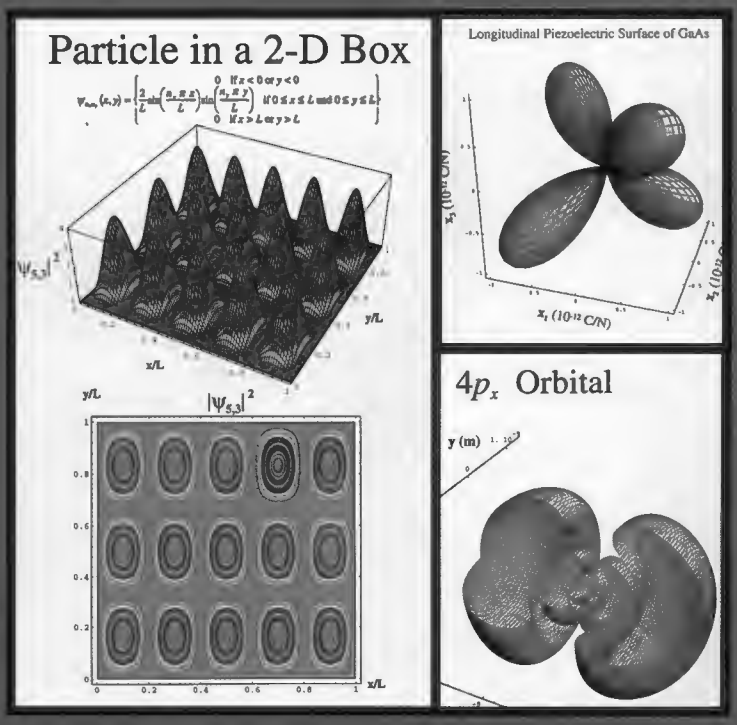
www.ems.psu.edu/PA_Climatologist





In the Energy Institute, fuel scientist Jonathan Mathews is taking the first step toward a virtual combustion laboratory for testing coals. The ultimate goal is to simulate the burning of coal computationally under all conditions available in practical devices—computing intermediate structures, heat release rates, pollutant emissions, and pollution reduction strategies without ever setting foot in a traditional laboratory. Current research is on relatively pure macerals and the first stage of the combustion process in which char is formed. This sequence illustrates the structural transitions of a bituminous vitrinite as it is converted into a char in a drop-tube reactor.

New technological capabilities are having a profound impact on teaching in the College, changing both substance and methods. In the George F. Deasy GeoGraphics Laboratory professional and student cartographers have become specialists in the design and production of multimedia software for undergraduate education in Geography and related disciplines. Shown here are some CD-ROM titles commissioned by leading textbook publishers and produced by the Deasy Lab www.deasy.psu.edu/ The Laboratory is currently designing and producing a certificate program in Geographic Information Systems, being prepared for Penn State's World Campus www.worldcampus.psu.edu/. Lab director David DiBiase teaches a general education course: Geography 121: Mapping Our Changing World, which provides an excellent example of the type of instructional courses now being devised: www.gis.edu/geog121/home.html



Darrell Schlom, associate professor of materials science and engineering, has revolutionized the teaching of solid state materials in the College by using the computer program Mathematica© to display three-dimensional models of mathematical expressions that clarify concepts for students in his class. His students were so enthusiastic about the new MatSE-413 course that they nominated Dr. Schlom for the 1997 Wilson Teaching Award and wrote eloquently about the way he brought physical meaning to complex mathematics. He has since published discussions of his experiments and received extensive professional recognition.

From réchauffé to recherché

Alistair B. Fraser

When the motion picture was invented, early practitioners saw it primarily as a means of distributing existing material, such as stage performances. It was some time before movies were recognized as a new medium with expressive possibilities which, while overlapping existing media, went far beyond anything previously attainable.

When the CD was adopted as a ROM for computers, there was a similar lack of vision as it was pressed into service as a distribution medium for existing books and encyclopedias. Indeed, reviewers of CD-ROMs, were quick to coin a derisive term to describe the products of such tunnel vision: shovelware. Now used more broadly, the word, shovelware can be taken to refer to any content shoveled from one communications medium to another with little regard for the appearance, usability or capabilities of the second medium.

What characterized these, and many other media when introduced, was that their value was seen only as one of access: the new medium offered a more ready way of distributing existing material. It was only later that designers realized that the horizons of effective communication had been pushed back and that now ideas could be presented in ways not previously possible.

More recently, the Worldwide Web has burst on to our consciousness. Quickly grasping the distribution possibilities of the new medium, universities everywhere have rushed to move course resources on-line. Things previously handled on paper or film -- syllabus , assignments, notes, data, diagrams, references, exams -- are now presented through the computer. One face of this headlong rush is the amazingly large number of community colleges and research universities with grand plans to distribute their courses across the world.

But, the efforts are virtually all of a piece: the delivery of academic shovelware. Certainly there is value in the broad distribution, but where is the pedagogical value added if one merely distributes virtually the same course resources through a computer rather than on paper? This sort of unimaginative computerization evokes a colossal, "so what?" in my mind. It is, réchauffé; it is warmed over, insipid.

The Web is a powerful new means of communication; its potential is vastly greater than that of merely distributing the réchauffé. Rather, it can offer students exquisite pedagogical resources that go far beyond anything possible with paper or blackboard; it can deliver the recherché, the exquisite.

A good teacher operates on many levels, but certainly one of them is that of communicating the mental models of one's discipline and beyond. Those models usually involve insights into how some aspect of the world works. They might be the processes by which the human immune system is believed to respond to invaders, how natural forces operate on air to build a cloud, or how the brain can extract something aesthetic from mere aesthesia. The example chosen does not matter, but whether in the sciences or humanities, we are constantly presenting our students with mental models of the behavior of the world around us. Indeed, these models include metamodels: models about how we even-think about models.

Alistair Fraser, professor of meteorology, is internationally known for his advocacy of the new ways of teaching. He has transformed several courses in Meteorology, making full use of the resources available through the Internet. In addition he has acquired a wide following of WEB devotees for his essays on "Bad Science" and received numerous awards for his sophisticated approach to WEB sites.

WWW.EMS.PSU.EDU/~FRASER/FRASER.HTML

In the past we relied upon words, diagrams, equations, and gesticulation to build these models piece by piece in the minds of the students. We now have a new tool -- not one which replaces the older ones -- but, one which greatly extends them: interactive computer visualizations. Now the teacher can build a pedagogical model and both student and teacher can interact with it to explore the behavior of the system in a way inconceivable in earlier times.

And, the amazing thing is that such interactive animations can be readily delivered through a web browser into not only the classroom, but the computer laboratory, dormitory room and the home. I provide such things to my students, and at the end of the semester 98% of them responded that such visualizations made it easier to grasp the ideas and concepts than conventional teaching tools have done (the other 2% were neutral; the number of student responding was 165 spread over participants in both general electives and the major).

At this point in such an essay, it would seem appropriate to insert an illustration of such a visualization. Alas, this is an essay in an older medium which is as incapable of delivering convincing example as would be a discussion of the colors of flowers in an old black and white movie. So, we are left with nothing but assertions (albeit ones born of extensive experience): almost all instructional material professors have put on the Web to date is shovelware; and, the Web is a medium whose power for pedagogical communication goes well beyond anything which universities are employing today.

SCIENCE NEWS

reported by Andrea Elyse Messer, Penn State Office of Public Information

Recent Abrupt Cold Event

At the Fall Meeting of the American Geophysical Union in San Francisco, Anna Maria Agustsdottir, a graduate student in Geosciences, reported on an abrupt event about 8,200 years ago when the world climate suddenly got colder and stayed that way for a few hundred years, before temperatures returned to normal levels. Agustsdottir is a doctoral candidate working with Professor Richard Alley.

"The event, which we are calling the 8K, was short compared with other more distant events," says Agustsdottir. "We see it in the Greenland ice cores as one of the biggest dips during the Holocene when temperatures abruptly decreased about 11 degrees Fahrenheit. This event appears to be very similar to, if somewhat shorter than, the Younger Dryas event that occurred about 12,000 years ago. We are trying to find the underlying cause for these sudden temperature drops."

The change in climate during this period can be seen not only in the temperature record from the Greenland ice cores, but also in the ice accumulation, in the indicators of forest fires and in the amounts of methane found in the atmosphere.

"Methane is not just an indicator of local climate change," she points out. "It indicates a global change in climate."

The researchers, who include Agustsdottir, Alley and Peter Fawcett of the University of New Mexico, note that during the 8K Greenland became cold, dry and windy, Canada became cold, and the North Atlantic Basin cold and fresh. Asia and Africa also showed colder dryer climate, while South America and North America were wetter.

They believe these events occur when the ocean conveyor system shuts down. The system is a series of currents that normally move warm water from the equatorial zone to the north. This water cools as it moves northward and the colder saltier water sinks and flows back toward the equator to replace water moving north. Temperature, water density and salinity control ocean currents. When the ocean conveyor shuts down, deep cold water formation stops in the north and the cyclical flow of water halts, cooling Europe and its surroundings.

Researchers do not know what shuts down the conveyor, but one possibility is an increase in fresh water in the North Atlantic that would decrease salinity and prevent the water from sinking.

Using a climate simulation model called GENESIS, they are trying to model events leading up to the 8K event, in order to simulate an ocean conveyor shutdown and temperature decline. The Penn State researchers have used this method on the Younger Dryas event with some success.

"Using conditions similar to today's oceans, the model response to a conveyor shutdown does not match data from the 8K event," says Agustsdottir. "However, shutdown from an ocean with a more vigorous conveyor does match observations. This indicates things were different in the early Holocene."

She considers the mechanism behind these sudden cold spells important because the climate changes are so rapid. If change is gradual, animals, plants and humans can adapt to the new environment; but if the change is abrupt, crops fail, rains do not come or come too frequently, and people do not have time to adjust.

Fire Regime Diversity Promotes Forest Diversity

For the past 94 years forest caretakers have restricted Mother Nature by suppressing forest fires. Now a Penn State geographer is trying to discover what the forests would have been like if we'd let them burn.

"I'm interested in how fire shapes the landscape. Resource managers are interested in restoring forests to what they were like before the arrival of Euroamericans," says Geography graduate student R. Matthew Beaty. "To restore forests, we must first understand their natural and historic variability."

Beaty and Alan H. Taylor, associate professor of geography, have found variation on a fairly local scale is important and that the environment, especially topography, is key. They have examined pairs of aerial photographs from 1941 and 1993 and noted significant changes in the Cub Creek Research Natural Area of the Lassen National Forest in California. These changes are remarkable because the Cub Creek area has never been logged or grazed—the only human impact in the area has been fire suppression.

Fire suppression began in 1905 and in response the open forest, characterized by widely spaced larger trees, became a closed forest densely packed with smaller trees,

Forest structure changes in the 20th century: top, before fire suppression; bottom, after fire suppression.

saplings and seedlings. Fire suppression has also changed the forest composition from mostly pine, which are fire tolerant, to firs which are more shade tolerant but fire intolerant.

"In the 20th century, fire suppression has changed the density and species diversity of these forests, but differently in each area. The direction of slope is critical," Beaty reported at the annual meeting of the Association of American Geographers in Boston. "The slope direction affects the microclimate, which in turn influences species distribution and fire vulnerability."

For their study, the researchers divided the area into three regions based on differences in topography. The watershed is very rugged with two ridges running east and west from its headwaters. To learn about the pre-Euroamerican fire history, they took wedges from existing trees to identify when past fires occurred. Because trees add one growth ring per year and the width of these rings is affected by climate conditions, fire years can be dated with accuracy.

"Some fires burned throughout the area," says Beaty. "In 1795, 1829 and 1883 there were major fires that burned everywhere, and these were also very dry years throughout California."

The three sites investigated were a south-facing slope, the headwaters, and a north-facing slope, separated by natural fire breaks. The south-facing slope is sunny and dry and includes abundant pines. The area previously averaged a fire about every nine years; it last burned in 1926. The north-facing slope has not burned since 1883 and is dominated by white fir; it used to burn on average every 35 years. There is also considerable difference in the severity of fires on the two slopes: while fires on the south-facing slope were light, fires on the north-facing slope were catastrophic, often producing brush fields. The fire history of the headwaters has characteristics of both areas and has burned, on average, every 17 to 25 years.

The historic differences in fire regimes within this small watershed contributed directly to its biological diversity. "One apparent outcome of fire suppression is that without fire each of these areas is becoming more homogeneous," says Beaty. "Today white fir has reached unprecedented dominance, while other species are in decline. If resource managers want to regain and sustain the remarkable diversity of these landscapes, they need to restore diverse fire regimes."

In the mud volcano area of Yellow Stone National Park, graduate students Pete Sak, Cindy Werner (far side of crater) and Post-doctoral researcher Liane Benning (near side) sample vent gas.

Mudpots at Yellowstone

While the caldron-like bubbling of active mudpots may be the most eye-catching phenomenon in the Mud Volcano portion of Yellowstone National Park, Penn State researchers have discovered that nascent and dying mudpots actually produce equivalent amounts of carbon dioxide.

"We know that geothermal systems put a lot of carbon dioxide into the atmosphere, and up until now researchers have estimated the amounts of naturally released carbon dioxide by counting and evaluating active sites," Geoscience graduate student Cindy Werner reported to the fall meeting of the American Geophysical Union. "We assumed that active mudpots would be the location of most carbon dioxide degassing. But we have found you cannot let your senses bias the research, especially with a gas that does not in itself destroy vegetation and cannot be seen or smelled."

Using a statistically designed sampling method, Werner and Geosciences professor Susan F. Brantley investigated the northeastern section of Yellowstone for carbon dioxide outgassing. Most of the carbon dioxide they measured was not related to the vents of active mudpots. Some visually inactive areas gave off as much as 32,000 grams CO_2 per square meter per day, compared with <30 grams/m^2/day on arable land and only 20 grams/m^2/day from healthy forest. The area where the researchers found high levels of carbon dioxide was a grassy field surrounded by healthy forest. The area did not look like a mudpot, but closer examination and soil samples indicated that it was infilled and had been a mudpot in the past. Other areas with unexpectedly high levels appeared to be new mudpots in their early stages.

Computer-based Forecasts Fare Well

Can a computer program win a weather forecasting contest? Not yet, but a Penn State statistical weather forecasting program did beat the consensus forecast in the 1996-97 National Collegiate Weather Forecasting Contest.

"The computer program came in 20th out of 737 initial participants," said Robert Vislocky, research assistant in meteorology. "Not too bad for a quick-and-dirty prototype program."

For the weather contest, Vislocky took ideas he and Professor J. Michael Fritsch had tested in the department, and created an automated forecasting system called Advanced Model Output Statistics [AMOS]. AMOS ingests routinely available weather data and by applying statistical processes for the specific forecast location, predicts precipitation and maximum and minimum temperatures.

Although AMOS was designed for only the cities and variables available for this contest, Vislocky points out that the system can be expanded to forecast for any location and for a vast array of parameters.

The 1996-97 contest had 737 participants: 67 professional meteorologists, 166 freshmen and sophomores, 324 juniors and seniors, and 180 graduate students.

Regional Climate Modeling

While global climate models attempt to capture the complex interactions of air, sea and land on a planetary scale, they may not provide sufficient information on a regional scale for practical purposes.

"The physics in regional models is much better than in the global climate models," says Gregory S. Jenkins, assistant professor of meteorology. "Regional climate models might provide more useful information for planners."

Global climate models use about 30 data points for the entire continental United States, while regional models use about 800 data points. Regional models also represent mountains better — global models smear them, making something like the Rocky Mountain chain insignificant. Global models also have difficulty defining coastlines, but the regional models can resolve the coastal area.

"We are using NCAR's GENESIS global climate model and a Penn State/NCAR regional climate model to discover what differences you get when climate change is modeled on a planetary or regional scale. We want to find any variation with elevated greenhouse gases in variables like precipitation, soil moisture and snow depth," said Jenkins at the annual meeting of the American Association for the Advancement of Science. "We also want to understand how the variables in the two models differ over various regions within the United States."

The regional model Jenkins uses is the one originally designed for short-range weather forecasting but it has been modified to investigate long-term climate. For climate modeling over seasons and years, vegetation and local variations become important.

"With some variables, like temperature, we seem to get the same results with both models," says Jenkins. "But soil moisture, for example, increases in the global model, but not in the regional model."

The research team included Giang Nong, a graduate student in meteorology, and an undergraduate John Haynes, who analyzed the global and regional models for twice today's carbon dioxide levels. Overall, the global models produced consistently high precipitation; however, the regional model does a better job at producing rainfall amounts similar to observation. The two-times carbon dioxide regional climate simulation for the Northeastern United States produced warmer temperatures, leading to more rain and less snowfall during winter. Less snow means less snowpack for spring melting.

"This type of result is important for the water balance," says Jenkins. "The snowpack is important because snow melts slowly, rather than running off immediately."

The regional models rely on the global models for input. Problems arise when interpolating to increase the number of data points 30 times. One way the researchers tested the models was to try to simulate present-day extreme events, like El Niño or the drought of 1988. "The GENESIS model, run with observed sea surface temperatures over 10 years, produced some correlation with real events for the 1986-87 El Niño but precipitation for both models was, in some places, incorrect," says Jenkins. "Precipitation looks like a simple variable, but it is really complex."

The simulation also had difficulty with modeling drought. Both models simulated the 1988 summer drought conditions over the central United States incorrectly. "These coupled global and regional models cannot give the best results yet because the coupled atmosphere-ocean models which provide boundary conditions for the regional climate model are still early in their development," says Jenkins. "But eventually the coupled atmosphere-ocean models will show us how extreme events like El Niño can moderate or exacerbate the effects of global warming. This will modulate our understanding along with regional climate model results." For example, normally the Southwestern United States has relatively dry winters, but during an El Niño, winters become much wetter. If the current climate models predict that greenhouse warming increases Southwestern aridity, then the models of the future, which can predict El Niño events, might show an El Niño year as a welcome occurrence, mitigating the effects of the warming trend.

Unmasking a Tangled Web of Interactions

While climate modelers are busy predicting changes in global, regional and local weather patterns, another team of EMS researchers in the Center for Integrated Assessment (CIRA) is trying to determine how those changes will affect everything from drinking water and agricultural production to flooding and public health.

"Studying climate change is not just studying the global climate, but what the shifts in climate will do to specific regions," says Brent Yarnal, associate professor of geography. "The climate models are only a small part of an integrated regional assessment of global climate change." Integrated assessment includes the economic and social consequences of global change, the choices that can be made to mitigate or adapt to these changes, and the impact humans have on climate. The human elements feed back into the climate models when policy decisions alter greenhouse gases or affect climate variables.

At the annual meeting of the American Association for the Advancement of Science, Yarnal told attendees about CIRA's use of overlapping projects to discover how regions and local municipalities contribute to and are affected by global change. The projects focus on the Susquehanna River Basin, which begins near Otsego Lake in New York and 444 miles later empties into the northernmost part of the Chesapeake Bay. About 3.8 million people live in the 27,500 square miles of the basin, mostly in Pennsylvania but including small portions of New York and Maryland.

Geographic information systems and complex visualization are the subject of a project by geography professors Donna Peuquet and Alan M. MacEachren, who are trying to put a fourth dimension– time– into the assessment. Working with enormous data sets that sometimes have blocks of data missing, the researchers try to capture the Susquehanna River Basin and track changes through time. Policy decisions on national, regional and local levels generally influence these changes.

Ann Fisher (agricultural economics), Richard Bord (sociology), and Robert O'Connor (political science), are investigating how people evaluate the risk of global climate change. "An interesting question is whether the person on the street views the risks in the same way that the policy makers do," says Yarnal. "Also, do perceptions change with scale? Are the risks considered acceptable on a national level, but not on a local level?"

Water resources, especially drinking water, are another important segment of CIRA research. A project investigating the vulnerability of water resources to climate variation and change found that the policy decisions made in the Clean Drinking Water Act actually reduce vulnerability to floods and drought. "Inadvertently, the government, in trying to ensure clean drinking water through institution of the Act, made people in the area less vulnerable to floods and drought and climate change," says Yarnal. "However, areas with small, independent drinking water supplies are still vulnerable because they have been allowed to defer meeting the requirements or are exempt from them."

One thing that climate change will bring is an increased frequency of severe weather events, which increase the potential for flooding. Flooding can bring on epidemics of waterborne diseases like cryptosporidiosis, a diarrheal disease that can pose major health problems for the elderly, infants and those with compromised immune systems. Cryptosporidiosis is found through Pennsylvania in cattle feces and flooding could introduce the cysts into the drinking water system. "A team of researchers led by Ann Fisher and colleagues at Johns Hopkins University found that only about half the people in any area actually follow boil water directives adequately or at all," says Yarnal. Increased filtration, boiling water, drinking bottled water and trucking-in water are all effective ways to avoid contamination. Balancing the expense of water treatment with the cost to the community in deaths, hospitalization, lost work and worker's compensation can establish an economically sound way to deal with potential outbreaks.

"Concerns about global warming are usually couched in worldwide or national terms," says Yarnal. "Our approach is to look at how changes in climate will influence people on a local and regional level."

CIRA researchers include Eric Barron, professor of geosciences; Jeff Carmichael, research associate Earth System Science Center; Robert Crane, professor of geography; William Easterling, associate professor of geography; Amy Glasmeier, professor of geography; Gregory Knight, professor of geography, Stephen Mathews, adjunct faculty in geography; Adam Rose, professor of energy, environmental and mineral economics; and J. Shortle, professor of agricultural economics.

How Does Your City Grow?

Microclimates caused by urbanization might not have much influence on regional climate, but they do impact considerably on local liveability. According to a Penn State meteorologist, urban planners need a way to predict the growth of cities and assess changing microclimates: the researchers have a computer model they hope will help. "The model developed by Keith Clarke at the University of California, Santa Barbara provides a probability that any location will be developed at each specific time," says Toby N. Carlson, professor of meteorology. "With this model, we can eventually predict the types of land use and the microclimates that will form."

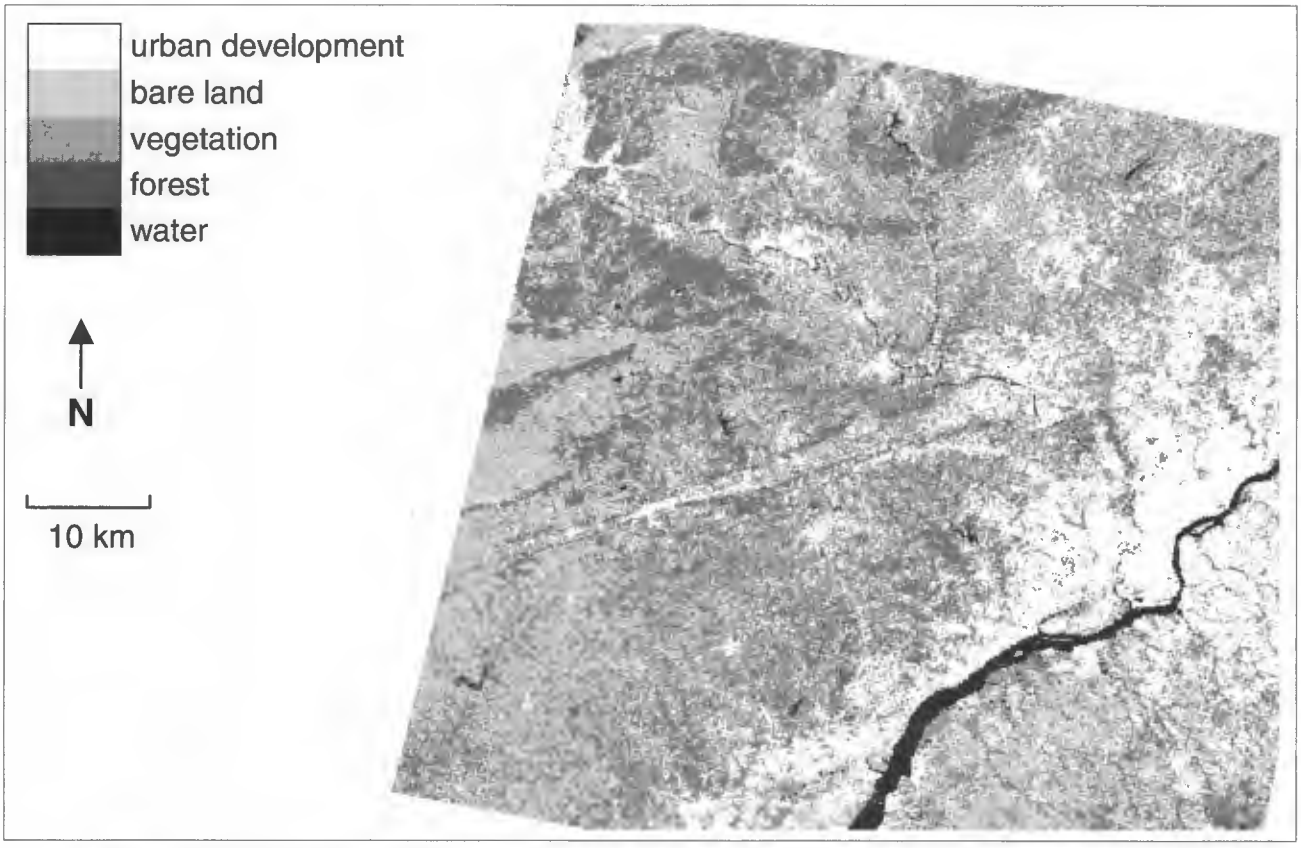
The researchers are applying Clarke's model to the Philadelphia metropolitan area and southeastern Pennsylvania. Carlson, meteorology research associate David Ripley, and graduate student Traci Arthur are using satellite image data to calculate land use types, such as forest crop, commercial, residential and water. They are also looking at the amount of vegetation, impervious surface area and various surface climate parameters. Their objective is to predict all these variables using the Clarke model, which currently provides only a probability that a given surface will become developed. The Penn State researchers examined satellite images over Eastern Pennsylvania between 1987 and 1996.

"In Pennsylvania, forest is remaining as forest, but farmland is turning over into suburban and urban areas," Carlson told attendees at the AAAS annual meeting. "Impervious surface area is increasing dramatically well outside older urban centers such as Philadelphia. In the Clarke prediction model, downtown areas remain stable with commercial development creeping out along major roads and the growth of housing developments on smaller roads. The base map data for this simulation comes from satellite remote sensing data. "In the satellite imagery, new housing developments sometimes look like deserts — hot and dry — when viewed from a meteorologic perspective," says Carlson. "Then lawns and trees are planted and the situation gets better, but it never gets back to the microclimate of the agricultural fields. It always stays warmer and dryer." These changes take place because of the changes in land use. Asphalt and concrete roads, sidewalks and driveways create impervious areas from which no moisture evaporates. Normally, evaporating moisture cools the ground, but with pavement, there is no cooling and it becomes noticeably warmer. Land use changes also change runoff patterns, especially when large areas impervious to seepage occur. The increased runoff can cause local flooding.

"We would like managers and urban planners to be able to see what changes have already occurred and might occur in the future, and be able to calculate such things as surface temperature index, a measure of how warm an area is." Carlson and his associates provide the Clarke prediction model with the local terrain, roads, bodies of water and protected areas and the land surface type as diagnosed from the satellite imagery.

"One thing we haven't done yet, is validate the Clarke model for Eastern Pennsylvania," says Carlson. To validate the model, the researchers will feed in information from the past and run the model up to the present. If the model's simulation matches the present urban picture as diagnosed from current satellite imaging, then the model is validated. If it doesn't, then parts of the model are tweaked until the past creates the present.

Readers can find out more about this research, together with an animation of the transitions from 1987 to 2050 at http://www.essc.psu.edu/~dajr/chester/index.htm.



1987 Landsat TM-derived land cover map of Chester County and surrounding area (resampled from 25 x 25 m² to 100 x 100m² surface resolution). The Delaware River is apparent in the east with the urban centers of Philadelphia, Pennsylvania, (NE) and Wilmington, Delaware, (SE) stretching along it. Chester County is located to the west of these two main cities.

The Blizzard of 1996

Most of us remember the Blizzard of 1996, but when Jon D. Radakovich recalls it, he can also explain it. Working as an undergraduate, with Hampton N. Shirer, associate professor of meteorology, Radakovich learned how to model the evolution of the blizzard using equations that capture the dynamics of storm development. Using these equations — which depend on air pressure, temperature, wind direction and wind speed at various levels in the atmosphere — Radakovich identified the key atmospheric conditions that produced the blizzard.

One of his most significant findings was that the surface low modeled by the equations coincided with the actual position of the surface low when the storm was at its most intense stage. The blizzard of 1996 caused the East Coast to report record snowfalls in numerous cities. During cleanup efforts, a warm rainstorm followed the blizzard's path. The melting snow and additional heavy rainfall caused people to abandon their shovels in search of higher ground, as flooding was reported throughout much of the eastern United States. "Approximately $3 billion in damage and 187 deaths were caused by the blizzard and the flooding that followed," says Radakovich, now a graduate student. "Virginia, Maryland, West Virginia and Pennsylvania were buried under more than 30 inches of snow in some areas."

In order to diagnose the atmospheric conditions that resulted in this damage, Radakovich used two equations — the Sutcliffe development equation and the quasi-geostrophic geopotential tendency equation. For widespread heavy snowfall to occur, air must be rising rapidly in the atmosphere for long periods of time and over large areas. The Sutcliffe development equation models mechanisms in the lower levels of the atmosphere (from 5,000 to 10,000 feet) that cause the air to rise, while the quasi-geostrophic geopotential tendency equation models mechanisms in the middle levels of the atmosphere (from 15,000 to 20,000 feet) that result in rising air. The second method is the newer of the two and a primary one used by modern forecasters.

Radakovich compared the computed results from both equations with those for the actual storm. He found that the older Sutcliffe development equation proved to be the more accurate model. Thus, mechanisms in the lower levels of the atmosphere dominated the development of the blizzard of 1996. The lack of success using the quasi-geostrophic geopotential tendency equation suggests that old methods such as the Sutcliffe scheme are still very useful and, in some cases, provide a better tool.

"Because of our success in using the Sutcliffe development equation," says Radakovich, "we recommended that the model be placed on the Department of Meteorology computer system so that students can witness these applications of dynamics firsthand. From our results, we believe that the Sutcliffe development equation can be valuable as a forecasting tool." Radakovich provides a more detailed account of his research procedures and results in his honors thesis, "A Case Study of the Evolution of the Blizzard of 1996 Through the Application of Quasi-Geostrophic Theory."

FACULTY & ALUMNI NEWS

James H. Adair, associate professor of ceramic science and engineering and director of the Particulate Materials Center, has been named a Fellow of the American Ceramic Society.

Michael M. Coleman, professor of polymer science, was named a Fellow of the American Physical Society at the 1998 spring meeting.

Tarasankar Debroy, professor of materials science and engineering, received the 1998 Warren F. Savage Memorial Award from the American Welding Society. This award recognizes the paper published in the *Welding Journal* that best represents "innovative research resulting in a better understanding of the metallurgical principles related to welding." The American Welding Society is the largest organization in the world dedicated to advancing the science, technology and application of welding. It serves more than 48,000 members internationally.

Richard E. Tressler, professor and head of the Department of Materials Science and Engineering, has been awarded the International Prize from the Japan Fine Ceramics Association (JFCA). The International Prize is given to a person who has made a remarkable contribution to the fine ceramics industry through international business development, technological development, and cooperative research. Tressler was cited for educating many fine scientists and engineers in the field of ceramics, for his leadership of the Center for Advanced Materials at Penn State, and his contributions as president of the American Ceramic Society.

Douglas Miller, research assistant in the Earth System Science Center, has been invited to join the External Advisory Board of the Center for Environmental Applications of the Oklahoma Climatological Survey. The Center utilizes a sophisticated atmospheric monitoring network, MESONET, to study the effects of dynamic climatological phenomena on environmental processes. Miller, a soil scientist, manages ESSC's Susquehanna River Basin project.

Merrilea J. Mayo, associate professor of materials science and engineering, has been awarded the OSA/MRS Congressional Fellowship that will allow her to work in Washington D.C. in the coming academic year as a staff member to the U.S. Congress on science and technology issues.

Lee Grenci, instructor of meteorology, was named a contributing editor for the magazine *Weatherwise*.

Lee Kump, professor of geosciences, has been elected as a Fellow of the Geological Society of America.

Shelton Alexander, professor of geosciences, has been appointed to a new committee of the National Research Council's Computer Science and Telecommunications Board, charged with examining "Intellectual property rights and the emerging information infrastructures."

Craig F. Bohren and Bruce Albrecht are authors of *Atmospheric Thermodynamics*, published by Oxford University Press.

Christopher J. Bise, centennial professor of mining engineering, received a Master of Health Science degree in Environmental Health Engineering from Johns Hopkins University, where he spent the past year on sabbatical leave.

Roger Downs, professor of geography, has been appointed to the National Academy of Sciences/National Research Council "Committee on Geography" for a three-year term.

Chunsan Song, associate professor of fuel science, was appointed to the executive committee, the program committee, and the website committee of the American Chemical Society, Petroleum Chemistry Division.

Ian R. Harrison, professor of polymer science, has received a Fulbright Award for a sabbatical visit to Thailand to lecture and consult at the National Metal and Material Technology Centre in Bankok, and a number of Thai universities.

Joe Schall, EMS writing instructor, is author of a new handbook for *Writing Recommendation Letters*. This 40-page text is designed to help professors write letters of recommendation for their students, especially for those applying for the nation's most prestigious scholarships. Specific information is provided for such scholarships as the Marshall, Truman, Fulbright, Udall and Rhodes. Eighteen specimen recommendation letters written by Penn State faculty members and graduate assistants are included. The book is available from the Dean's Office, 116 Deike Building, University Park, PA 16802 at a cost of $7.00 [checks made out to Penn State].

...a new handbook
Writing Recommendation Letters
by Joe Schall

available from
Dean's Office
116 Deike Building
University Park, PA 16802

Long-Qing Chen, associate professor of materials science and engineering, has received the creative research award of the National Science Foundation, which provides him with a special extension of his research grant in order to continue work deemed especially useful. NSF makes only two or three such awards each year. Chen is a materials theorist working on modeling microstructural evolution during phase transformation and processing. A publications list can be found at: http://www.personal.psu.edu/faculty/l/q/lqc3/

The Era of Materials, edited by **S. K. Majumdar, R. E. Tressler** and **E. W. Miller** and published by the Pennsylvania Academy of Science, provides a comprehensive new look at the materials that play a role in everyday life. The book is written almost exclusively by faculty in Penn State's Department of Materials Science and Engineering and Materials Research Laboratory. *The Era of Materials* is designed to enlighten the technically literate layman about current trends in a wide array of materials. In the introduction, MatSE Department Head, **Richard Tressler**, traces the evolution of materials use and examines their potential as circumstances change in the environment, health care, information technology, the energy field, and the country's infrastructure. The 25 chapters cover both the fundamentals of materials science and specific issues in the development and characteristics of today's materials.

H. Reginald Hardy, Jr., professor of mining engineering, is co-editor with Michel Aubertin of the *Proceedings of the 4th Conference on the Mechanical Behavior of Sal*. The conference was organized by the Ecole Polytechnique and McGill University, Montreal, with the collaboration of The Pennsylvania State University, and held June 17 and 18, 1996. Hardy is also editor of the *Proceedings of the Sixth Conference on Acoustic Emission/Microseismic Activity in Geologic Structures and Material*, a conference held at Penn State on June 11 to 13, 1996. Both volumes were published in 1998 by Trans Tech Publications.

EMS Outstanding Staff Awards for 1997: Nancy Warner, staff assistant in the Department of Energy, Environmental and Mineral Economics; **Lynn Persing**, staff assistant in the Department of Meteorology; and **Frank Driscoll**, technical support staff in the Department of Materials Science and Engineering.

The Center for Advanced Materials has received funding from the National Science Foundation for the development of electrochemical instruments that can measure pH in hydrothermal solutions at high temperatures. Research will be conducted at Penn State, Princeton and Temple universities.

John A. Cicirelli, assistant professor of environmental engineering at Penn State Beaver, received the Campus Advisory Board's Teaching Award for outstanding classroom instruction. Ciciarelli, who has taught geology and geological sciences at the Beaver Campus since 1971, was chosen for his strong interest in students, understanding of the subject matter, willingness to offer additional help, and enjoyable teaching style. He holds his B.S. from Notre Dame and both M.S. and Ph.D. in geology from Penn State. He has served as Fulbright Lecturer at the University of the West Indies in Barbados and as a visiting professor at Notre Dame. He has published three books: *Practical Guide to Aerial Photography, with an Introduction to Surveying, Practical Physical Geology, Problems and Solutions*, and a *Study Guide for Contemporary Geology.*

Alan Davis, professor emeritus of geology, is one of an international group of authors of a new handbook *Organic Petrology*, which completely revises and expands its predecessor Stach's *Textbook of Coal Petrology* to now cover the whole field of the petrology of organic matter in rocks. The book deals with physical, chemical and microscopic characterization, geology and biology of the formation of organic matter, maturation and increase in coal rank and the generation of hydrocarbons, the industrial processing of coal and the solution of geologic problems such as the determination of thermal and burial histories. It addresses undergraduate and graduate students, scientists and engineers concerned with the assessment, mining and utilization of coal and oil shales, and those involved with the occurrence, exploration and evaluation of petroleum and natural gas and their source rocks.

Appointments

Larry Achterberg has been appointed as Director of Business and Human Resources in the College of Earth and Mineral Sciences, succeeding Everett Tiffany, who has retired. In this position Achterberg will oversee EMS business and administrative procedures, coordinate the acquisition and utilization of support system equipment and facilities, and direct the operation and security of administrative information systems. In addition, he will serve as the College's Human Resources Representative, supervise budgets and manage the Dean's office. Achterberg has been a member of the College staff since 1992 and previously served as assistant to the College's financial officer. He holds a B.S. degree in biology from Cal Poly San Luis Obispo, California, and an MBA in finance from Penn State, and has completed substantial graduate work in human resources at Cornell University. Before joining Penn State, he was a manager at AccuWeather, Inc., and served as assistant to the president at Exstar Financial Group, Solvang, CA. He has also supervised research laboratories at Penn State and Cornell Universities.

Peter Heaney is a new faculty member in the Department of Geosciences with the rank of associate professor. He comes to EMS from Princeton University, where he served as assistant pofessor of mineralogy. Heaney's primary field of interest covers: crystal structure analysis of minerals, the geochemistry of silica, polymeric speciation in aqueous fluids, and phase transitions in rock-forming minerals. Dr. Heaney received his undergraduate education at Harvard College and his M.A. and Ph.D. in geology from Johns Hopkins University, and then served two post-doctorates: at Smithsonian Institution's Department of Mineral Sciences at the National Museum of Natural History, and in the Department of Earth Sciences, Cambridge University. He studied at Cambridge as an NSF-NATO Fellow and also as Visiting Scholar at Wolfson College. In 1994-95 he was invited to serve as a Distinguished Lecturer for the Mineralogical Society of America. Among his current committee appointments is the Committee on Minerals and Health Hazards of the Clay Mineral Society.

Andrew N. Kleit has joined the faculty as associate professor of energy, environmental and mineral economics. He comes to Penn State from the Ourso School of Business Administration at Louisiana State University, where he received the 1996 Departmental Award for Excellence in Undergraduate Teaching. Dr. Kleit is interested in environmental economics, industrial organization, antitrust, regulation and law and economics. He received his education at Middlebury College and Yale, then prior to beginning his academic career, held a number of positions as an economic advisor. In Washington, D.C., he served as a junior staff economist to the Council of Economic Advisors of the Executive Office of the President; as an economist with the Bureau of Economics of the Federal Trade Commission, and as economic advisor to the director of the FTC Bureau of Competition, and in Ottowa, he served as senior economic advisor to the director for investigation and research of Consumer and Corporate Affairs Canada. He has published extensively, including an FTC monograph: *Disentangling Regulatory Policy: The Effects of State Regulations on Trucking Rates*, co-authored with Timothy Daniel [1995] and a book published by Kluwer Publishing [1996] and co-edited with Malcolm Coate: *Competition Policy Enforcement: The Economics of the Antitrust Process.*

Zili Yang has been appointed assistant professor of energy, environmental and mineral economics. He comes to the College from the MIT Center for Energy and Environmental Policy Research, where he was a research associate. Dr. Zang received his B.S. in mathematics from the University of Science and Technology of China; M.S. in management science from Tianjin University, China; and M.A., M.Phil., and Ph.D. degrees in economics from Yale University. For the past five years he has been the principal researcher responsible for economic modeling and policy analysis aspects of a large-scale multidisciplinary research project on global change at the Massachusetts Institute of Technology.

Cem Sarica joins the College as associate professor of petroleum and natural gas engineering. He was previously at the University of Tulsa, Oklahoma, where he served as associate director of Tulsa University Fluid Flow Projects and adjunct professor, teaching classes in the graduate and undergraduate programs and supervising a wide range of research projects associated with flow in pipes and fluid behavior in wells. He received his B.Sc. and M.Sc. in petroleum engineering

from Istanbul Technical University and his doctorate from the University of Tulsa. He spent two years as a consulting engineer for Brill Engineering in Tulsa, and from 1990 to 1992 he served as an assistant professor at Istanbul Technical University.

Retirements

Alan Davis, professor and director of the Coal and Organic Petrology Laboratories in Penn State's College of Earth and Mineral Sciences, has retired as professor emeritus of geology. He has been at Penn State since 1973, when he was appointed associate professor of geology.

At Penn State, he served in the Coal Research Section as assistant director until 1986, and from 1986 to 1987 as director. From 1987 to 1992 he served as director of the Energy and Fuels Research Center, and then from 1992 to 1997, as director of the Coal and Organic Petrology Laboratories. One of the functions of these centers was maintenance of the Penn State Coal Sample Bank and Database, which serves as a library of coals for researchers.

His research interests focused on the optical properties of coals and their relationships with coal origin and utilization. He used luminescence and reflectance microscopy in the study of coal structure and the interpretation of the thermal, tectonic and environmental histories of coal.

In 1994 he received the Reinhardt Thiessen Medal of the International Committee for Coal and Organic Petrology for his contributions to coal science. In 1998 he was one of an international group of authors of a new textbook, "Organic Petrology."

Davis has been active in professional organizations throughout his career. He was named a Fellow of the Geological Society of America, and served as chair of the Coal Division of the Geological Society of America and for four years as president of the International Committee for Coal and Organic Petrology. He has been actively involved with the Coal and Coke Committee of the American Society for Testing and Materials for 20 years.

Davis received his B.Sc. in geology from Imperial College, London; M.S. in geology from Penn State in 1961; and his Ph.D. in geology from the University of Durham (U.K). In the United Kingdom he worked for John Taylor and Sons and New Consolidated Goldfields before commencing his career as a coal scientist. From 1957 to 1958 he was employed by the National Coal Board's Opencast Executive and Coal Survey. He served as a senior research associate at the University of Newcastle-upon-Tyne (U.K.) from 1961 to 1965, and after receiving his doctorate, accepted a position with the Geological Survey of Queensland. He returned to Australia in 1993-94 to spend a sabbatical leave at the University of New South Wales and the Australian National University in Canberra.

David P. Gold, professor of geology, has retired from the University with emeritus status. He has been at Penn State since 1964 and served as chair of the Geology Graduate Program from 1977 to 1982.

Dr. Gold received his B.S. in Geology-Chemistry and M.S. in Geology from the University of Natal, South Africa, and his Ph.D. in Geology from McGill University, Canada. From 1962 to 1964 he lectured at Loyola College of the University of Montreal, prior to joining Penn State's program in geochemistry and mineralogy as a research associate. He was named associate professor of geology and geophysics in 1968 and professor of geology in 1975.

He is an elected fellow of both the Geological Society of America and the Geological Association of Canada, and received the Barlow Memorial Medal of the Canadian Institute for Mining and Metallurgy, and the Geological Association of Canada in 1968, and the Presidents Medal of the 24th International Geological Congress in 1972.

Primarily an economic geologist, Gold has interests ranging from remote sensing applications in geology to the tectonic setting of ore deposits. He is especially known for his contributions to shock metamorphism and impact craters, fracture trace and lineament analysis, and the emplacement mechanics of carbonatites and kimbolites. He served as a Distinguished Lecturer for the American Geological Institute, as president of the Yellowstone-Bighorn Research Association, and as leader of field conferences and geological field trips in Montana, Québec, and Pennsylvania.

Duff Gold taught fifteen different courses at Penn State over his thirty-year teaching career, focusing primarily on economic and structural geology, but also including such topics as petrofabrics, lunar processes, problems in remnant magnetism, and the geology and economics of construction materials and industrial minerals. His outstanding undergraduate teaching was recognized by the college with the Matthew J. and Anne C. Wilson Award in 1970. From 1966 to 1997 he served as director of Penn State's Geoscience Field School, an eight-week study period in the Rocky Mountains that most geoscience undergraduates consider the pinnacle of their education as geologists. In his department, he has served as a significant alumni point of contact for two decades. He has been a strong supporter of the Steidle Museum and the Nittany Mineralogical Society. Gold served as a member of the University Faculty Senate from 1983 to 1998, chairing a number of committees and serving as a member of many senate initiatives, including Faculty Advisory Committee 1993-96 and Senate Representative on the Graduate Faculty Council 1993-98. He was appointed to the University's Commission for Undergraduate Education in 1992.

Peter Gould, Evan Pugh Professor of Geography, has retired with emeritus rank after 35 years of service to Penn State.

Gould is a leading human geographer of his generation, universally admired for the exceptional range of his scholarly interests, and widely recognized as a pioneer of the 'new geography' of the 1960s and 70s which transformed the discipline through the application of mathematical and increasingly rigorous methodology. Gould's international reputation has been a significant contributing factor in the development of Penn State's Department of Geography into its position of eminence in American geography.

He is author of 17 books, some 160 scholarly papers, and innumerable lectures delivered

worldwide to audiences as diverse as the student convocation of Clark University, the World Computer Conference, Le Congrès du Groupe Dupont, and the Infectious Disease Epidemiology Seminar of Walter Reed Medical Center.

He is well known for his early studies of spatial perception and spatial modeling, notably his 1974 book *Mental Maps*, coauthored with Rodney White, and his work in the Lund Studies in Geography titled, *People in Information Space: The Mental Maps and Information Surfaces of Sweden* (1975).

A dominant theme in his research has been the spatial diffusion of both ideas and disease, exemplified by such wide ranging studies as, *The Structure of Television* (1984), *Fire in the Rain: The Democratic Consequences of Chernobyl* (1990), and *The Slow Plague: A Geography of the AIDS Pandemic* (1993).

Throughout his career Gould has sought to define geography's place in the humanities and pursued intellectual connections with other disciplines, both formally and informally. Seminars with leading humanists led to texts such as *A Search for Common Ground* (1982) and *A Ground for Common Search* (1988), while his view of his own discipline was expressed in *The Geographer at Work* (1985), a book translated into both Italian and Japanese.

His scholarship has been especially appreciated in Europe, where the degree of *Docteur Honoris Causa* was conferred on him by the Université Louis Pasteur, Strasbourg in 1982. He received the gold medal of the Prix International de Geographie, St. Dié, France in 1993, and in 1997 the Anders Retzius Gold Medal of the Swedish Society for Anthropology and Geography, conferred by the King of Sweden. He received the Penn State Faculty Scholar Medal for Outstanding Research Achievement in 1981.

Gould came to Penn State in 1963 as assistant professor in the Department of Geography, following three years on the faculty of Syracuse University. He received his B.A. *summa cum laude* with high honors in geography from Colgate University, and M.A. and Ph.D. in geography from Northwestern University. At Penn State, he was named associate professor in 1964, professor in 1968, and Evan Pugh Professor in 1986.

Beyond his doctoral studies of transportation in Ghana, he has conducted research in the field in Kenya, Tanganyika, Uganda, Venezuela, Mexico, Trinidad, Jamaica, Sweden, Norway, France and Portugal, and spent sabbatical leaves at the Geographical Institute, Lund, Sweden, and the University of Grenoble, France. He has served as a member of the National Research Council Committees of Behavioral and Social Sciences, and from 1977 to 1980 served as director of the Social Science Research Council, and subsequently as a member of its Corporation. He currently serves as an advisor to a number of journals: *MappeMonde*, *Geografiska Annaler*, *The AIDS Leader*, and *Sistema Terra*.

He is a member of Phi Beta Kappa, Amnesty International, and Greenpeace.

Robert E. Newnham, Alcoa Professor of Solid State Science and Associate Director of the Materials Research Laboratory, has retired from the faculty as professor emeritus. He has been a member of the faculty since 1966, when he came to Penn State from MIT as an associate professor. He was appointed as professor in the Department of Materials Science and Engineering in 1970, and served as chairman of the Solid State Science Program of the Graduate School from 1972 to 1990. He was named Alcoa Professor in 1987, and elected to the National Academy of Engineering in 1989.

Newnham is known worldwide for his work in ferroelectric materials, particularly electroceramics, composite materials for electronic applications, and currently, smart materials. Among many other achievements, he discovered polar glass-ceramic pyroelectric sensors, and a new class of composite thermistors and chemical sensors, and pioneered the development of composite piezoelectric transducers.

He is author or co-author of more than 500 research papers and three books: *Structure-Property Relations* published in 1975, *Classic Crystals* published in 1987, and *Piezoelectricity* published in 1992. For his research contributions he received the Citation Classic Award in 1987, the American Ceramic Society's E.C.Henry Award for the Best Paper of the Decade 1979-1988, the Distinguished Merit Award of the University of Illinois in 1989, the Real Advances in Materials Award of the National Association of Technical Societies in 1994, numerous 'best paper' awards, and 13 patents.

Professor Newnham's teaching ability was apparent from the start of his Penn State career, and was recognized by the Wilson Award for Outstanding Teaching from the College of Earth and Mineral Sciences in 1972. In 1985 he received a distinguished speaker award from the Institute of Electrical and Electronic Engineers, and in 1990 the Outstanding Educator Award of the Ceramic Education Council.

In addition, Newnham has served as a distinguished speaker at numerous universities, including his recognition as ACS Sosman Lecturer and Orton Memorial Lecturer, Dow Lecturer at Northwestern University, Wulff Lecturer at MIT, McMahon Lecturer at Alfred University, Pond Lecturer at John Hopkins University, plenary lecturer of the European Ceramic Society, and Turnbull Lecturer of the Materials Research Society. He was named an Honorary Professor of Huazhong University of Science and Technology in China in 1988, and was awarded an honorary Doctorate of Science by Hartwick College, NY in 1996.

He served as vice chair of the U.S. National Committee for Crystallography and as a member of the National Research Council Solid State Sciences Committee, as president of the American Crystallographic Association, and counselor of the American Ceramic Society, and served as co-editor of the *Journal* of the American Ceramics Society for ten years.

Among his honors are Penn State's Faculty Scholar Award (1984), the John Jeppson Medal (1991), the International Ceramics Prize of the Academy of Ceramics (1992), the Centennial Award of the Ceramics Society of Japan (1991), and the Albert Victor Bleininger Memorial Award (1995). He received the Humboldt Senior Scientist Award in 1994 and was named an Honorary Member of the Materials Research Society of India and Distinguished Life Member of the American Ceramic Society.

Newnham received a B.S. in mathematics from Hartwick College, M.S. in physics from Colorado State University, Ph.D. in physics from Penn State, and Ph.D. in crystallography from Cambridge University (U.K.). He served as a research fellow at the Cavendish Laboratories, Cambridge, and subsequently as assistant and associate professor at MIT.

Peter A. Thrower has retired from Penn State as professor emeritus of materials science. He has been a member of the faculty in the Department of Materials Science and Engineering for twenty-nine years, and since 1980 has served as coordinator of the department's graduate program.

Thrower received B.A., M.A., and Ph.D. degrees in physics from Cambridge University, U.K., and served as a scientific officer at the U.K. Atomic Energy Authority at Harwell from 1960 to 1969, before joining the Penn State faculty as an associate professor.

He is a specialist in carbon materials, graphite, and carbon composites. Thrower has served as editor-in-chief of the international scientific journal *Carbon* since 1983, and will continue in this position following his retirement. From 1973 to 1998 he also supervised the production of volumes 8 to 26 of *Chemistry and Physics of Carbon*, serving ten years as joint editor and fifteen years as editor of these volumes.

Professor Thrower has an outstanding reputation for his undergraduate instruction, and taught the basic introductory course in materials science for twenty years, in addition to advanced classes in electron microscopy and carbon and graphite materials. His general education course on materials regularly drew one of the highest enrollments at the University. In 1991 he turned his class notes into a textbook, *Materials in Today's World*, published by McGraw Hill; a second edition was printed in 1992.

His teaching achievement was recognised by the College of Earth and Mineral Sciences in 1991 with the Matthew J. and Anne C. Wilson Award for Outstanding Teaching, and in 1998 he received the University's Milton S. Eisenhower Award for Distinguished Teaching.

Thrower served as a member of the University Faculty Senate from 1979 to 1998, and since 1992 as a member and subsequently chair of the University Promotion and Tenure Committee. He also serves as a member of the Executive Committee of the American Carbon Society.

Alumni Achievements

Tom Casadevall '74 M.S. geology, '76 Ph.D. geochemistry has been appointed as the Deputy Director of the U.S. Geological Survey, a newly stablished position in which he is responsible for oversight of the agency's scientific and management activities. Casadevall is a leading authority on volcanic hazards and aviation safety and is author of more than 90 technical publications. He has served USGS at the Hawaii, Alaska, and Cascades Volcano Observatories, as project chief for studies of geology and mineral deposits of the western San Juan Mountains, Colorado, and as assistant chief of the Branch of Volcano and Geothermal Processes. In 1996 he became director of the USGS Western Region. He is a Centennial Fellow of the College of Earth and Mineral Sciences.

Jon Nese '83, '85 M.S., '89 Ph.D. meteorology, previously associate professor at the Penn State Hazleton Campus, has accepted a new position as Chief Meteorologist at the Franklin Institute Science Museum in Philadelphia. He will be responsible for managing the overall operation of the Franklin Institute's Weather Center as both an operational forecasting facility and as an exhibit, and will deliver forecasts and other meteorological information to various media outlets in the Philadelphia area. He will also assist in the development and maintenance of Meteorological and Earth Sciences exhibits. Nese is a member of the GEMS Board of Directors. His new e-mail address is jnese@fi.edu.

Olumide Phillips '74 M.S., '76 Ph.D. Petroleum and Natural Gas Engineering has been appointed vice chairman of Texaco Overseas (Nigeria) Petroleum Company. Dr. Phillips has been with Texaco throughout his career. He was previously assistant managing director of asset development and new business and assistant managing director of operations. In addition he has served as an adjunct professor and external examiner at a number of Nigerian universities. His wife Dr. Toyin Phillips, who also received her doctorate from Penn State, is managing director of Gateway Bank, one of the most prominent financial institutions in Nigeria.

Ihor A. Kunasz '68 M.S., '70 Ph.D. geology is serving as the 1998 president of SME, the Society for Mining, Metallurgy and Exploration, Inc. At the AIME annual meeting in Orlando, Florida, he received the 1998 Hal Williams Hardinge Award for outstanding achievements in the field of industrial minerals. Since his doctoral thesis on the origin of the lithium at Silver Peak, Nevada, Kunasz has become the leading authority on lithium brines. He was chief geologist of Foote Mineral Company when it was acquired by Cyprus Minerals Company, and he subsequently became the company's leading spokesperson in Russia and the initial negotiator on the first Russian gold deposit to be developed by a western mining company. He served on the National Research Council panel on Alternate Energy Systems, and was a member of the Academy's expedition to the saline lakes of Tibet. [http://www.idis.com/aime]

MUSEUM NOTES

Andrew Sicree, museum curator

During the past few years, the Museum has experienced a dramatic upswing in activity. New events are being developed by or co-sponsored with the Museum and these are drawing record numbers of visitors. Thousands of school kids, high school students, and college students visit the Museum each year. We draw visitors from all across Pennsylvania, and from the surrounding states. Some high school groups come from as far as four hours drive away! A sampling of current Museum activities includes:

The Saltillo Mastodon Dig—Excavations at the Saltillo Mastodon site in Huntingdon County will resume in late July or early August (when the water table drops in the bog). Last year, the Museum recovered about 100 bones from the site, and this Fall we hope to find the rest of the skeleton. This all-volunteer effort is led by paleontologist Shirley Fonda '76 Ph.D. Geology.

The Nittany Mineralogical Society—Now in its fifth year as a museum-sponsored organization, the Nittany Mineralogical Society is a geology/mineralogy club with a membership of more than 60 Penn State students, faculty and staff, and local residents. The Society is headed by John Passaneau, PSU Physics Department, and holds monthly meetings in the Museum gallery. In February, forty-nine people, guided by Duff Gold, went to the American Museum of Natural History in New York to view "The Nature of Diamonds", a special exhibition of uncut diamonds and diamond jewelry. The Society's next bus trip will be an excursion to Pittsburgh on Saturday, August 29th, to view the Hall of Gems and Minerals at the Carnegie Museum of Natural History.

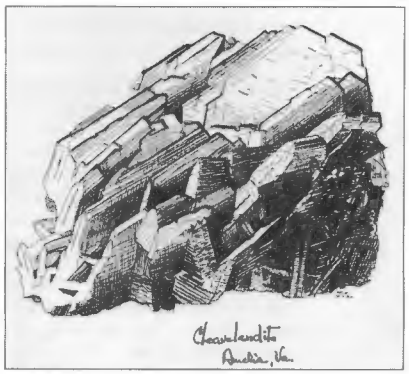
Monthly Lectures—The Nittany Mineralogical Society and the Museum co-sponsor a monthly lecture series that has brought to campus such speakers as Kurt Nassau, author of *The Physics and Chemistry of Color*; Sam Berkheiser, Director of the Geologic Division of the Pennsylvania Geologic Survey; and William Cassidy of the University of Pittsburgh, who spoke on "Collecting Meteorites in Antarctica".

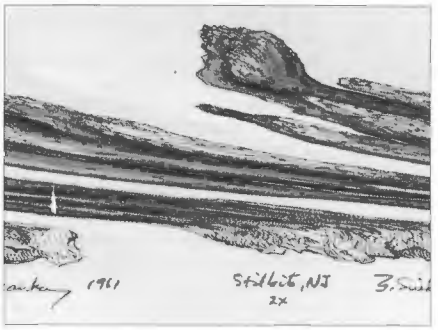
The Nittany Junior Rockhounds—The Nittany Junior Rockhounds is a recently-founded geology club for kids eight years old and up. Led by Dr. Craig Brandt – a surgeon from Altoona, PA – club members in recent months studied crystals, fossils, and the structural geology of Central Pennsylvania.

Annual Mineral Symposium—Last Fall, the second Penn State Mineral Symposium was held under the auspices of the Museum. The weekend-long symposium featured Richard Hauck of the Sterling Hill Mine in Ogdensburg, New Jersey, and a dozen other speakers. Field trips were conducted to Greenwood Furnace and to mineral localities in Bellefonte, Warrior's Mark, and Roaring Spring, PA. Due to popular demand, the third Mineral Symposium will be held in April, 1999.

Junior Education Day—Minerals and Materials Junior Education Day is the big annual educational event conducted by the Museum and the Mineral Society. Last year, nearly two hundred grade schoolers took part. Organized by local high school teacher Frank Kowalczyk, this day-long event features ten activity booths aimed at educating student participants about minerals, their properties, and the metals and other materials that can be made from them. Students view demonstrations of materials such as superconductors, shape-memory metals and low-melting alloys, organized by MatSE professor Darrell Schlom, and are given free samples of minerals and metals to encourage them to begin their own mineral collections. This year, Junior Education Day will be held on Saturday, October 10.

For further information, call (814) 865-6427.





Ink drawings of minerals in the Steidle Collection. From top to bottom: cleavelandite, garnet, stilbite, pectalite.

THESIS LIST

Spring 1997

A total of 196 degrees were granted by the College of Earth and Mineral Sciences at the University's 1997 Spring Commencement in May: 147 bachelor of science degrees, 49 advanced degrees. Following is a list of the advanced degree recipients and titles of their theses or papers.

Ceramic Science & Engineering - Akira Nakajima, Ph.D., *Low Temperature Liquid Phase Sintering in the Magnesium Aluminosilicate Glass-Alumina System.*

Fuel Science - Mine Gunes Ucak, M.S., *Activated Carbon Preparation by One-Step Steam Pyrolysis/Activation of Furit Stones.*

Geography - Karen Borza Arabas, Ph.D., *Fire and Vegetation Dynamics in the Eastern Serpentine Barrens*; David Lee Barnes, M.S. two-paper option;*Relief Representation: An Historical Perspective*; and *Hypsometric Colors and Hill-Shading for Base Maps*; Stewart Cameron Bruce, M.S., *Space and Society in a Railroad Town: The Making of Renovo, Pennsylvania, 1863-1925*; Michael Hugh Carlin, M.S., *The Production of White and Puerto Rican Identities and Places in Allentown, Pennsylvania*; Elizabeth Dirks Fauerbach, M.S., *Examining Electronic Atlases: A Definition and Case Study*; Robin Michelle Leichenko, Ph.D., *Exports, Employment, and Production: A Causal Assessment for U. S. States*; Shannon Taylor Waldron, M.S., *The Spring Creek Watershed: Grassroots Organization and Local Water Management in Centre County, Pennsylvania.*

Geology - James Curtis Redwine, Ph.D., *Controls on Porosity and Permeability in Fracture-Flow and Conduit-Flow (Karst) Rocks of the Knox Group, Southern Appalachian Fold-and-Thrust Belt, Alabama, USA.*

Geosciences - Yang Chen, Ph.D., *Temperature- and pH-Dependence of Silicate Dissolution Rate at Acid pH*; Arnold Gabriel Doden, Ph.D., *The Geology, Petrology, and Geochemistry of Ultramafic Igneous Rocks from Porcupine Dome and Grassrange, Central Montana*; David Terrell Mc Conaughy, M.S., *Joint Initiation and Propagotion in the Devonian Rocks of the Appalachian Plateau*; Ruth A.J. Robinson, Ph.D., *The Origin and Significance of Grain-Size Trends in Ancient Fluvial Deposit.*

Materiols - Douglas Munroe Beall, Ph.D., *Structure and Surface Chemmistry of Borate and Boroaluminate Glasses*; John Michael Delucca, M.S., *A Characterization Study of an Aluminum-Titanium Electrical Contact to P-Type 6H Silicon Corbide*; Shikik Johnson, M.S., *Vibrational Spectroscopy of Alkaline Earth Aluminate Phosphors with Magnetoplumbite-Type Structure*; Patrick James Leamy, M.S., *Electrophoretic Deposition for Formation of Porous Chemically Bonded Hydroxyapotite Coatings*; Roger Isaac Martin, Ph.D., *Phase Equilibria in the P2O5-CoO-CaF2-NaF-H2O Quinary System and the Formation of Apatite*; Milton Douglas Mathis, Ph.D., *Microwave Synthesis Using Multicomponent and MultiphasicSystems*; Carina Onneby, Ph.D., *XPS Study of Silicon Oxycarbide Formation on SiC Surfaces at Ambient Temperatures*; Manwen Yao, M.S., *A Study on Magnetoplumbite Structure Materials as Potential Substrates for High Tc Superconducting Thin Films*; Katsuhito Yoshida, Ph.D., *Chemical Vapor Deposition of Films in the Boron and Nitragen System.*

Materials Science & Engineering - Darren Robert Bryant, M.S., *Oxidation and Volatilizotion of BN Interphases in SiC Fiber-Reinforced SiC Matrix Composites*; William Cermignani, Jr., Ph.D., *Synthesis, Characterization, and Oxidation of Boron-Doped Carbons*; Sonya Diezhandino, M.S., *Borate Melt Wetting Behavior on Carbon Surfaces*; Lei Gao, M.S., *Characterization of Irreversible Processes at the Li/Poly[bis (2,3-di-(2-methoxyethoxy) propoxy)phosphazene] Interface on Charge Cycling*; Donald Francis Heaney, Ph.D., *The Effect of Photo Illumination on the Corrosion Resistance of Stainless Steels*; John S. Idasetima, M.S., *Damage Evolution of Unidirectional and Multidirectional Carbon Fiber Reinforced Epoxy Matrix Composites*; Seongtae Kwon, Ph.D., *Pressing and Densification of Seeded Boehmite Powder Derived Alumina*; Irina Kriksunov, M.S., *Development of Methods for Assessing the Level of Cathodic Protection in Underground Pipeline Systems*; Ramakrishna Poduri, Ph.D., *Theory and Computer Simulation of the Precipitation of Ordered Intermetallic Compounds in Binary and Ternary Alloys* ; David Earl Romans, Ph.D., *Sorbent Performance in Fluidized-Bed Combustors: The Effect of Calcination on the Sulfation Rate and Calcium Utilization*; Kevin Lewis Rugg, Ph.D., *Mechanical Behavior at High Temperatures of Single Fiber Microcomposites;* Anant Kumar Singh, Ph.D., *Synthesis, Structure, and Surface Chemistry of Silicon Oxycarbide Glasses*; Kristina Alexceevna Skokova, Ph.D., *Selectivity in the Carbon-Oxygen Reaction*; Sapna Halim Talibuddin, Ph.D., *Microstructure of Melt-Miscible Semicrystalline/Amorphous Polymer Blends.*

Meteorology - Joseph John Charney, Jr., Ph.D., *Discrete Frontal Propagation in a Non-Convective Environment*; David Joseph Nicosia, M.S. paper, *Mesoscale Snowbands and Associated Frontogenesis: Case Studies of Three Northeastern Snowstorms*; Perry Craig Shafran, M.S., *Summertime Circulation Patterns in the Lake Michigan Area.*

Mineral Economics - Samuel Nii Addy, Ph.D., *The Mineral Sector and Economic Development in Ghana: An Economy-Wide Study;* Nathan Collamer, M.S., *Essays in: Economics of International Cooperation to MitigateGlobal Climate Change*; Dongsoon Lim, Ph.D., *The Economic Impacts of Globol Warming Policy on the Chinese Economy*; Amit Mor, Ph.D., *Naturol Gas Projects in the Developing World: An Empirical Evaluation of Merits, Obstacles, and Risks*; Jennifer Ann Smead, M.S., *Economic Voluation of Risk Perceptions: Measuring Public Perceptions and Welfare Impacts of Electric Power Facilities.*

Mineral Processing - Udayini Pendyala, M.S., *Stability and Rheology of Coal Water Slurries*; Kemal Yildirim, Ph.D., *An Investigation of Powder Production by Dry Grinding in Tumbling Media Mills.*

Mining Engineering - Leonid Vladimirovich Entov, Ph.D., *Development of a Finite Element Package and Modeling Approach for the Evaluation of Mining Impacts an Groundwater Resources*; Biman Kumar Sadhu, M.S., *Remediation of Acid Mine Drainage (AMD) by Injection of Fly Ash-Lime Grout.*

Summer 1997

A total of 69 degrees were granted by the College of Earth and Mineral Sciences at the University's 1997 Summer Commencement in August: 21 bachelor of science degrees, 48 advanced degrees. Following is a list of the advanced degree recipients and titles of their theses or papers.

Ceramic Science & Engineering -William Neville Howard, Ph.D., *The Influence of Dopants and Impurities on the Nucleation and Growth of Diamond by Chemical Vapor Deposition*; C. Scott Nordahl, Ph.D., *Microstructural Evolutian and Densification of Seeded Transition Aluminas*; James Forrest Tressler, Ph.D., *Capped Ceramic Underwater Sound Projector: The "Cymbal".*

Geography -Jason Michael Allard, M.S., *The Climatic Impacts of Jet Airplane Condensation Trails (Contrails) in the Northeast U.S.*; David Joseph Brown, M.S., *Science vs. Shifting Cultivation in Sri Lanka: A Social Study of Agricultural Science*; Graeme Barton James Burt, M.S., *The Political Ecology of Regional Landscape Change: Linking the Global and Local in Alamos, Mexico, From 1970-1990*; Ansu Anna John, M.S., *Nutrient Management on Pennsylvania Dairy Farms: Deepening the Context of Water Pollution Abatement*; Gareth Edward John, M.S., *George Catlin and the Native American West: A View on a Landscape Spectacle;* Peter Halloran Pascale, M.S., *The Impacts of the Safe Drinking Water Act on Community Water systems and Changes in Drought Vulnerability.*

Geosciences -Karen Lynne Bice, Ph.D., *An Investigation of Early Eocene Deep Water Warmth Using Uncoupled Atmosphere and Ocean General Circulation Models: Model Sensitivity to Geography, Initial Temperatures, Atmospheric Forcing and Continental Runoff*; Recep Cakir, M.S., *GIS-Based Seismic Hazard Assessment Around the City of Izmir in Western Turkey*; Melissa Ann Nugent, M.S., *Temporal Evolution of Feldspar Surfaces During the Initial Stages of In-Situ Weathering*; Nikolaos Tzetos, M.S., *Thermal Modeling of the Lithosphere of the Northern Aegean, Greece.*

Materials - Isaac Robin Abothu, M.S., *Nanocomposite Versus Monophasic Sol-Gel Processing of Electroceramics*; David Peter Cann, Ph.D., *Thermochemical Interactions at Electrode Interfaces in Electroceramic Applications*;Sanjay Chandran, M.S., *Air Acoustic Transducers Using Bending-Mode Actuation*; Anand Thiruvengadathan Krishnan, M.S., *NOx Reducation from Low Temperature Flue Gases Using Ammonia Selective Catalytic Reduction*; Matthew Alan Stough, Ph.D., *Diffusivity and Solid Solubility in an Alumina-Zirconia System.*

Materials Science & Engineering - Andrew Savio D'Souza, Ph.D., *Static SIMS Study of the Chemistry and Hydroxylation Behavior of Amorphous Silica Fracture Surfaces*; Brian Scott Deforce, M.S., *Effect of a Crevice on the Corrosion of Reinforcing Steel in Simulated Concrete Pore Solutions*; Andrei Fyodorovich Kazakov, Ph.D., *Computational Study of the Effect of Pressure on Soot Formation in Laminar Premixed Flames*; Jessel Mark Mc Connie, M.S., *The Effects of Carbon Dioxide on Limestone Dissolutian in a Flue Gas Desulfurization System*; Michael Joseph Morgan, M.S., *An Investigation Into The Effectiveness of Impressed Current Cathodic Protection Under Simulated And Actual Microbiologically Influenced Corrosion (MIC) Conditions*; Miklos Paul Petervary, M.S., *The Effects of Si-O-C Based Coatings on the Properties of Sapphire Fiber*; Venkata Rama Murty Vedula, Ph.D., *Thermal Cycling Behavior of Open Cell Ceramic Foams.*

Meteorology -David John Beberwyk, M.S., *Surface Layer Forced Marine Atmospheric Boundary Layer Convective Eddies*; Joseph Robert Davis, M.S., *Tropical Cyclone Aircraft Reconnaissance: It's Importance and How it Has Added to the Understanding of Tropical Cyclone Structure*: Craig Vincent Gilbert, M.S., *Using the National Weather Service Weather Surveillance Radar-1988 Doppler Network to Detect Non-Precipitating Clouds: An Initial Evaluation*; Daniel Patrick Guertin, M.S., *Potential Vorticity Diagnostics of Observed Tropical Cyclones*; Robert Edward Hart, M.S., *Forecasting Studies Using Hourly Model-Generated Sounding*; Francine Jaskiewicz, M.S., *Tropical Convection and the Hadley Cell in the Western Pacific Basin*; Mandana Mariam Khaiyer, M.S., *The Impacts of Mesascale Dynamics an Cirrus Structure Evaluated Using a High-Resolution Mesoscale Model*; Ruei-Fong Lin, Ph.D., *A Numerical Study of the Evolution of Nocturnal Cirrus by a Two-Dimensional Model with Explicit Microphysics*; Ricardo Carlos Munoz, M.S., *Morning Transition of the Atmospheric Surface Layer*; Giang Tuan Nong, M.S., *Vertical Structure of Convective Wakes in the*

Equatorial Western Pacific during Toga; Matthew Lin Pearce, M.S., *Non-Classic and Weakly Forced Convective Events: A Forecosting Challenge for the Dominant Form of Severe Weather in the Mid-Atlantic Region of the United States*; Aric Nicholas Rogers, M.S., *Chaotic Marine Atmospheric Boundary Layer Structures Isolated and Identified Usinig Statistical and Temporal Analysis Techniques*; Derek Anthony Sovchik, M.S., *Validation of Cirrus Cloud Parameterizations Using Observations*; Robert Travis Williams, Jr. , M.S., *Mesoscale Atmospheric Simulations of Marine-Layer Refractivity in the Southern California Bight.*

Mineral Economics - Hugh Brett Humphreys, Ph.D., *Applications of Garch Models to Energy Commodities*; Narayanan Ramanathan, M.S., *Essays in Energy Economics: Analysis of Changes In Energy Use in India and Interfuel Substitution in U.S. Electric Power Generation*; Christine M. Silver, M.S., *Estimating Cost Structures for Fossil-Fuel-Fired Electric Utilities in the Northeast, East Central, and Mid-Atlantic States.*

Mineral Processing -M.D. Muzayin Alimon, M.S., *Fine Particle Separation by Column Flotation-Role of Entrainment*; Mohamed Fofana, Ph.D., *Evaluation and Design of Magnetic Fluid Separators for Density Separations*; Miriam Paula Leffler, Ph.D., *A Comparative Study of Batch and Continuous Column Flotation of Fine Coal.*

Mining Engineering -Shambhu Sharan, M.S., *Longwall Dust: Quantification of Dust Generated by Shearer and Outby Sources.*

Petroleum & Natural Gas Engineering -Jamil Akili, M.S., *Modeling of Three-Phase Surge Flow for Optimizing Perforation Cleanup*; Eric Neal Gourley, M.S., *Application of a Local Grid Refinement Technique in Modeling Impermeable Barriers.*

Fall 1997

A total of 95 degrees were granted by the College of Earth and Mineral Sciences at the University's 1997 Fall Commencement in December: 54 bachelor of science degrees, 41 advanced degrees. Following is a list of the advanced degree recipients and titles of their theses or papers.

Geography - Juan Manuel Gonzalez, Ph.D., *The Elusiveness of Poverty: Unveiling Concealed Histories of Deprivation in Narino, Colombia*; David D. Rickter Rain, Ph.D., *Eaters of the Dry Season: The Changing Worlds of Circular Labor Migration in Maradi, Niger, West Africa*; Elizabeth Ann Wentz, Ph.D., *An Integrated Approach to Analysis in Geographic Information Systems: A Perspective Derived from a Study on Shape.*

Geosciences - Tucker Drew Burkhart, M.S., *Time-Lapse Seismic Monitoring of the South Timbalier Block 295 Field, Offshore Louisiana*; Anil Deshpande, Ph.D., *Quantitative Characterization and Modeling of Lithologic Heterogeneity*; Timothy Raymond Filley, Ph.D., *The Formation of Organic Sulfides by Reaction of Lipids with Aqueous Sulfides in Three Holocene Sediments*; Andrew Robert Hoover, M.S., *Reservoir and Production Characteristics of the South Timbolier 295 Field, Offshore Louisiona, With Outcrop Analogues and Comparison To 4-D Seismic Results*; Takeshi Kakegawa, Ph.D., *Surfur Isotope Geochemistry of the Archean Sedimentary Rocks*; Rosemary Alice McKenney, Ph.D., *Formation and Maintenance of Hydraulic Habitat Units in Streams of the Ozark Plateaus, Missouri and Arkansas*; Daniel Cailian Pope, M.S., *Thermal-Mechanical Modeling of Andean Orogenesis by Ablative Subduction*; Richard Doyle Sucher, M.S. *Assessment of the Hydrogelogic Regime for the new Enterprise Quarry at Roaring Spring, Pennsylvania.*

Materials - Xuecang Geng, Ph.D., *Numerical Modeling and Experimental Study of Piezocomposite Transducers*; Luz Adriana Camacho Gonzalez, M.S., *Effect of Copper Oxide on the Liquid-Assisted Sintering of o Copper-Silver (CuAg) Alloy*; Weimin Jiang, Ph.D., *Alkali Activated Cementitious Materials: Mechanisms, Microstructure, and Properties*; Xin Lin, MS., *Estimation of Transition Metal-Go-N Ternary Phase Diagrams for the Development of Electrical Contacts to GaN*; Todd Michael Link, M.S., *Failure of Zircalay Clodding Under Severe Loading Conditions*; Mark Patrick McNeal, Ph.D., *The Effects of Grain ond Particle Size on the Microwave Dielectric Properties of Ferroelectric Borium Titanate*; George A. Risch, M.S., *Sinter-Forging of Fine-Grained Barium Titanate.*

Materials Science & Engineering - Rose Maglares B. Filley, M.S., *Molecular Composition and Early Carbonization Chemistry of FCC Decant Oils*; Bruce Carlton Folkedahl, Ph.D., *A Study of the Viscosity of Coal Ash and Slag*; Wanida Janvikul, Ph.D., *Functionalization of Polyolefins via Borane/Oxygen Chemistry: Synthesis and Reaction Mechanism Study*; Andrew Joseph Konop, M.S., *Polyelectrolyte Collapse Induced by Aggregation of Oppositely Charged Surfactants*; Johanna Leigh Lacey, M.S., *Effects of Dopants and Microstructure on the Properties of Lead Zirconate Titanate Thin Films Deposited by Pulsed Laser Deposition*; Honglan Lu, Ph.D., *Synthesis of Reactive Polyolefins via Metallocene Catalysts and Their Further Functionalization Reactions*; Lori Ann Narvett, M.S., *Experimental Evidence For Intramolecular Screening Efffects In Hydrogen Bonded Polymer Blends*; James Matthew Sands, Ph.D., *Determination of Polymer Chain Orientation in Rubbed Polyimide Films*; John D. Zielinski, M.S., *The Effect of Molecular Weight on Intra-Molecular Hydrogen Bonding.*

Metals Science & Engineering - Dana Masami Goto, Ph.D., *Ductile Fracture and Failure Criteria of Hy-100 Steel Weldments.*

Meteorology - Sandra Traci Arthur, M.S., *The Use of Satellite Remote Sensing in Monitoring and Predicting the Effects of Urbanization on the Local Microclimate*; William Benjamin Bray, M.S., *New Methods for the Estimation of Late-Precambrian Atmosphere Oxygen*; Michael David Pontrelli, Jr., M.S., *The Ingredients of a Devastating Terrain-Induced Flash Flood Along the Eastern Slopes of the Central Appalachians: The Modison County, Virginia, Flood of 27 June 1995*; John Joseph Rozbicki, M.S., *Tests of a Convective Wake Parameterization in the Single Column Version of CCM3*; Timothy Sean Sotack, M.S. paper, *Hydrostatic Adjustment of a Thermally Forced Atmosphere.*

Mining Engineering - Pallab Ranjan Chakraborty, Ph.D., *A Virtual-Reality-Based Task Training Model For Mine-Equipment Operation*; Aiping Wang, M.Eng. Paper, *Economic Analysis of Methane Droinage Systems for Underground Mines.*

Petroleum & Natural Gas Engineering - James Paul Ashbaugh, M.S., *Numerical and Analytical Models of Secondary Migration in Faults: Dynamic Controls on Hydrocarbon Column Height*; Zhiyuan Cai, M.S., *Conditional Simulation of Porosity of a Heterogeneous Anisotropic Core*; Nor-Azlan Nordin, Ph.D., *Multiphase Equilibria of PCB-Contaminated Natural Gas Systems*; Anon Punnahitanon, M.S., *The Study of Perforation Damaged Zone Using Viscous Fluid Miscible Displacement and X-Ray Computerized Tomography Imaging Technique.*

Polymer Science & Engineering - Raymond Hu, Ph.D., *Synthesis and Characterization of Boron Containing Carbon Based Materials.*

Solid State Science - Kamau Wa Gachigi, Ph.D., *Electrical Energy Storage in Doped Antiferroelectric-Ferroelectric Phase Switching, Chemically Modified Lead Zirconate Ceramics.*

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Robert Lavin, *Hand Sheet Mill-Modern Sheet Mill*, c. 1960,
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