1  Penn State 1997  
John Dutton

2  Departmental Review  
Materials Science & Engineering  
Richard Tressler  
Geography  
Roger Downs  
Geosciences  
Michael Arthur  
Energy, Environmental & Mineral Economics  
Adam Rose

15  100 years ago

16  Development News  
John Dietz

17  Diversity Enhancement News  
Josie Herrera

19  Museum News  
Andrew Sicree

20  Science News  
Andrea Messer

26  College News

31  The Center for Integrated Regional Assessment

32  Learning Opportunities Break Loose from Classroom Constraints  
Tim Robinson

34  Scholarship Recipients

36  Student News

37  Thesis List

Earth & Mineral Sciences  
Volume 66, No. 1  
1997

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.

Subscriptions to Earth and Mineral Sciences can be obtained without charge by writing to: Editor, Earth and Mineral Sciences, 116 Deike Building, The Pennsylvania State University, University Park, PA 16802.

Editorial Director: John A. Dutton  
Editor: Judith Kiusalaas  
Editorial Assistant: Jennifer Rogers  
Design: Cathy Zangrilli

Cover: At the College’s Open House, John Zielinski (graduate - Polymer Science) demonstrates the Nylon Rope Trick to Kevin Shmihluk (junior - North Penn High School) and his mother, Karen Shmihluk. This was part of the Advanced Materials Demonstration in Steidle Building.

This publication is available in alternative media on request.

The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state or federal authorities. The Pennsylvania State University does not discriminate against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status. Direct all affirmative action inquiries to the Affirmative Action Office, The Pennsylvania State University, 201 Wirtz Building, University Park, PA 16802-2801.
Penn State 1997

We begin our second century and the 66th volume of the Bulletin with a new, more spacious design and a review of our EMS departments. It has been a number of years since we have presented a detailed examination of all the departments, and we believe it is important to provide readers with an overview of the many changes that have taken place. Equally important are the department heads’ discussions of the future and the ideas the faculty have put forward about the trends in their disciplines. These are the ideas which will shape our future.

As the College of Earth and Earth and Mineral Sciences moves into a new century of teaching and research eager to meet new challenges and take advantage of new opportunities, it does so as part of a major university. Penn State is a very different institution from the small, isolated, land-grant college that nurtured the early years of the School of Mines one hundred years ago.

Today Penn State is a huge complex enterprise offering instruction in 24 different locations across the Commonwealth of Pennsylvania, and it is claimed that more than 95% of Pennsylvanians live within 30 minutes of a Penn State campus. These include the flourishing College of Medicine at the Milton S. Hershey Medical Center, the Pennsylvania College of Technology in Williamsport, and the Behrend College in Erie. The University provides more than 190 baccalaureate programs and annually enrolls more than 77,000 undergraduate and graduate students. There are more than 4,200 full-time faculty members.

A recent reorganization of the Commonwealth Campus System brought an increase in graduate programs to some campuses across the state and a sharpening of focus. New relationships are continually being forged between the academic colleges at University Park and the Commonwealth Colleges, such as the innovative cooperation now underway between our Polymer program and the Pennsylvania College of Technology. Meanwhile continuing and distance education is also expanding, offering programming at more than 400 sites across Pennsylvania and involving the creative attention of increasing numbers of faculty members.

The size and complexity of Penn State is reflected in an annual operating budget that in 1996-97 topped $1.68 billion, a mammoth sum which the local newspaper took pleasure in pointing out is approximately the same as the national budget of Peru. Penn State is no longer entirely sustained by the state—the 1996 state appropriation provided only 16.8% of the University’s operating funds, and as a result an increasing proportion must come from tuition, from auxiliary enterprises, and from corporate and alumni support. Penn State’s increase in research has been spectacular: the University is now 10th in the nation in total science and engineering research and development—expenditures of $330.8 million in 1995—and is second nationally after MIT in industrially-sponsored R&D. At the same time Penn State remains an overwhelmingly Pennsylvanian institution. Of the University’s more than 345,000 living alumni, nearly 200,000 live and work in the Commonwealth. One in sixty Pennsylvanians is a Penn State alumnus. Of current students, more than 88% are Pennsylvania residents.

In recent years a number of significant changes have taken place that have affected university operation. The University became a member of the Committee on Institutional Cooperation (CIC), an academic consortium of Big Ten universities and the University of Chicago, when Penn State joined the Big Ten. CIC activities provide a welcome opportunity to share experiences and explore new ideas in education. Then in January, Penn State and the Dickinson School of Law merged, thus closing what many had felt was a major gap in the university’s academic program. Dickinson is located in Carlisle, Pa., and is the oldest of the independent law schools. It was founded in 1834 by a noted jurist, John Reed. Admission to the school’s 530 places is highly competitive—approximately 10% of the school’s current students are Penn State graduates. Among the 5,700 alumni of Dickinson Law School is H. Jesse Arnelle, chair of the Penn State Board of Trustees. Andrew Curtin, governor of Pennsylvania during the Civil War, graduated from Dickinson in 1837.

On the University Park Campus, the Bryce Jordan Center with its 15,000-seat indoor arena has added greatly to the variety of entertainment offered in the Centre Region and given new impetus to the basketball program. A new Paterno Library is being added to Pattee, which will itself undergo considerable renovation, providing improved space for the library’s more than 4 million books and documents. The Campaign for the Library, strongly supported by Head Football Coach Joe Paterno and his wife Sue, raised more than $13 million for the project. The expanded Palmer Museum of Art continues to bring pleasure to visitor and resident alike, and even the Creamery has undergone a facelift in recent years. Meanwhile a master plan for the University Park Campus is now back on the agenda and ideas for extending the campus west across Atherton Street and eastward around the stadiums are being debated.

In sum, these are exciting and stimulating times at Penn State, and in EMS we are delighted to be a part of a vibrant university and contribute in many ways to its strength and renown.

John A. Dutton, Dean of the College
Departmental Review

As the College enters its second century, we asked the Departments to review recent changes in their programs and disciplines. We also asked them to look ahead and tell us what they could see. In this issue we have the response of Materials Science & Engineering, Geography, Geosciences, and Energy, Environmental, & Mineral Economics. In the next issue of the Bulletin we will continue the series with discussion of Mineral Engineering and Meteorology, and some of the College’s research centers.

MATERIALS SCIENCE AND ENGINEERING

Richard E. Tressler

As it celebrates its thirtieth anniversary as an academic department, the Department of Materials Science and Engineering (MatSE) is enjoying a period of high achievement and dramatic change. It is both the largest department overall in the College, with 37 tenure track faculty members, and has the highest research expenditures, with more than $10 million in 1995-96. Supported by close relationships with independent research centers such as the Center for Advanced Materials, the Particulate Materials Center, the Intercollege Materials Research Laboratory, and the Energy Institute, and strong ties with materials programs in other parts of the University, the department conducts a vigorous research program and offers an exceptionally broad range of academic programs.

The Department Today

A number of major organizational changes have taken place in the department over the past few years. They revolved around our decision to unify our academic programs by offering one degree—Materials Science and Engineering—at both the undergraduate and graduate levels instead of separate degree programs in ceramics, metals, polymers, and fuels.

We had many reasons for this structural change. Although the department was formed in 1967, it had still operated academically as four sub-departments until the 1990s, partly because of the historic independence of the units, and because it was argued that this had the advantage of providing obvious focal points for potential students and faculty in these areas. However, materials science has developed a long way in thirty years and there were administrative difficulties in operating that way. With completely separate degree programs and rather rigidly interpreted discipline boundaries, our students were missing the opportunity to become more broadly educated as materials scientists. Furthermore there were gaps in our coverage of major segments of the materials industries—such critical areas as electronic and photonic materials were completely omitted in the old structure. Only two of the degree programs were accredited engineering programs, and fuel science, internationally known for its graduate work and research, had perennial difficulties attracting undergraduate students.

With the new organization, first Metals and now Polymers has been renamed to stress its engineering components in addition to science, an entirely new option has been added in Electronic and Photonic Materials; and the B.S. program in Fuel Science has been replaced by an innovative joint program with the Department of Chemical Engineering. The changes are not quite as sweeping as they sound at first: we still have Programs in Ceramic Science and Engineering, Metals Science and Engineering, Polymer Science and Engineering, Electronic and Photonic Materials, and Fuel Science. As before, each program is administered by a chair, with the exception of the new Electronic and Photonic Materials Program which is currently administered by the chair of Ceramics Dr. David Green. Dr. K. Osseo Asare is the current chair of the Metals program, Dr. Paul Painter chairs the Polymer program, and Dr. Alan Scaroni is chair of Fuels. Faculty members still have strong allegiance to their primary discipline, but there is much greater flexibility and joint responsibility than previously.

Undergraduate Programs

The B.S. degree in Materials Science and Engineering was designed to broaden the scope of student work and to broaden the specialties available. Many more courses are taught to all MatSE undergraduates—specialization is achieved with about 2/3 of a year of courses—somewhat more for the Polymers option with its organic chemistry emphasis, and somewhat less for the Electronic/Photonic option which shares many courses with Ceramics and Metals. The new degree program was adopted in Fall 1995, and the first students are now graduating from the program.

Within the Polymers option, students can choose either a polymer science and engineering study track or a polymer science and technology processing track. The latter was put in place for students who want to follow careers in a manufacturing environment in the plastics industry. They receive two semesters of hands-on fabrication experience using Penn State’s state-of-the-art Plastic Manufacturing Center at Penn College in Williamsport. The Penn College faculty cooperated marvelously in making this offering available to our students. About one-third of our current students in the Polymers option have chosen this track.
As we considered ways to build our strength in Fuel Science, we outlined a concept for a new accredited engineering program in Energy and Environmental Engineering and conducted a mock ABET accreditation visit for the potential program with distinguished external visitors. The feedback and valuable advice we got from these visitors was that the program looked a lot like a chemical engineering program with a strong emphasis on fuels and their usage. Taking this advice, we embarked on a completely new idea—to collaborate with the Department of Chemical Engineering (in the College of Engineering) in offering an Option in Energy and Fuels within their chemical engineering major. The Option incorporates much of the material from our former major, but it is updated and merged with the chemical engineering core. The result is a hybrid that has been well-received by chemical engineering students, with about 10 students per class choosing this option (far more than the fuel science major had in any of the past 20 years). We broke new ground at Penn State with this unusual cross-college cooperation, but we feel it is a win-win situation for all involved.

There was also such demand for polymer courses by the chemical engineering students that we decided recently to also offer a Polymer Engineering Option in the chemical engineering major. The program is new, but indications are that this option for chemical engineers will also be popular, and it will not compete with our own major in any significant way.

Our strategy in the last cycle of engineering accreditation (ABET) was to continue separate accreditation of Ceramic Science and Engineering and Metals Science and Engineering, primarily because of the strong urging by the professional organizations that represent the employment base for these graduates that we do this rather than seeking a blanket MatSE accreditation. As part of that strategy, we also asked for accreditation of the EPM option as a MatSE program. The accreditation evaluation and formal visits were completed in Fall 1996 and all our programs received excellent reports. Thus we expect to receive full six-year accreditation for three options within our MatSE degree. With our recent faculty hiring in Polymers we have emphasized the engineering aspects of the discipline—polymer processing and properties and electronic and photonic applications—so that we can seek engineering ABET accreditation for that option also.

The Graduate Programs

As part of our effort to bring more coherence to our academic programs, we have consolidated all our graduate degrees under one label. We now offer M.S. and Ph.D. degrees in Materials Science and Engineering, with specialization in the four former program areas. Again, many courses are taken in common, but the regimentation is less than at the B.S. level; in fact at the doctoral level neither the exams for candidacy nor the comprehensive exams are uniform in approach and implementation. Nevertheless our objective is to move gradually toward greater uniformity and less confusion for students.

A few years ago, the Intercollege Graduate Program in Materials (formerly the Solid State Science program) was transferred to an office in the College of Engineering, where it is directed by materials scientist Dr. Robert Pangborn, professor of engineering science and mechanics. Our department advocated this move and decided to use the IGPM program for those students in our department who want a broader materials science degree. Since our department offers the IGPM core courses and a majority of the other courses taken by IGPM students, and about half of the IGPM students are advised by our faculty, we have a large stake in the implementation of the program. There are two study tracks: materials science and materials engineering. At the present time the students in Materials Science concentrate on materials synthesis and characterization, often in the broader areas of biomaterials, electronic, and functional materials; students in Materials Engineering tend to be in structural materials processing and properties, including surface engineering and corrosion.

MatSE's Role in the Penn State Materials Research Community

It is common knowledge that the materials research community at Penn State is very large and complex. Some years ago, Penn State Provost John Brighten took steps to ensure that the multifarious efforts in materials would be better coordinated. He established a coordinating body, the Materials Research Institute (MRI), consisting of a Board of Directors and a Director. The Board of Directors is comprised of the heads of the various materials research centers and laboratories around the campus, the department head of MatSE, the director of IGPM, and several at-large members, who are distinguished materials researchers and professors in the various departments. The original director was Penn State's Senior Vice President for Research.

In monthly meetings the Board gradually became better informed about the diverse materials activities on campus and endorsed a plan for new initiatives to be housed in a new materials research building—the MRI Building—in the Penn State Research Park. They also participated in the process of developing an institutional proposal to the NSF-MRSEC program. With this experience as background, the new Vice President for Research Dr. Rodney Erickson asked the MRI "It is both the largest department overall in the College...... and has the highest research expenditures......the department conducts a vigorous research program and offers an exceptionally broad range of academic programs."
MatSE has had a major role in the establishment and operation of many of the interdisciplinary centers and laboratories that comprise Penn State's Materials Research Institute. The largest of these is the Intercollege Materials Research Laboratory (the former MRL). In January 1997, Dr. Gary L. Messing, professor of ceramic science and engineering and director of the Intercollege Particulate Materials Center, took on the additional position of Director of the Intercollege Materials Research Laboratory (IMRL). IMRL has been a highly-successful world-renowned center for research in materials, particularly inorganic nonmetallic materials, and has continued to have an excellent funding base. Dr. Messing will emphasize the broadening of the research themes by attracting current faculty members to participate in IMRL programs, and by adding new faculty members in conjunction with the academic departments. Currently six MatSE tenure-track faculty members have formal appointments at IMRL, and several more participate in IMRL-based research projects.

Under the direction of Dr. Carlo Pantano, the Materials Characterization Laboratory (MCL), formerly the Mineral Constituion Laboratory, has assumed a larger role at the University and provides analytical services to the entire Penn State community. Dr. Pantano has also transferred part of the laboratory into major new facilities in the MRI Building in Research Park. Our department remains the major user of these facilities and supports MCL with cost-sharing on equipment purchases and salary support for technical staff.

The Energy Institute (EI), formerly the Energy and Fuels Research Center, is a College-wide facility directed by Dr. Alan Scaroni, who also chairs the Fuel Science Program. While coal research continues to play an important role in the Energy Institute's activities, the research focus has broadened in recent years to all aspects of fossil and alternative fuels use. The dominant theme in most of the current projects is environmental aspects of fuel use. The Institute has active programs in the production of specialty fuels and chemicals, catalysis, carbon-based materials, advanced combustion technologies, emissions control, and environmental chemistry and geochemistry. Of the 20 faculty members associated with the Institute from EMS and the Eberly College of Science, 12 are from MatSE.

The Center for Advanced Materials, directed by Dr. Digby Macdonald, is a College-wide facility with affiliated faculty from the departments of chemical engineering, mechanical engineering, and engineering science and mechanics, but primarily from MatSE. Under Dr. Macdonald, the areas of emphasis have shifted away from the high-temperature ceramic materials that dominated CAM's early years when it had core funding from GRI. Today CAM's primary focus is corrosion, damage prediction, battery technology, and other applications of electrochemistry.

MatSE faculty members also participate in research projects across campus in such areas as the Electronic Materials Processing Laboratory and the National Nanofabrication Center in MRI Building.

Enrollment Trends

In recent years the department has experienced a decline in enrollment that mirrors the overall decline in engineering enrollments nationwide and also reflects a problem of visibility—high school students who wish to become engineers automatically apply to a college of engineering. The problem is frustrating but we are addressing it vigorously. We have established a strong recruitment program, directed by Dr. John Hellman and Dr. Carlo Pantano, that includes new recruiting materials, extensive mailings, outreach activities by faculty members, an Open House, and a number of initiatives to increase our visibility among engineering students and would-be engineer high school students. The intense activity is beginning to reap rewards and I hope to be able to report increases in enrollment in coming years.

At the graduate level, the recent enrollment history also shows a gradual decline. This is a direct result of funding trends—an overall decline in federal government funding of research in our areas and the trend toward shorter contract periods. The latter leads principal investigators to do their research with post-doctoral researchers rather than graduate students, who require longer-term funding. To reverse this trend we are working with research sponsors in an attempt to forge longer lasting relationships.

In association with our recruiting activities, we have begun an aggressive fund-raising effort to increase the number of scholarships we can offer to potential students and can use to support the students who excel. These efforts have led to several new scholarship endowments in the past five years by individuals (the Anthony J. and Alberta L. Perrotta Scholarship, the Harmon Family Endowment in Metallurgy, the George H. and Madeleine Hager Todd Scholarship, and the Richard E. & Sue Alexander Tressler Centennial Scholarship) and scholarships resulting from the generosity of people honoring former faculty members (the George Brindley/Jung-oock Choe Graduate Fellowship, and the Floyd A. Hummel Scholarship in Ceramic Science and Engineering). Meanwhile, corporate sponsorship is being reborn in the form of a General Motors
Scholarship Program for minorities and a PPG Scholarship for minorities, and the AVX/Kyocera Foundation recently presented a $200,000 gift to endow scholarships in materials science and engineering. We are very grateful for all this support, but confess that the need is still great because Penn State’s costs have increased more rapidly than inflation, so we look forward to continued interest in the program from alumni, friends, and corporations.

Trends in Materials

Materials is an enabling technology. New engineered systems in energy conversion, telecommunications, artificial organs, weapons systems are invariably materials-limited. This means that new materials or processes must be invented for them or the design or anticipated performance is compromised. Many opportunities in R&D manufacturing are created by this situation, yet at the same time an automatic and frequently near-term focus is also assured. Thus in an era of shrinking federal R&D budgets, much of the research focuses on applications and very little truly exploratory and fundamental work is being funded unless a clear path to application is obvious.

Since the label, materials, has inherent and implied relevance, scientists from solid state physicists to condensed matter theorists and organic and inorganic chemists have adopted that label for their endeavors, thus multiplying greatly the numbers of researchers who are seeking support for their materials research. Competition for funds, regardless of the source, has become much more intense in the last ten years, and certainly since the publication of the NRC study Materials Science and Engineering for the 1990s.

The demand for materials scientists and engineers remains robust at all levels, since materials are so important to the U.S. and global economy and to U.S. defense. The role of MatSE departments in universities has evolved to one of an integrating and an interpreting role between the basic sciences and the customer engineering disciplines. The research and instruction will increasingly focus on applications and design of materials for specific functions and systems.

At Penn State our strategic planning has been guided by these forces and the recognition that the following key areas will be areas of growth. We have strength in most of these areas; in others we can be a competitive factor by adding faculty and/or staff.

Key Areas

Computational Materials Science and Engineering

This area includes design of materials at the atomic/molecular level, the microstructural level, and the mesoscopic level—essentially all levels of structure. It includes lifetime prediction incorporating all degradative modes; for structural materials, for example, corrosion, fatigue and creep rupture. The dynamics of materials change via thermally activated processes and stochastic processes are also included. At Penn State we have emphasized this area in recent faculty hiring, and we are interacting with researchers in the Colleges of Science and Engineering to leverage our capabilities.

Energy Generation and Storage

This includes all aspects of fossil fuel storage and conversion; for example, advanced fuel cells, syn-fuel production from natural gas and coal, combined cycle power generation, advanced batteries and supercapacitors; hydrogen and biofuels, and so forth. Penn State is uniquely positioned to capitalize in the these areas with the Fuel Science group in MatSE. In our strategic plan, we are proposing the addition of a natural gas usage specialist to enhance our capabilities in this area.

New Photonic and Magnetic Materials and Structure

Electro-optic and photonic materials and devices will replace electronics in the interest of speed of information processing. New processes and manufacturing systems will be required. New magnetic materials and thin film structures are required for advanced storage systems and new recording equipment. In collaboration with our colleagues in the Colleges of Science and Engineering, we plan to add strength in both of these areas to continue to move Penn State into the upper echelon in these important technical areas.

Materials in Medicine

The realization of artificial organ systems and long-lived prostheses requires new and improved materials. Both soft and hard tissue replacement are being actively pursued, and our department is engaged in several projects collaboratively with Hershey Medical Center and the Department of Bioengineering. This area of materials will experience significant growth and many opportunities will be available to appropriately-trained students. We plan to add a faculty member to bolster our efforts in this area, in collaboration with other units at Penn State, especially the Life Sciences Consortium.

Environmentally-Benign Processing of Materials and Recyclable Reusable Material

Industry is aggressively pursuing these areas because of government regulation and because economic benefits are often discovered beyond the simple market appeal for the products. A new mentality is being promulgated that says that successful new processes will be environmentally benign. Research opportunities abound and employment opportunities for students are plentiful. We plan to replace faculty with specialists in this area and add a new position as opportunities arise.
Smart Materials and Devices
Materials and devices that self-diagnose, self-heal, or change properties as required in use are becoming a reality in research laboratories. Penn State has been a leader in this area, and we intend to maintain that position with faculty replacements and cooperative efforts with the other engineering disciplines.

GEOGRAPHY
Roger Downs

As a scholarly field, the discipline of geography is in better shape than at any time in the past thirty years.

There are several reasons for this assessment. In the popular consciousness, there is greater awareness of the idea and a deeper understanding of the importance of geography than ever before. In pre-college education, geography is recognized as necessary and central to a good education for all students. In terms of geography's icon, the map, interesting printed maps are more readily available and used more than ever before.

Of greater long-term importance to the future of geography, the technology of Geographic Information Systems (GIS) is becoming indispensable to business, government, and academic researchers. And despite skirmishes among emerging "-isms" and "-ologies," academic geography is growing quantitatively and more importantly, achieving greater significance in areas ranging from regional economic policy to global physical systems to visualization.

Turning from the world of geography at large to the world of geography at Penn State, we have equal reason for optimism. The Department of Geography celebrated its 50th anniversary in Fall 1995. That event coincided with the announcement that the department was ranked #1 in the National Research Council's Study of Research-Doctorate Programs in Geography. In the 1982 version of the NRC report, the Department was ranked #2 on one of the NRC's scale and #3 on another.

While we were-and are-gratified by that recognition of achievement, we decided that we needed to do three things: first, to look back to understand why and how that success was achieved; second, to look around at our current activities and operations; and third, and most important, to look forward to the next ten years. We asked ourselves: what must we do to ensure that geography at Penn State remains a program that is respected both nationally and locally?

Looking back was easy because many of us had lived through the period of department building. The institutional growth of geography at Penn State and more particularly, the fostering of excellence has been a steady process built on some key principles. First, the department has sought-and hired-the very best scholars in geography rather than the very best scholars in a narrowly defined part of the discipline. This principle relates directly to a second one: change the department's emphasis to reflect and if possible anticipate emerging strengths in the discipline. The third principle is to encourage faculty to engage in research and teaching beyond the bounds of the discipline. Geography is a springboard to other areas of scholarship.

These principles account for strategic transitions in the department. In the 1960s and 1970s, it was a world center in quantitative and modeling approaches to geography. In the 1970s and early 1980s, it was a center for scholarship in human geography. As of the late 1980s, major structural changes occurred, changes that are the basis of the current ranking and that are the platform for our strategic plans for the next ten years. These changes are the department's participation in the College's Earth System Science Center, the development of a strength in nature-society (or human-environment) relations, the development of geographic information science (the nexus among cartography, geographic information systems, and remote sensing), and the development of the Deasy Geo-Graphics Laboratory. In each case, the department made a decision to invest heavily in terms of faculty, students, teaching, space, and equipment in these areas. The success of those decisions is another reason for the department's current ranking.

Looking back was easy because many of us had lived through the period of department building. The institutional growth of geography at Penn State and more particularly, the fostering of excellence has been a steady process built on some key principles. First, the department has sought-and hired—the very best scholars in geography rather than the very best scholars in a narrowly defined part of the discipline. This principle relates directly to a second one: change the department's emphasis to reflect and if possible anticipate emerging strengths in the discipline. The third principle is to encourage faculty to engage in research and teaching beyond the bounds of the discipline. Geography is a springboard to other areas of scholarship.

These principles account for strategic transitions in the department. In the 1960s and 1970s, it was a world center in quantitative and modeling approaches to geography. In the 1970s and early 1980s, it was a center for scholarship in human geography. As of the late 1980s, major structural changes occurred, changes that are the basis of the current ranking and that are the platform for our strategic plans for the next ten years. These changes are the department's participation in the College's Earth System Science Center, the development of a strength in nature-society (or human-environment) relations, the development of geographic information science (the nexus among cartography, geographic information systems, and remote sensing), and the development of the Deasy Geo-Graphics Laboratory. In each case, the department made a decision to invest heavily in terms of faculty, students, teaching, space, and equipment in these areas. The success of those decisions is another reason for the department's current ranking.

Looking back was easy because many of us had lived through the period of department building. The institutional growth of geography at Penn State and more particularly, the fostering of excellence has been a steady process built on some key principles. First, the department has sought—and hired—the very best scholars in geography rather than the very best scholars in a narrowly defined part of the discipline. This principle relates directly to a second one: change the department's emphasis to reflect and if possible anticipate emerging strengths in the discipline. The third principle is to encourage faculty to engage in research and teaching beyond the bounds of the discipline. Geography is a springboard to other areas of scholarship.
Given this information about the context for geography, three ideas have guided the department's assessment of its current status and shaped our plans for future directions. First, as a college subject, geography is increasingly popular among students and is seen as necessary for understanding the world by employers, policy makers, teachers, and parents. These changes will become significant as more students are exposed to more and better geography throughout the K–12 curriculum. The National Geography Standards and the forthcoming Advanced Placement curriculum and testing program in geography will reshape the image of geography and challenge students to use geography to understand their world. The changes will translate into an increasing role for geography in general education at Penn State and to the likelihood of additional majors, minors, and honors students in geography. It will require significant changes in the scope and sequence of instruction in the department's undergraduate program.

Thus, for example, we have been awarded—and filled—a new position to develop and teach a World Geography course, Geography 40. It will address the global contexts in which world events occur, thus setting economics, demography, culture, politics, and international affairs into their spatial and regional structures. It will do so by taking advantage of educational technologies—smart classrooms, computer-based coursework that offers self-paced individual and collaborative learning. Those educational technologies are at the heart of the pioneering work being done by David DiBiase and the staff of the Department's Deasy Geo-Graphics Laboratory in developing coursework that is computer-based and that draws on new models of pedagogy.

Second, the analysis of employment trends in geography offers crucial data on current and projected enrollment and degree patterns, current labor market demands, and projections of future labor market demands. From these data, we have identified trends that we believe characterize the market facing our graduates in the 21st century. And once again, trends point to a need for significant restructuring of our undergraduate and graduate teaching programs: we need to make better use of internship programs, to foster communication skills in students, and make stronger links among content knowledge, technical sophistication, and problem-solving abilities.

As an example of this restructuring, we have developed a new course, Geography 121, Mapping Our Changing World, that focuses on the production and use of geographic information in the context of social and environmental problems. This course will open the door for students who want to pursue work in cartography, remote sensing, GIS, and global positioning systems. The key is not only its integrated approach but also its use of the World Wide Web and state-of-the-art, computer-based instruction technologies.

Third, the Department must respond to, and take advantage of, the national agenda for geography that is outlined in the National Research Council report, Rediscovering Geography. Based on an extensive program of research and analysis, the report presents a consensus statement of the state of the discipline, its current and potential role in science and society, and things that must be done in order to realize the discipline's potential. Rediscovering Geography identifies critical issues and constraints for the discipline, clarifies priorities for teaching and research, and links developments in geography as a science with national needs for geography education. On these bases, Rediscovering Geography lays out a research agenda that we view as a challenge for reshaping the research, teaching, and service programs of our department.

The agenda sees a discipline that is grappling with the idea of non-linearity, that explores the ramifications of nature–society interactions, that sets its work into a local–to–global continuum, that recognizes the interdependence between places, that develops comparative analyses using longitudinal data, that emphasizes the role of technologies for spatial analysis and visualization, and that fosters geographic literacy through an understanding of geographic expertise.

We strongly support the belief that geography can—and must make significant contributions to science, society, and education. We argue this for two reasons. Rapid technological changes in geography—especially in terms of geographic information science, visualization, and computer-assisted learning resources—present major opportunities for research and teaching. The intellectual strengths of geography as a discipline—its linking of human and physical environment realms, its spanning of the local to global scale continuum, and its ability to translate science into policy—combine with the particular strengths of the University and the College to give the Department of Geography an opportunity to enhance its overall intellectual strength.

So how do we do this? One way is to continue with current research programs. We have a diverse range of work underway. Alan Taylor is working with the government of China on the preservation of bamboo forest stands sufficient to support the giant panda population. Alan MacEachren and Cynthia Brewer are developing ways in which medical researchers at the Centers for Disease Control can use color gradations on maps to understand epidemiological patterns in disease, work that is mirrored in Peter Gould's modeling of the spread of HIV in populations at varying spatial scales in the US. Gregory Knight and a group of colleagues are beginning a multi-year exploration of the regional dimensions...
of global change, involving both climate variability and change and processes of social and economic change as well: to what extent can global change forecasts be adapted to understand regional impacts in places such as the Susquehanna Basin, Bulgaria, and the US-Mexican border region? Amy Glaesmer is working with the Appalachian Regional Commission to explore the differential spatial impact of federal development policies on states and communities throughout the region. That list is but a small illustration of researchers who are exploiting the distinctive insights and perspectives of geography to pursue basic research and policy applications.

But we must also look ahead to new research areas. We must make strategic choices. We must improve and we must be seen as improving our overall quality in terms of research leadership, faculty, and graduate students. We have decided that a key to success is visibility and distinctiveness. We must lead and be seen to lead in areas that are newly emerging in the discipline. We have identified three such areas: visualization, biogeography, and medical geography. They were chosen because they link our own Departmental strengths with those of other units in the University, and they link basic research with social needs in terms of technology and policy. In each case, we believe that a strategic application of resources can leverage the success that we have already demonstrated.

Take the idea of visualization, for example. Visual representations of Earth—its environments and people—are undergoing remarkable changes as a result of new scientific and societal needs for geo-referenced information and rapidly evolving technologies that can manage and manipulate information in innovative ways. Geographic visualization will play a fundamental role in the development of the discipline over the next decade. Geo-referenced information is essential to understanding and problem-solving in domains ranging from ecosystem management to public health monitoring to land use planning to utility system design. The maturation and convergence of technologies supporting the capture, management, analysis, and display of geo-referenced information makes it possible to understand spatial patterns and processes at a variety of spatial scales (global to local) and over a variety of time periods (current and historical, short- and long-term). Given the volumes of data available from direct measurement and from models, the power of the analytic techniques that can be brought to bear on the data, and the complexity of the questions that need to be addressed, there is an increasing need for the development, application, and communication of visualization tools.

Work on visualization is central to geography and it must be central to the Department of Geography. Within a few years, we expect the Department to be the leader in this area. We want to be able to integrate visualization theory and practice into the research, policy, and instructional domains.

If we could imagine what the Department will look like in ten years, then we would see continuity. It will be a program in which research drives teaching and is translated into policy. It will be a Department that continues to be integrated into the College of Earth & Mineral Sciences but that also has built strong bridges to other Colleges such as the College of the Liberal Arts (through collaborative work in environmental history and spatial cognition) or the College of Agriculture (through the work on global to regional relationships) or the College of Medicine (through work on disease diffusion).

We will see change, some predictable, some not. We will have “written the book” on geographic visualization, on the link between technology and pedagogy in the spatial sciences. Over the next two years, we will see a turnover of approximately 35% of the faculty in the Department. But despite those changes, the Department will always be what it has been: a home for good scholarship, for good teaching, and for good colleagues. It will stand for excellence in teaching, innovative and distinctive research, and above all else, a commitment to place and to collegiality.

References


GEOSCIENCES
Michael A. Arthur

Geoscience is an integrative science—the primary discipline for the study of resource extraction (mineral, hydrocarbon, groundwater), geologic hazards (volcanoes, landslides, earthquakes), the scope and rapidity of global and regional change (climate dynamics), and global biodiversity related to earth system history and environmental change. We bring a long time scale and evolutionary perspective to the research and views of other scientists and engineers in the College.

The Department of Geosciences at Penn State is an excellent and steadily improving program, now ranked 12th out of 100 Ph.D.-granting geology departments in the U.S. according to the 1995 National Research Council Survey of research and PhD programs, making Geosciences the second–highest–ranked department at Penn State (after Geography) on a percentile basis. This represents a significant overall rise in perceived quality since the last report a decade ago.

Penn State’s Geosciences faculty have the highest level of grant/contract procurement of any CIC Geoscience Department (CIC Geology Dept. Report, 1995 and 1996), and our faculty are recognized leaders in their fields. As individuals they hold 10 editorships or co–editorships and 23 associate editor or editorial board memberships of major geoscience journals. Geoscience faculty members chair at least 12 national or international policy–making or advisory committees for the earth sciences and are members of about 25 others. They also take part in many interdepartmental programs and initiatives and provide a bridge between earth sciences and other disciplines such as physics, chemistry, biology, agricultural sciences and engineering. Through these interactions the Department promotes its strengths and extends its teaching and research capabilities.

Since 1989–90 the number of applicants for our graduate program has increased, but we have kept our graduate numbers about constant in an effort to improve overall quality and provide support for all students. We have had 92 students in residence in 1996–97. The quality of students has also improved, as reflected in GRE scores and GPAs of admitted graduate students. Virtually all graduates are employed initially in geoscience fields, with highest employment in environmental and hydrogeology firms and the petroleum industry; many Ph.D.s placed as faculty at major educational institutions.

Our undergraduate program is equally strong. Six years ago we completely revamped our undergraduate curriculum to focus on “core education” supplemented by specialty electives. Compared with other programs at Penn State, the demand for Geosciences specialization is considered moderate, but compared with other CIC institutions, our Geosciences program consistently has equal or higher demand. Nationally, we have one of the 5 highest undergraduate major enrollments. In 1996–97, we had 76 undergraduate Geoscience majors and 107 undergraduate Earth Science majors.

The 1989 Gorham Report on Undergraduate Programs ranked Penn State Geosciences 12th in the nation (out of 190 programs). Other indicators of quality and responsiveness include the fact that Geoscience faculty are devoted to innovative and quality education, as indicated by their involvement in initiating CAUSE courses, new Honors courses, the EMS Freshman Seminar, the application of technology in teaching, and the initiation of new General Education courses. Departmental exit polls indicate that graduating seniors highly valued their experience and rated our teaching and advising efforts highly. Between 83 and 90% of our graduates are employed within 6 months of graduation or have continued on to graduate school in their fields.

But what of the future? We view the mission of the Department of Geosciences as being to create new knowledge; to train the next generation of Geoscientists; to train scientifically literate world citizens; and to provide high expertise in service to the university, public and profession. The relative effort we distribute among these categories varies as societal needs change and our careers progress. Below I present a forecast as to where the Department of Geosciences will be heading over the next five years or so. First of all, it will do so under the sage leadership of its newly appointed Department Head, Professor Rudy Slingerland. After 8 years as Head, I am returning to full–time teaching and research.

Demand for New Knowledge

Today most Earth system research is driven by the universities, at least in North America, because industry and government agencies continue to minimize their research role. Note, for example, the recent dismantling of the U.S. Geological Survey and Bureau of Mines and the elimination of many petroleum industry research laboratories. The creation of new knowledge will also depend largely on faculty and students within the major research universities. Research will be limited by funding. The funding of science for science’s sake is beginning to fade as a public interest, and curiosity–driven research, though important, may occupy a diminishing proportion of federal research funding.

The main focus of research will revolve around problems of societal relevance, including the prediction and mitigation of geologic hazards, and problems of water and soil quality. The earth scio-
The Department of Geosciences at Penn State is now ranked 12th out of 100 Ph.D.-granting geology departments making Geosciences the second-highest-ranked department at Penn State (after Geography) on a percentile basis. Geosciences faculty have the highest level of grant/contract procurement of any CIC Geoscience Department. Geosciences faculty members chair at least 12 national or international policy-making or advisory committees for the earth sciences and are members of about 25 others. The Demand for Geoscientists

As of 1989, about half of the 71,000 geoscientists in the United States were employed by the petroleum industry, 14% were in academia, 12% in geoscientific (environmental) consulting, 12% in government agencies, 8% in domestic mining and minerals industry, and 4% in other [Solid-Earth Sciences and Society, National Research Council, 1993]. Employment figures show several boom-and-bust cycles over the last 40 years, related to employment needs in the petroleum and mineral industries, a fact well known to geoscience practitioners. The supply of geoscientists from American colleges and universities closely tracks these trends—our department is no exception, having experienced a low around 1990. A recent counter-trend has its roots in the early 1980s, when environmental legislation created increased demand for hydrogeologists, geophysicists, and low-temperature geochemists—for example, during 1988–89, petroleum-related hiring declined by 33% while hydrogeology and geological engineering increased by 43% [op. cit.]

Predicting future demand for geoscientists is an inexact science at best, but several trends seem clear: demand for hydrogeologists, low-temperature geochemists, and process geomorphologists will exceed other specialties but the growth rate will lessen, as indicated by the number of hirings last year, conjectures in such trade journals as Slayback, Geotimes, and GSA TODAY, and our survey of environmental consulting firms (PCPG Newsletter, August, 1995). Most believe growth in environmental employment will be slow to moderate (GSA TODAY, March, 1995). Interestingly, as profit margins have narrowed, firms have become more interested in geoscientists with terminal bachelor’s degrees because they demand lower salaries.

Successful applicants for jobs in environment-related fields usually possess a strong fundamental science background, with specialized technical knowledge in fluid mechanics, low-temperature aqueous geochemistry, and rock physics (Knight, Professional Geologist, August, 1994). Computer and writing skills also are highly valued. Also, sustained demand for highly-trained professionals (mostly at M.S. level) will continue in environmental geochemistry and hydrogeology. It also seems clear that as jobs shift away from problem definition towards remediation, the demand for geological engineers will grow.

Hiring has also begun again in the petroleum industry, probably because down-sizing in the industry during this cycle is complete. Petroleum-based fuel consumption is rising, and domestic U.S. exploration is steady but with increased interest and activity in high-risk technologically-demanding offshore areas. Overseas exploration is booming. The next 5 years will bring major opportunities for employment at M.S. and B.S. (support) levels. Training in computer technology, seismic processing and interpretation, physical stratigraphy and rock properties for reservoir characterization and related problems will be essential.

On a less optimistic note, excess capacity in the mineral industry suggests demand for exploration geoscientists will remain minor through this decade. Predicted widespread shortages of non–fuel minerals have never materialized because of the success of exploration efforts. World mineral supplies are adequate for the foreseeable future despite increased rates of consumption. Demand for geoscientists in government will also be low because of the downsizing of the USGS mentioned above. The number of faculty positions in academia is expected to remain constant over the next 5–10 years [GSA TODAY].

In education we see an emphasis on multidisciplinary studies and work, together with fundamental science and mathematics training. Computer science and technology (information handling and scientific visualization), numerical modeling and statistical techniques, the interface between geology and engineering, economics and public policy, and microbial dynamics/health science will all be of interest to future earth scientists.

The Demand for an Enlightened Citizenry

In the next century it will be critical for our society to understand the links between human activities and the Earth system. The need for a literate, inquisitive population should not be underrated. Issues of environment, global change, hazard mitigation, and the depletion of natural resources are all Geoscience issues, and we as a community will continue to take the responsibility to work toward a society knowledgeable in these issues. Our educational programs should reflect this need and we should guarantee accessibility to this information.
Opportunities in the Geosciences: Where will the Department Go?

The faculty at Penn State have been pre-eminent in the general field of high-temperature aqueous geochemistry, ore deposit geochemistry and mineralogy-petrology throughout much of the twentieth century. Over the past decade, in combination with the Earth System Science Center, global geochemistry and climate (paleoclimate) dynamics have also become major focuses of excellence. Complementing these strengths, faculty in hydrogeology, geomorphology, and geodynamics/geophysics have continued to build an international reputation for Penn State Geosciences. There is no doubt that substantial changes in research and teaching emphasis have occurred over the past decade, and that evolution will continue. In the past year we have recently hired a process geochemist and are presently searching for faculty in environmental geochemistry and physical hydrogeology in order to replace retiring faculty in these pivotal areas and/or to strengthen our geo-environmental emphasis.

In our strategic planning efforts we have identified two interdisciplinary areas of societal significance, ripe for scientific advance: geodynamics and geofluids. In our planning for future development of faculty expertise we adopt as a model the Earth System Science Center, which serves as an example of ways in which academic excellence can be achieved through topical focus. Earth system science has experienced phenomenal growth and support in EMS and within the Department of Geosciences. This focus is very strong at present, and the faculty in this area, mostly hired over the past 10 years or so, are capable researchers and teachers. They are also strongly collaborative and bridge easily to other departmental foci. Maintenance of earth system science strength in geosciences is of great value, and many of our recommendations will advance earth system science research and teaching in EMS.

Geodynamics, the modern embodiment of plate tectonics, encompasses disciplines and efforts aimed at understanding the processes which shape the Earth. Of primary importance is resolving the fundamental questions of how, where, and why the Earth's lithosphere deforms in both catastrophic (earthquakes, landslides, volcanism) and less damaging modes. The discipline which attempts to answer these questions is called Lithospheric Geodynamics.

The national and international importance of this field has been identified both in the NRC Report (Wylie, 1993) and the actions of the National Science Foundation, NASA, and other agencies. NSF has initiated several new programs within EAR, among them Continental Dynamics (CD) and Active Tectonics (AT). The newest of these programs is the AT program (funded by 'taxes' on all of the EAR program budgets) which focuses on supporting research in problems of plate boundary tectonics, earthquake hazards, and neo-tectonics. NASA has directed its Geodynamics program to focus on issues of natural hazards and neo-tectonics.

This decade and into the next century there is great potential to resolve some of the critical problems of lithospheric geodynamics. Plate tectonics has provided the ground rules, but not the answers. These lie in detailed, multi-disciplinary studies of the processes which produce earthquakes, landslides, volcanism, surface deformation, and other forms of mass wasting.

Fluids in the atmosphere and the surface of the hydrosphere are characterized by large-scale circulation driven by gravity and temperature gradients. In the last century, the rates of movement of these air and surface-water masses have been quantified and the chemistry of the major reservoirs analyzed, although interactions of sediment and biota with surface water remain poorly characterized. Rates of fluid flow and controls on chemistry of fluids deeper in the earth, from as shallow as the vadose zone to as deep as volatiles contained in the mantle, are much more poorly constrained, largely because of the lack of understanding of the impacts of biological systems, the slow rates of flow, the inaccessibility of deep fluids, and, until recently, the lack of tools to sample and date such fluid reservoirs. Fluxes of elements through the biosphere, hydrosphere, and lithosphere thus remain largely unquantified.

These holes in our scientific knowledge have been summarized in the recent publication, Solid-Earth Sciences and Society. In this publication, eight top priority areas for research opportunities are delineated. Of these 8 areas, three are directly and two are indirectly aimed at questions concerning fluids in the earth. Further evidence of the importance of such research questions is manifested in the rapid expansion in membership of the American Geophysical Union in the last decade (present membership, 36,000), especially in atmospheric, hydrologic, and oceanographic sections. Some of this growth represents recognition that, in a world of limited resources and growing human population, water is our most fragile resource. Scientists trained in research concerning the major fluids in the earth's crust thus have the benefit of strong job markets, richly funded research programs, and educational opportunities. The Department of Geosciences therefore proposes to enhance our capabilities in the general area of geofluids, with an emphasis on quantification of rates and mechanisms of flow and on reaction between rocks and fluids in the Earth's upper crust.

In light of the above, the following are anticipated faculty additions over the next 4 to 5 years—bearing

"nationally we have one of the 5 highest [Geoscience] undergraduate major enrollments..."
in mind some possible retirements and departures. Obviously, our objectives could change somewhat as we evaluate impact and development of certain fields: Crustal Imaging; Rheology; Observational Crustal Deformation; Mineralogy of Surfaces; Geomicrobiology; Radiogenic or Cosmogenic isotopes or Hydrothermal Geochemistry; and Environmental Geomorphology.

The Undergraduate Program in Geosciences

We have been actively expanding and improving technology in course offerings, developing new General Education and Diversity course and enhancing our contribution to the Undergraduate Honors curriculum. This effort will undoubtedly continue as the result of planned efforts by our energetic and devoted faculty. A really new initiative, that involves a 5-year B.S./M.S. program, is outlined briefly below.

A great strength of our undergraduate program is the senior thesis. Our experience has been that a significant fraction of our undergraduates can and do perform graduate-level research in their senior year. We feel that the best of these students, with an additional year, could be transforming these projects into master’s theses. We therefore plan to institute a 5-year combined B.S./M.S. program in Geosciences. Interested students would apply to the program in the fall of their sophomore year at Penn State, and exceptionally strong candidates would be considered for admission directly out of high school. Admission requirements would be rigorous, for we feel that only the best of our students would succeed in this ambitious program. These students would be expected to complete all the requirements for the B.S. (except for electives and the senior thesis) by the end of their junior year; the fourth and fifth years would involve research and graduate coursework exclusively.

Professional Masters Program

We have also proposed instituting a new one-year-in-residence professional master’s program in Applied Geosciences. Although the name is decided broad, we will focus our academic program on two initial options for graduate study: environmental hydrosciences and petroleum geology. Students would take a demanding and rigorous course load and existing courses would be supplemented by problem-based courses, developed in response to needs identified with the help of industrial affiliates. The capstone of the professional master’s degree program would be a research portfolio that would include reports of individual and group research projects written during the course of graduate study, and a final report, in thesis form, on the results of the core research project. Over the years, the environmental and petroleum industries have focused their hiring at the B.S. and to some extent at the M.S. level, thus there are thousands of geoscientists with baccalaureate degrees currently employed by industry. We sense a strong interest among these professionals in a program that would allow them to receive advanced training and an advanced degree while continuing their employment. In practical terms, this requires distance education, and we intend to devote a serious effort toward distance learning in the Applied Geosciences professional M.S. degree.

Even with the predicted demise of some proportion of earth science graduate programs in the U.S., the EMS Department of Geosciences looks forward to an exciting and successful future. We do, of course, welcome any comments from our department alumni and friends and thank you all for your generous support of our programs.

ENERGY, ENVIRONMENTAL, AND MINERAL ECONOMICS: RISING TO THE CHALLENGES OF A NEW CENTURY

Adam Rose

A n assessment of recent trends and some reasonable foresight into the future indicates that our department will continue to play a pivotal role in research and training in EMS, the economics profession, and in the private and public sectors. We recently changed our department name to better convey the breadth of our expertise, experience, and potential. Even traditionalists will acknowledge that Mineral Economics covered all the energy and environmental areas. As an issue-driven field, however, it is important to our future to make this more apparent to others so that we can position ourselves to address major challenges in the 21st Century.

Although fears raised during the 1960s and 1970s about exhausting our mineral and energy resources have been put to rest, price volatility continues, and price increases can be expected. Attempts to regulate prices in these industries have typically caused more problems than they have solved, and the reversal to an era of deregulation will take years to work itself out. At the same time, concern has increased about the environmental consequences of mineral/energy extraction, processing, transportation, and end-use. The toxicity of metal pollutants and the greenhouse gases generated from the combustion of fossil fuel have greatly extended the severity and scope of possible damage. The tendency to look toward regulatory solutions may be as misguided here as it was with respect to pricing. In all these respects, the expertise of economists is
indispensable in evaluating the efficient and equitable allocation of resources, especially in identifying incentive, or market-based, policy remedies. Moreover, although there are many academic programs in the U.S. that address minerals, energy, or the environment separately, there are very few that address all these, as well as the interaction between them. New areas such as sustainable economic development and industrial ecology, both emphasize that we can have economic growth without despoiling our environment, and that in fact the quantity and quality of environmental resources are key ingredients in this pursuit.

Our department for decades was known as the leader in Mineral Economics. It was clearly the leader in research and offered pioneering advances in instruction, such as the use of computers in the classroom. The vast majority of the faculty in MnEc departments at other universities were Penn State Ph.D.s, and our M.S. and B.S. students were successful in business, financial institutions, and government. Unfortunately, in some cases just the perception and in other cases an actual narrowness, combined with competition for university budgets and tightening of external funding, caused many of these departments to be disbanded or absorbed into other units.

Our persistent success and clear broadening of focus have helped us to avoid a similar fate. Today, we consider our peer institutions to be not only the Colorado School of Mines Economics Department (itself expanded from a MnE designation), but also the Engineering-Economic Systems Department at Stanford, the University of California–Berkeley Energy Program, the Natural Resources Program at the University of Michigan, and several agricultural economics departments with an emphasis on natural resources and the environment (e.g., Wisconsin, Maryland, and Cornell).

We are steadily ascending to compete favorably with these programs and to stand tall among our sister programs in the EMS, all of which have maintained strong national and international recognition. We are doing so with the complete turnover of our faculty during the past 10 years and with a majority of assistant professors.

Indications of our recent continued success include such awards as: The Penn State Faculty Scholar Medal in the Social Sciences, U.S. Bureau of Mines Outstanding Young Scholar Award, and Outstanding Student Paper Awards from various professional societies. It includes our invited participations in major decision processes, such as the Rio Earth Summit. It is indicated by frequent publications in leading journals in our fields, as well as books by prestigious publishers. In recent years, our external funding increased significantly to the point where we ranked first among social science departments at Penn State in external dollars per faculty full-time teaching equivalent.

This included numerous grants from the National Science Foundation and NSF-sponsored centers, as well as contracts from EPA, DOE, and DOE-sponsored labs. It also includes our major role in a $1.6 million NSF Grant on “Modeling Integrated Regional Assessment of Global Environmental Change.”

Our Graduate Program is as strong as ever. We are able to attract exceptional students in terms of the quality of their credentials upon entering our Program, as well as the quality of theses they take with them to enter the professional world. More of our Ph.D.s are taking academic positions, and those going to industry and financial institutions are commanding near six-figure salaries.

Our major weakness has been our Undergraduate Program in terms of both the number of majors and enrollment of non-majors in our courses. This mirrors somewhat the enrollment declines in economics and business, but runs counter to the healthy increases in the environmental field. We have taken major steps to rectify this situation and to take advantage of latent student demand. This includes the establishment of two options in our undergraduate major, one in the Environment and the other in Business. We also expect that our Department's name change will add to our visibility.

Also, in the past we have been characterized as a “discovery major.” However, as issues pertaining to natural resources and the environment accelerate in importance, we can expect more students to come looking for us fresh out of high school. This is evidenced by an increasing trend in the number of students who come to us earlier in their university education and can be helped along by our involvement in developing teaching materials and having our research widely disseminated to not only professional, but general, audiences so that students are aware of us before coming to Penn State.

We are revamping our undergraduate curriculum. This includes redesigning courses and considering joint teaching and the establishment of course sequences with other departments. Prime candidates are courses in the areas of industrial ecology, environmental valuation, risk assessment, and natural hazard mitigation that overlap with interests in Materials Science, Geosciences, and Geography. Our expertise in economics/statistics can help provide an important input into the Meteorology Department's efforts to determine the dollar value of accurate weather prediction. Our expertise in valuing use and non-use of values of the environment is a nice complement to the traditional valuation of mineral resources in Mineral Engineering. Greatest potential exists in the business area. An increasing number of undergraduate and graduate students in EMS want to start companies of their own or enter a management track earlier in their careers. Our
expertise in Business/Finance, with a special emphasis on the applications of interest to our College, should make our courses the first to be considered.

The above speaks to a greater teaching service role for our Department, but is only one reflection of a more profound aspect of our activities--innovation and research. Examples include:

• A monthly forecasting model of U.S. energy markets (Timothy Considine).
• The analysis of the use of derivatives in Mineral Finance (Ahmet Kocagil).
• Valuation of ecosystems (Jeffrey Lazo).
• Determining the effect of hazardous facility siting on property values (Katherine McClain).
• Implications of deregulation on world energy markets (Richard Gordon).
• The continuing evolution of industrial ecology (Robert Ayres).
• Estimating the regional and national costs of global warming policies for areas ranging from Pennsylvania to China (Adam Rose).
• Quantifying and valuing risk perceptions (Jeffrey Lazo).
• Incentives for commercialization of new clean energy technologies (Ahmet Kocagil).
• Technical change and returns to scale in electric power generation (Timothy Considine).
• Estimating economic losses as a result of natural hazards (Adam Rose).

Not only has this work been carried out and spearheaded by members of the Department, but often in conjunction with major centers within the College and across campus. These include the Earth System Science Center, the Energy Fuels and Research Center, the Environmental Resources Research Institute, and the Center for Integrated Regional Assessment. It also includes affiliations with organizations around the world, including the National Center for Earthquake Engineering Research, National Institute of Building Sciences, and Institute for Economic Analysis and Stanford Energy Modeling Forum in the U.S., as well as those in other countries. Even more important is the re-establishment of our Department's own Center. Richard Gordon's former Center for Energy and Mineral Policy Research has been transformed into the Center for Energy and Environmental Risk Assessment under the able direction of Professor Timothy J. Considine.

We continue to be called upon for our expertise by important government agencies, such as EPA and DOE at the national level and by state and local governments. We continue to advise international organizations such as the U.N. and World Bank. We contribute expertise to professional organizations such as the National Mining Association and the Center for Energy and Economic Development. We continue to advise industry on a limited basis, and thereby lies our greatest potential for future growth. We seek ways to strengthen our ties with companies involved in producing our natural resources and financing these activities, as well as companies involved in accessing andremedying the environmental consequences.

Our Department will continue to be a leader in methodological advances in our fields. This includes research on econometric forecasting, applied demand analysis, computable general equilibrium modeling, option pricing, environmental valuation, risk management, and policy analysis. This work will continue to be integrated into our curriculum, with an emphasis on appropriate applications, so that our graduates will be capable of using the most advanced methods in their future work environments.

We have and will continue to be an issue-driven field, but we may also become a technology-driven one. The efforts of other EMS units in the area of visualization afford numerous opportunities for us. Economics textbooks are often presented in the same dry format of simple line graphs as in the past 100 years, but lend themselves well to other and more modern presentations. This includes the mapping of resources, the networking of trade flows, and the valuation of the environment. Personal computers are now so powerful and easy to use that they lend themselves to teaching students some of the most sophisticated transactions of finance and can be used to enhance participation of students and others in experimental economics. Members of our Department have already been involved in the development of expert systems, such as the National Institute for Building Science software development for earthquake loss estimation. Opportunities abound for similar involvement in environmental valuation and finance.

Internationalization will also help drive future activities in the Department. We are increasingly asked to share our expertise with those around the world. We already have instruction planned on the topic of industrial ecology for presentation in Chile and mining–economic interactions in South Africa. Other opportunities include our involvement in helping establish the course for natural resource allocation in the transitional economies of Eastern Europe and the former Soviet Union and in helping developing countries with joint implementation of greenhouse gas mitigation.

One great indicator of our future potential is a trend that continues in the economics profession as a whole. Standard economics departments, including the one at Penn State, continue to move toward more work in elaborate theory, and have abrogated a great middle ground in applied economics. We are ready to fill this vacuum as future needs and opportunities arise.
Dr. John A. Dutton accepts a check for $200,000 from Richard Rosen, president and CEO of AVX Corporation in Myrtle Beach, S.C. to endow the AVX/Kyocera Foundation Scholarship in Materials Science and Engineering. The funds will assist the Department of Materials Science & Engineering in recruiting undergraduate students and support those already enrolled in the College. AVX is a leading manufacturer of multilayer ceramic capacitors used in the telecommunications and electronics industries.

**100 Years Ago ...**
from The Mining Bulletin, Volume III, No. 2, March 1897

**SUMMER SCHOOL**

"The fourth summer school of the students in the course in Mining Engineering will this year be held in the Schuylkill Valley region of the anthracite coal fields. The members of the Sophomore and Junior years together with a few volunteers of the graduating class will leave State College on Thursday, June 17th, making their first stop at Shamokin, Lyndhurst Hotel, remaining till Monday morning, June 21st, meanwhile visiting the Henry Clay colliery which is one of the largest owned by the Philadelphia and Reading Coal and Iron Co. The breaker at this mine is a large one and prepares the coal from the several openings in the vicinity. At the Excelsior Coal Co.'s colliery the electric installation will be examined. On Monday the party will visit the Alaska shaft which is fitted with air locomotives for underground haulage.

The next stop will be at Ashland where the Potts colliery of the P. & R. C. & I Co., will give the students a clear idea of the method of mining gaseous coal on steep pitching seams. The construction of dams for isolating portions of the mine from the work will be noted here. The several forms of day lamps and safety lamps are here used. The Goyne pump works will have given permission for the inspection of a large compound, duplex pump dissected ready for shipment.

Shenandoah will be the next headquarters of the party until the following morning. The Indian Ridge mine and the Plank Ridge jig house will be visited and the operations of robbing pillars and of filling excavations with culm ('called slushing') will be noted as will also the mode of hoisting from the surface through an underground shaft.

At the Plank Ridge washery the students will have an opportunity to witness the recovery of the small sizes of coal from the old culm, heaps of which so much has been written. The Maple Hill colliery, which is not only the largest but the finest equipped mine in the region, will be accorded the next day, while on Friday and Saturday the class will have opportunity to "plumb" the Indian Ridge shaft and extend the lines underground. On Monday morning the party will take a trip through the Mahanoy valley and visit the Gilberton shaft which is being sunk for the purpose of draining the Gilberton and Draper mines and may reach a depth of something near to 1000 feet. The class will witness the method of stripping coal at the Boston Run Colliery.

Thence the class will proceed down the beautiful valley of the Lehigh and visit the Bethlehem works of the Bethlehem Iron and Steel Co., and the great pump the "President" and other machinery at the Friedensville zinc mines, in Lehigh county, where the party will disband."
Author James Gregory Lord observed that "one of the great strengths of free society is the availability of choice. Nowhere is this principle demonstrated so clearly as in our philanthropic organizations -- where people freely choose to devote their own time, talents and resources to enhancing the quality of our lives."

As I conclude my first year as the Director of Development for the College of Earth and Mineral Sciences, I am greatly encouraged by the fact that so many of you demonstrated your interest in enhancing the lives of EMS students and faculty by deciding to devote your time, talents and resources to support the College's various programs and departments. Your personal involvement and philanthropic gifts enhance the teaching, research and service missions of the College by allowing us to continue to pursue initiatives and values that define EMS.

As we look forward to the next century, the College faces many challenges, including how we might continue to improve ourselves in an era of fiscal restraint and uncertainty. A partial answer to this challenge is to increase our attention on fund raising activities.

Many of you may know by now that Penn State (and EMS) is preparing for a major fund raising campaign. Building on the momentum of the successful campaign that concluded in 1990, Dean Dutton and his colleagues began planning for step two: a campaign focused on raising endowments to provide dedicated funds to support academic programs and related initiatives. The Dean reasoned that if Penn State is to remain strong, it is imperative that we develop permanent sources of revenue that are not subject to legislative actions or economic uncertainty.

We have an exciting array of faculty and students in EMS. The variety of research and academic interests in the College has attracted talented and individualistic faculty and students from around the world. Because of this, the focus of EMS fund raising activities during the campaign will be on our overwhelming commitment to these people -- students and faculty -- primarily through the creation of endowed funds. Our purpose will be to attract and reward talent and create additional opportunity and access. In short, the campaign is about people -- people who make a difference during their stay in the College.

It is essential that students, faculty and programs that contribute so directly to our growth and vitality be strongly supported. The creation of endowment funds in these critical areas will be a top priority. Endowment is important because it provides financial sustenance year after year. Endowment brings permanence to the institution and its programs. It means stability in times of economic uncertainty and diminishing government funding and it creates the flexibility to pursue initiatives that define the College, setting it apart from its peers. This coming year, the College will focus on creating funds that support undergraduate student scholarships, graduate fellowships, faculty positions, and programs that improve our ability to educate our students.

This past year has given me the opportunity to talk to a number of alumni and friends who have achieved great personal and professional success in their lives. One such alumnus is Frederick C. Langenberg ('55 Ph.D. Metall.). Fred has a real love for the College and encourages us to always strive to be the best. He sets high standards for himself and he encourages us to do the same. He often talks about "raising the bar" in EMS. Most of the time Fred is talking about making faculty and students "stretch," but lately I've taken his comments to apply to our alumni as well.

The current fiscal year (which ends June 30, 1997) has been a "stretch year" for EMS alumni in terms of giving. Contributions, both in number of gifts and total dollars given to the College, will be the highest ever. These gifts will have a broad-based and long-term impact on the College since many were earmarked for the EMS Centennial Education Fund and other endowed funds.

Faculty and staff were also frequent and substantial donors, as seen in the EMS Centennial Staff Scholarship. Also, eleven (of 29) new inductees into the Obelisk Society, the College's leadership gift society, were current or retired faculty members. It means a great deal when faculty believe so strongly in the College that they are willing to provide their personal philanthropic support in such a major way.

As we seek to raise the bar in the EMS development efforts, we are going to make a few changes in our two primary recognition organizations -- the Dean's List and the Obelisk Society. In the past, annual contributions of $500 or more placed a donor on the Dean's List. After much discussion, we decided to raise the level for the Dean's List to $1,000 for the next fiscal year (beginning July 1997). Annual donors are the lifeblood of the College and we encourage all EMS alumni to continue to support us on an annual basis.

Membership in the Obelisk Society has been conferred on those who have given a total of $10,000 to the College during their lifetime. The Obelisk Society celebrates a group of distinguished alumni and friends whose loyalty and dedicated support inspire and strengthen the College. Through their generosity, the College maintains a focus on talent, on excellence, and on the remarkable achievements of all members of the College community. Effective July 1, 1997, the level for membership in the Obelisk Society will increase to $25,000.

Dean Dutton has observed that "If the College is to continue to flourish, we will increasingly depend on the vision and commitment of alumni. As public funds for higher education continue to decrease, the future of higher education depends on the educated, on those who benefited in their own education from the investments made by others."

We believe the campaign for the College of Earth and Mineral Sciences, and the larger campaign for Penn State, allows alumni and friends to contribute to the continued achievement of the College.

Your support has been refreshing and I am very excited about the positive impact that your gifts have had on the College. As you contemplate your own interest in investing in the College, you should know that I would be delighted to talk to you about your plans.
The College of Earth and Mineral Sciences recognizes that diversity includes appreciation and respect for differences in race and ethnicity, in gender and sexual orientation, in age and life experience, in nationality and language and in physical capabilities' (EMS Diversity Plan, 1995). This college has always had a highly diversified environment with students and faculty from every part of the world, but EMS was slow to recognize the need to provide resources and support systems to ensure that women and traditional American minorities (African/American/Blacks, Hispanics and Native/Americans) would be successful. The Diversity Enhancement Program has now been entrusted with that mission.

I am a product of this College. I graduated with an M.S. in earth sciences in 1993. I taught in the Department of Environmental Sciences at the DuBois Campus for three years. For the past year and a half, I have been the Director of the EMS Diversity Enhancement Programs. I am also Hispanic/American and as such, I have shared the experience of other women and students of color. I had a sense of isolation because I was the only person of color or the only woman in most of my classes. There were not enough students of color with whom I could identify. There were no faculty of color for me to look up to or model myself after. Therefore, I took this position in hopes of improving the situation.

Broadened Goals and Objectives

When I was offered the position in January of 1996, I took responsibility not only for minority students, but also embraced the small number of women and adult learners who were part of the EMS community.

The EMS Diversity Plan was re-written to incorporate new goals. Existing programs were detailed, accomplishments were identified, and actions needed to support future achievements were outlined. My emphasis was on meeting with students to determine their concerns, to inform them of existing programs and to help them understand and evaluate curriculum choices in order to graduate.

Attracting and Retaining Students of Color

The College of Earth and Mineral Sciences has had difficulty attracting and retaining students of color. From students I found that we were not marketing EMS programs effectively to potential students. We also were not retaining the few students of color who did enroll. My experiences led me to believe that this was an issue of climate. If students feel isolated and unsure of their status, they shy away from services that could help them succeed. Thus, one of the first things I did was to have an open house at the Museum to meet the underrepresented students and to have them meet College leaders. Several faculty and staff joined us. I took the opportunity to familiarize the students with some of the services available to them in the College.

I then began to hold focus group lunches with students to talk about issues. I wanted to get an idea of what they thought might be a way to improve the climate for students of color. Students commented that increasing the numbers of minority students and continuing to meet with each other and interact together would start to make things better—they would not feel so alone and isolated. I began sending them important information about our programs, scholarships, internships and anything that could benefit them. I gave them valuable information regarding available support systems in the College and in their field of study. When Spring 1996 semester ended, most knew each other and felt comfortable being together. Most of all, they knew what was there for them. This was probably the biggest step we needed to take. Several of these students are now good friends, and I have a constant flow of students communicating with my office.

Accomplished Goals

Other successes are evident this year. In Fall 1996, I recruited three outstanding freshmen. These students were immediately paired with an upper division or a graduate student who would be in charge of making their transition into the College a positive one. Two of those students, Stefan Williams and Sean Miner, made the Dean's List in Fall 1996 and again in Spring 1996. I
will continue to assign peer mentors to the new freshmen this fall.

By the conclusion of Spring semester of 1997, 24 undergraduate minority students were enrolled. We have increased our enrollment primarily through students who have transferred into the College after having been in the University a semester or two. Our EMS students of color now "sell" our programs by proclaiming their high level of satisfaction to their friends. Our new aggressive marketing has increased awareness of our programs.

The expected result of our recruitment and retention effort is that students will graduate on time. In May, four students of color graduated: James Baca, graduated with distinction and Christopher Castro graduated with highest distinction.

Attracting and Retaining Women

Since 1988, we have witnessed a steady increase in the enrollment of undergraduate women in EMS programs (from 120 in 1988 to 253 in 1996). Building on the successes of the Diversity Enhancement Programs, I focused on finding ways to help these women in the College. Again, I established email communication with them and provided them with important information on opportunities available to them. Their response was overwhelmingly positive: most women—graduate and undergraduate—were pleased that the College was taking an interest in helping them as a group.

I then surveyed the women in the College for their opinions about the need for a mentoring program. Most agreed it would be beneficial and felt that such a program should be a high priority for the College.

Program Visibility

My tenure as director of Diversity Enhancement Programs has been marked by a flurry of activity directed towards accomplishing the College's diversity goals and objectives. We have seen the revival of pre-existing programs and the creation of new ones. Hence, EMS now boasts one of the most progressive and effective diversity initiatives in the University.

Today, we have a total of 38 minority students, graduates and undergraduates. This fall, five students of color, three Hispanics and two African/Americans, will enter as freshmen.

To make our program more visible, I have visited high schools and spoken with guidance counselors, teachers and students. Just recently I traveled to Philadelphia and started to establish relationships with potential feeder schools for EMS environmental programs. I have also sent program information to about 600 public schools in the surrounding states of Maryland, Delaware, Ohio, New York and New Jersey.

I have attended the national conventions of minority professional associations such as the National Society of Black Engineers, the Society of Hispanic Professional Engineers and the National Hispanic Sustainable Energy and Environmental Conference. At these, I have made innumerable contacts with industry representatives. I have provided them with EMS program information. I have apprised them of the skills with which our students graduate, and how they can be effective employees who would enhance their work places.

To make EMS diversity efforts more visible in the University community I have joined a number of university groups. Last year, I was appointed by President Spanier to the Commission for Women, and headed a subcommittee to look at mentoring programs for women. I was appointed by Vice-Provost Jim Stewart to the Commission on Lesbian, Gay and Equity. I was also appointed to the executive board of the WISE Institute by Dean John Dutton. As a result, I helped to select the scholars and fellows for the Claire Boothe–Luce Foundation Scholarships and Fellowships. I also became the liaison to the Engineering Co-op Program and helped recruit students for internships and co-ops from our College.

More recently I revived our connection with the Eastman Kodak: Business Engineering Science and Technology Summer Scholars Program, and this summer we will have an opportunity to present EMS programs to twenty-four students and potential undergraduates from New York and Pennsylvania.

This connection with the University at large has allowed me to demonstrate the College's commitment to diversity issues and support for university-wide efforts.

Involving Alumni

In order to make the programs more visible to potential students and financial donors to the programs, we have created a web page that can be found within the Student Center site at: http://www.ems.psu.edu. Here we have detailed several of the activities we have initiated and others that we would like to start. I am sure that as we continue to be visible, we will recruit more people who believe in the mission and vision of the Diversity Enhancement Programs.

Some of our objectives include: recruiting students who will bring excellence and diversity to the College; helping students to achieve their goals; helping the College to achieve its diversity goals; assisting job placements. We have begun to work with GEMS to help us achieve these goals. Anyone who is interested in becoming a mentor or who would like to contribute to our efforts in any way, please contact me. Our students could use your help!

Josie B. Herrera, 25 Deike Bldg
Phone: 814–863–2751, Fax: 814–863–7708
Email: jbh3@psu.edu
Western Mining Artworks Donated by Colorado Artist

Well-known Colorado artist Pat Patterson recently donated five of his original artworks, four pen-and-inks and one watercolor, to the College of Earth & Mineral Sciences Museum. Mr. Patterson has been painting and sketching Colorado scenes for over thirty years. His works include scenes of historic Western mining operations, particularly the mine head frames and gold mills which can be found scattered throughout the Colorado Rocky Mountains.

An Illinois native and a graduate of the Chicago Academy of Fine Arts, Mr. Patterson served as an artist with the U.S. Navy during World War II. He worked as art director for a printing firm in Seattle after the war, then moved to Denver where he has done advertising and fashion art, book illustrations, store and office designs, and well as his work hangs in private and corporate collections throughout the United States and in France, Canada, and Germany, as well.

Mr. Patterson’s donation consisted of a water color and a pen-and-ink drawing of the Red Elephant Mill near Lawson, Colorado and pen-and-ink drawings of the Golden Cycle Mines in Victor, the Argo Mill in Idaho Springs, and the Mollie Kathleen Gold Mine in Cripple Creek, Colorado. Mr. Patterson also donated reproductions of a number of his other mining works, including scenes of the Pozo Mine in Russellville, the National Mine and Central City/Coeur d’Alene Mine both in Central City, the Crystal Mill, Gunnison County, and the famous Matchless Mine in Leadville, Colorado.

Pat Patterson’s donation is a much-appreciated new addition to the mining and mineral industries art collection built up by Dean Edward Steidle. Western mining art is a weak point in the Steidle Collection but, with the help of friends like Mr. Patterson, it is an area we are improving upon.
Science News

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

DIXIE MAY NOT RISE AGAIN

According to Dr. Amy K. Glasmeier, professor of geography and the John D. Whisman Appalachian Regional Scholar, countries like Mexico that look at the amazing rise of commerce and industrialization in the rural American South for guidance, may benefit from looking at the realities rather than the rhetoric. “The so-called free market approach of the South has been recommended as a development model for other developing regions and countries,” she says. “However, government policies in the South—particularly infrastructure investments and trade protection—played a key role in the South’s transformation.” This transformation began after World War I and reached its peak in the late 1970s. The conversion from rural farm to rural industrialized society was not without its consequences and was certainly not achieved in a laissez-faire, free-market climate. The South embraced certain aspects of the New Deal programs of the 1930s, particularly infrastructure, but explicitly rejected the social aims. The combination of roads, military installations, trade protection and the large influence of the Tennessee Valley Authority helped to bring the South near to the economic level of the rest of the country. “One agency, the Appalachian Regional Commission, has spent $5 billion on roads since the 1960s,” says Glasmeier.

In the course of industrializing the economy, the social structure remained backward. “Developing areas need to make significant decisions and choices,” Glasmeier told attendees at the annual meeting of the American Association for the Advancement of Science in Seattle. “The approach must be deliberate. Governments can’t just pour money into regional economies and expect beneficial results to filter down to those who need it.”

Using the example of the South, it seems clear that strong, stable, national macroeconomic policies are necessary for successful regional policies, says Glasmeier. All areas cannot be treated identically. Natural and human resources must be considered when deciding where the federal government can improve the situation and where it cannot.

The overall statistics for the South imply that the South’s convergence on national economic norms has benefited all the region’s residents. However, inequitable social conditions, especially in respect to rural minorities, means that high levels of inequality have persisted over time. According to Glasmeier, poverty rates for Black/African Americans in the South are three times those for Whites, the South continues to spend less per pupil on public education than other U.S. regions, and the share of Black southerners completing less than a high school education appears to have increased relative to the national average. The South spurred development regulation. These same lures became local milestones. Businesses expecting low tax structures balked at increased taxes for education. Unskilled, low wage workers are not prepared to meet the demands of today’s global market.

“Major efforts to enhance the human capital component of the region are increasing,” says Glasmeier. “But, changing the quality of the skills in a region is a long-run process that takes considerable resources, commitment and, most of all, patience.” One consequence of investing in human capital is that the most qualified people will leave for better jobs. In the rural South, this outmigration was to Northern cities. “Only after substantial investment was made in the region’s physical assets did skilled workers return to the area,” says Glasmeier. “If you build a road from Merida to Mexico City, you must be certain that the people in Merida can benefit from the opening of the road. If they are educated and highly skilled, rural people will move to Mexico City for higher wages.”

Professor Glasmeier suggests that any development policy must consider a region’s resources. She warns that programs on a national level probably will not be sensitive to local particularities. Once the myth of regional development without an infusion of federal money, expertise and preferentiality is laid to rest, developing areas can learn much from the commercialization of the rural South and from the mistakes that were made.

MONSOONS OF ARABIAN SEA CONTROL PRODUCTIVITY AND CARBON EXPORT

Speaking at the Fall meeting of the American Geophysical Union, Dr. Raymond Najjar, assistant professor of meteorology said that investigation of the oxygen and nutrient content of the Arabian Sea could help shed light on how monsoons influence ocean productivity and the carbon cycle.

“The monsoons of the Arabian Sea create peculiar ocean currents in the area,” he explains. In the summer, the monsoon blows from the southwest up the Arabian Sea toward Pakistan. Because of a combination of wind and the Earth’s rotation, the summer monsoon pushes water away from the Somali coast and the eastern edge of the Arabian peninsula. The water that leaves these coastal areas is replaced by water that wells up from depths and is very high in nutrients. In the winter, the monsoon reverses and blows from the northeast.

“This monsoon does not have as much impact because it pushes water toward the Arabian Peninsula resulting in downwelling, not up-welling,” says Najjar. “However, the strong winds cause turbulent mixing, which brings up some nutrients, but not on the scale of the summer monsoon.” He adds, “The productivity of the Arabian Sea increases dramatically with an increase in nitrate. This productivity is in the form of tiny plankton, which are the lowest link in the ocean’s food chain.”

Najjar is using data compiled by the National Oceanographic Data Center since 1990, to assess the average nutrient content of Arabian Sea surface waters on a monthly basis throughout the year. The annual cycle is distinct: from June through August, there is a huge burst of nutrients in the area, especially off the Arabian coast, and in January and February there is a lesser, but still noticeable, increase in nutrients. In summer, the nitrate levels rise, as do nitrite levels, but the latter are somewhat more complicated to analyze, according to Najjar. The phosphate levels follow nitrate, but silicate shows no regular pattern. The ocean temperature goes down, even though it is sum-
mer, because the water coming up from the depth is much colder than the surface water. Water high in nutrients is usually low in oxygen, and so the surface water contains less oxygen than expected from equilibrium with the atmosphere. Summer fishing in the Arabian Sea has long been a productive and economical pursuit, Najjar; however, is not interested in fishing, but in understanding the role that the ocean plays in the climate system, especially in regulating the amounts of carbon dioxide—a greenhouse gas—in the atmosphere.

When nitrate increases productivity, the tiny organisms convert carbon dioxide in surface waters to organic forms of carbon. Some of this carbon leaves the surface layer of the ocean where it could once again become carbon dioxide and is stored in the deeper layers of the ocean. "For every nitrate molecule removed, there are about eight carbon dioxide molecules removed or exported from surface waters," says Najjar. "This removal of carbon from surface waters causes atmospheric carbon dioxide to be lower than it would otherwise be. By estimating the average decrease in nitrate after the summer monsoon, we can estimate the role that this area of the ocean plays in carbon export and atmospheric carbon dioxide regulation."

RIVER SEDIMENT MAY HOLD KEY TO LAND USE PATTERNS

A record of rainfall, river flow, land use and human migration may be stacked away in the sediments at river mouths, according to researchers from the Earth System Science Center. "We are looking at the Susquehanna River Basin and will be looking at sediment cores taken from the Upper Chesapeake Bay to determine the connection between sedimentation patterns at the river's mouth, land use patterns in the basin and climate variability," says Dr. Ana P. Barros, assistant professor of civil engineering.

The researchers have not yet taken sediment cores at the mouth of the Susquehanna—work begins this summer, but they have pieced together the climate and land use data. They have also tested their hypothesis against an inventory of previous field studies in the estuary. Barros; Sara J. Gordon, graduate student in geosciences; and Rebecca Bidwell, an undergraduate Women in Engineering and Science Research intern, have combined historic flood and precipitation data with basin geology and changing historical land use patterns to create a database that reflects the effects of people and climate. The researchers presented their geographic-information-system-based basin-scale assessment of land use and climate variability covering 1850 to the present at the spring meeting of the American Geophysical Union in Baltimore.

Some of the factors considered in the model are farming, human migration, streamflow, rainfall, soil type, economics, land cover and land use. The researchers believe they can determine the sediment that was put down through time by understanding the location of the expected sediment source and the expected amounts of sediment. "Certainly we should be able to see the major cycles of variability in the climate and erosion regimes in the basin," says Barros. "Such things as prolonged drought or exceptionally wet weather that caused flooding should be evident."

Historic climate data are not continuous or totally accurate. While there is 100 years of good streamflow data and in some places 80 years of rainfall data, in other places there are only 40 or 50 years worth or even less. By looking at the sediment, the researchers hope to link core layers with climate and sedimentary regimes and fill in the missing pieces. To do this, the core layers will need to be dated. The researchers plan to use lead isotope ratios to determine when the sediment layers were laid down. Pollen included in the sediment can also help with dating. "This type of dating has been done before by Grace Brush, so we are confident that it can be done," says Barros. The composition of the sediment layers, including pollen, trace metals and even mine tailings could lead back to the source. If large amounts of sediment can be shown to come from one area of the basin during a specific time period, then that information can be correlated with the rainfall and streamflow data to see if large amounts of sediment were expected from that area at that time.

By linking land use patterns and expected erosion rates, the effects of farming, rail and road construction and other human uses can be assessed and checked in the sediment cores. In this way, the Penn State researchers can attain a better understanding of the interactions between human agency, climate and landscape evolution.

EARTHQUAKES ILLUMINATE MANTLE UNDER TIBET

A new way of looking at seismic waves recorded at monitoring stations in Tibet can shed light on the structure of the mantle beneath this immense plateau, according to a Penn State researcher. "Tibet is interesting because of its high elevation and because there, the Indian and Asian continents meet and form the Himalayas," says Dr. Kevin P. Furlong, professor of geosciences. "This makes it a very important site to study the role of plate tectonics in the evolution of continents. "We tend to know very little about the deformation beneath the crust. If we have some insight into how the crust and mantle deforms where continents collide, we can better model these collisions."

Previous research looked at averaged events and found a nearly uniform orientation of the mantle rock in an east-northeastern direction. However, the assumption has been that the mantle rock is horizontal, and the only orientation directions are considered two-dimensional, according to Furlong. "When we look at the individual rather than averaged events, we find that each station shows a different orientation pattern, which implies that the mantle rock is not horizontal, but oriented in three dimensions," Furlong told attendees at the fall meeting of the American Geophysical Union Conference in San Francisco. "The rock is not just oriented by cardinal direction, but is also tilted."

Furlong is trying to determine the orientation of olivine in the mantle beneath Tibet. Olivine, the principal mineral in the upper mantle, is a mineral composed of magnesium, iron and silica, and is anisotropic. Anisotropic materials exhibit different physical properties depending on direction. For example, the direction in which seismic wavetravel through the material. In this case, seismic p waves travel faster in one direction than in the other, and seismic s waves split into two polarized components which travel at different speeds. The difference between the arrival times of the fast and slow s waves and the polarization directions are caused by the distance traveled and the effect of anisotropy. "In simple areas of the Earth, the anisotropy found in olivine is unimportant because the minerals
crystals are oriented at random and the s wave times average out,” says Furlong. “However, in highly deformed areas, this deformation provides directionality and a fabric in the rocks becomes apparent. If we can read this fabric, we can use it as a proxy for how the rocks deformed.”

Working with Thomas J. Owens of the University of South Carolina, Furlong looked at individual seismic events that occurred in the southwestern Pacific and western North America but were recorded at one of the 11 monitoring stations in Tibet. “These seismic events are the proper distance from Tibet so that the seismic wave must go through the Earth’s core before it arrives in the mantle beneath Tibet,” says Furlong. By going through the molten core, the original s wave is converted to a p wave and then changes back into an s wave when it re-enters solid mantle. “By going through the core, we know we have a nice wave form to begin with,” says Furlong. “Then we can evaluate the effects of the deformed mantle localized beneath Tibet.” These effects include identification of three distinctly different patterns in the seismic data, which theoretically imply three different directions of deformation of the olivine in the mantle beneath different parts of Tibet. The patterns are similar when comparing stations in the northern, middle or southern parts of the areas, but differ from area to area.

In the region of Tibet sampled by the seismic transect, there appears to be a systematic pattern, although it is not yet certain that this pattern of mantle deformation extends throughout Tibet. However, theoretically, the olivine fabric should relate to the forces that existed during collision and the actual deformation of the mantle rock. “In theory, we should be able to look at the orientation of the fast and slow paths in the olivine and determine the direction and amount of inclination of the rock,” says Furlong. “In practice, we are combining the information we have on the mantle fabric with models of rock deformation to determine the plate tectonic processes which have led to the development of the Himalayan and Tibetan Plateau.”

OCEAN CIRCULATION, NOT PLANETARY CYCLES MODERATING GREENLAND TEMPERATURES

Contrary to popular expectations, Greenland was cooling during the few thousand years before this century, and surprisingly, the winters were cooling more than the summers, according to a Penn State researcher. Accepted theory holds that variations in the earth’s orbit, the wobbles and wiggles over thousands of years, control a good portion of the seasonal warming and cooling of the planet. These cycles—called Milankovitch Cycles—alter the difference between summer and winter. Currently, the Earth is closer to the sun during the northern hemisphere winter than it was a few thousand years ago, and farther from the sun during the northern hemisphere summer, so summers should have been cooling while winters warmed.

“It’s a nice story, but unfortunately, it doesn’t seem to account for the past Greenland climate record,” says Dr. Richard B. Alley, professor of geosciences. “Information from the Greenland ice cores does show that the summers have cooled, but also that the winters have cooled.” The Greenland ice coring projects produced two thermometers to measure temperatures in central Greenland’s past. One, a combination of borehole temperatures and stable-isotope records, is very good for year-round temperatures. The other, the frequency of melt incidents, records temperatures in the summer.

“If we believe both temperature records, then 8,000 years ago, Greenland summers were a bit warmer than today, and Greenland winters were also warmer,” Alley told attendees at the spring meeting of the American Geophysical Union. “In fact, the winters were perhaps twice as much warmer than the summers.” Because the thermometers indicate that the winters have cooled, some other cause must be found besides Milankovitch cycles. Alley suggests that ocean heat transport may be the key.

“If, over the last few thousand years, the ocean’s transfer of heat to the area around Greenland has declined, then this would be a simple explanation for the overall cooling,” says Alley. “This is not unlike what happens with the ocean circulation when rapid cooling events have occurred in the past,
LETHAL ITALIAN CARBON DIOXIDE SPRINGS KEY TO ATMOSPHERIC CO₂ LEVELS

The often lethal carbon dioxide springs that dot central and south-central Italy, may hold the key to understanding current and ancient levels of this greenhouse gas, according to Penn State geoscientists.

"Generally, when researchers compute total non-anthropogenic carbon dioxide flux, non-volcanic sources such as central and south-central Italy are ignored," says Dr. Derrill Kerrick, professor of geoscience. "However, the contribution from areas like Italy can be quite sizable." Carbon dioxide in the atmosphere contributes to greenhouse warming and climate change. Volcanoes have long been thought the major contributor of carbon dioxide, but there are large areas with vents expelling non-volcanic carbon dioxide in Italy, California and other places.

While volcanoes produce the gas from magma, the carbon dioxide vents in Italy are expelling gas generated at depth from metamorphism of rocks that were formed by marine organisms and are composed of calcium carbonate.

The 200-mile area of Italy between Florence and Naples produces an enormous amount of carbon dioxide, yet no one has tried to measure the amount before, the researchers told attendees at the fall meeting of the American Geophysical Union in San Francisco. We don't have a sense of how much is going into the atmosphere, they said. "People have known about these springs for a long time," says John D. Rogie, graduate student in geosciences. "At Acqua Terme, the boiling water and carbon dioxide geyser is encased in glass and is part of a spa resort." In one location, the researchers note, a spring has been cased and tapped to supply carbon dioxide to a Coca Cola bottling plant. "These sites are locally known, but not generally publicized outside of Italy," says Kerrick. "Some produce virtually 100 percent carbon dioxide and are quite lethal. The area around such vents is typically littered with animal carcasses and people have died in these areas." One reason these places are so lethal is that carbon dioxide is invisible and heavier than air. The gas sits on the ground and flows to low areas. Animals and humans caught in these areas can be killed before they have time to leave.

Kerrick and Rogie are working with a team of Italian scientists including G. Chiodini and A. Frondini from the Dipartimento Scienza Della Terra, University of Perugia; Francesco Parello of the University of Palermo and Angelo Minissale of the University of Florence. The Italians already have a home-made device for measuring the flow of carbon dioxide from vents and the researchers have made a variety of devices to measure the diffuse degassing through the soil.

"We estimate that there are between 150 and 200 carbon dioxide vents in this area of Italy," says Kerrick. "One vent east of Naples emits over 200 tons of carbon dioxide per day." The researchers note that emissions from some vents are equivalent to that of some volcanoes. The flux from the vent east of Naples is equivalent to the combined crater and diffuse flux from Vulcano, a volcanic island near Sicily. When looking at diffuse degassing, the researchers found one area that measured less than a tenth of a square mile, yet emits 150 tons of carbon dioxide per day.

The researchers note that Mt. Etna, a volcano which produces 35,000 tons of carbon dioxide per day and is the largest single source of natural carbon dioxide in the world, is located in this area of Italy. Unlike many other volcanoes, Etna is not in an area where tectonic plates meet. Assuming that most carbon dioxide in the past came from areas of subduction vulcanism may not be the way to model carbon dioxide production, according to the researchers. There is a great deal of gas coming from carbon dioxide vents and the area around these vents that must be taken into consideration.
IN SEARCH OF HABITABLE MOONS

Recent identification of Jupiter-like planets around distant stars has raised hopes of extraterrestrial life outside our solar system, but not on the gas giants themselves. "While gas giants probably will not support life, the moons orbiting these planets might meet the requirements necessary to sustain life," says Darren Williams, graduate student in astronomy and astrophysics at Penn State. In the journal Nature, Williams, James F. Kasting, professor of geosciences, and Richard Wade, associate professor of astronomy and astrophysics, outlined these requirements.

"First, the gas giant must orbit its star within the habitable zone - the zone around a star where the solar flux allows liquid water to exist," Williams says. "If the orbit is too distant, water freezes. If it is too close, high temperatures cause the hydrogen in water to be lost to space." The researchers examined the known gas giants to see if they fell into their star's habitable zone. "Only 16 Cyg Bb and 47 Uma B come near to being in the habitable zone," says Williams. "Also, moons around gas giants must be able to sustain an atmosphere for billions of years and must also be close enough to their planet to have a stable orbit."

A moon's mass, the ionizing radiation it receives, the solar flux and the magnetic effects of the gas giant all play a part in trying to remove the atmosphere. If a moon is too small, heating will cause the molecules of oxygen and nitrogen in the atmosphere to attain escape velocity - the speed at which the moon's gravity will no longer hold them -- and disappear into space. To retain oxygen and nitrogen, the moon must be at least .07 the size of the Earth. But stellar heating is not the only consideration. When ionized atomic nitrogen recombines with electrons, it may also be lost to space. A moon must be at least .12 the mass of Earth to keep from losing appreciable amounts of nitrogen by this process.

Another way to lose atmosphere is through the action of the gas giant's magnetosphere -- the area in which the planet's magnetic field operates. Moons in the magnetosphere lose atmosphere because of bombardment by trapped energetic charged particles. A planet with its own magnetic field is protected from this effect, but, until recently, it was thought small bodies, like moons, did not have magnetic fields. "The Galileo spacecraft's recent identification of a magnetosphere around Ganymede, which is only .03 the mass of Earth, suggests that some moons may not be affected by their planet's magnetosphere," says Williams. "We also know that Saturn's moon Titan travels in and out of the magnetosphere, but still has a dense nitrogen atmosphere.

This may not be the problem it was once thought. To retain an atmosphere, moons must first form an atmosphere. Moons around extra solar gas giants might have received their water through bombardment by icy comets or carbonaceous asteroids, but research in our own solar system suggests that moons orbiting Jupiter-size planets have trouble retaining volatiles from comets. If, however, moons originated in the outer part of stellar nebula, they may have incorporated large amounts of water. These moons may have somuch water that, when in the habitable zone, they are oceanic with little dry land. Between these watery moons and those devoid of water are inner moons like Jupiter's Europa which have a good balance of rock and water and are most likely to be Earth-like.

In the long term, habitable moons must also be able to compensate for the increasing brightness of their suns through time. An increase in carbon dioxide, from volcanic activity, can cause greenhouse warming which compensates for a fainter sun. As the moon ages -- and the star becomes brighter -- rock weathering continues to remove carbon dioxide from the atmosphere, but a decrease in geologic activity reduces the amounts of carbon dioxide replaced by geologic activity which, in turn, decreases greenhouse warming. Normally, for a planet to retain internal heat and remain geologically active for 4.5 billion years, it must be at least .23 the mass of Earth or just over twice the mass of Mars. This would be a large, planet-sized moon. Moons close enough to gas-giants, however, may be warmed by tidal heating -- the gravitation pull on the moon of the gas giant. These moons would support tectonic activity or at least individual volcanoes.

Williams is not the first to suggest moons of gas giants as likely locations for extraterrestrial life. In the popular film "Return of the Jedi," the Ewoks race through a terrestrial-looking landscape on the Forest Moon of Endor; in pursuit of the minions of Darth Vader, while the planet orbits a gas giant similar to Jupiter. The planets 47 Uma B and 16 Cyg Bb are not perfect subjects for habitable moons. 47 Uma B lies just outside the habitable zone and 16 Cyg Bb has an orbit that is so eccentric it traverses the entire habitable zone dipping inside and outside the acceptable orbit. While these are not perfect, there seems to be sufficient flexibility and variety of factors to suggest that given a large enough gas giant with large enough moons, life could evolve and persist.

LAB RESULTS AND REAL WORLD OUT OF SYNC

The way that soil minerals break down and how they react with groundwater are important bits of information for anyone studying groundwater pollution and soil contamination, but sometimes the information gathered in the lab doesn't quite match what happens in the real world, according to Penn State geologists.

"It's fairly well known that weathering experiments in the lab don't match natural weathering mechanisms," says Melissa A. Nugent, graduate student in geosciences. "Laboratory rates are often several orders of magnitude faster than those observed in natural environments."

Nugent, Dr. Susan L. Brantley, associate professor of geosciences, and Dr. Yang Chen, a recent Penn State graduate, looked at samples of albite feldspar from Quebec that had been buried in central Pennsylvania soil and removed after six months, one year and two years to try to understand the mechanism of weathering.

When minerals weather in nature, molecules in the rock dissolve in groundwater, react to form coatings, form other minerals or simply wear away. In the laboratory, researchers are usually only looking at one
process at a time, which may explain the discrepancies with the natural world.

“Our investigation of the surface of the feldspar after it was in the ground shows an initial slight decrease in aluminum on the surface and then an increase in the concentration on the surface,” Nugent told attendees at a meeting of the Geological Society of America in Denver.

“Lab experiments usually show a depletion of aluminum and sodium,” she added. Feldspar is generally made up of sodium, aluminum, silicon and oxygen, and is the most abundant group of minerals on Earth.

“We haven’t looked at the aluminum chemistry in the ground in detail yet,” says Nugent, “So we don’t really understand what is going on with this amorphous aluminum coating.”

Other researchers have looked at the surface of feldspars from the ground and not reported enriched aluminum layers.

The geologists are also monitoring conditions in the field where the feldspar samples are buried, recording acidity, water volume and ion concentrations to try to understand the mechanisms underway in the soil.

“If we know the saturation state and other kinetic variables for both the laboratory and field experiments, then we should be able to compare the results of both and better understand what is happening in the soil,” says Nugent.

Also working on this project are Dr. Carlo Pantano, professor of ceramic science, and Dainele Cherniak, department of earth and environmental science at Rensselaer Polytechnic Institute.

ANCIENT METHANE MIRRORS CLIMATE RECORD

Analysis of the methane concentration of fossil air trapped in Greenland ice cores indicates that the methane levels closely follow other measures of ancient climate change on millennial time scales, according to researchers at Penn State and the University of Rhode Island, Narragansett.

The researchers reported in the journal Science, that their data verify general patterns of methane concentration changes seen in Antarctic and other Greenland ice cores, and provide a detailed picture of methane variations with respect to shorter, orbital climate cycles and short-term warming events.

Methane concentrations in the atmosphere are primarily driven by changes in temperatures and precipitation.

“Before 1800 A.D., the dominant methane source was decomposition of organic material in natural wetlands,” says Dr. Todd Sowers, assistant professor of geosciences at Penn State. “Other sources including termites, wild animals, wildfires, methane hydrate release and the oceans may have accounted for as much as 40 percent of the total methane sources during the pre-industrial Holocene and the last glacial maximum.”

Because dispersion of methane through the atmosphere takes a relatively short time, methane that becomes trapped in the layers of glacial snow reflects global changes in the methane balance and therefore global changes in temperature and precipitation. Just like tree rings, yearly deposits of snow on glaciers can be counted and analyzed to determine the year the layer was created and something about the global climate at that time.

Previous examination of both Antarctic and Greenland ice cores indicate that there are a variety of factors which may have influenced the paleoatmospheric methane record retrieved from ice cores, including seasonal solar variations and rapid warming events. The methane concentration changes indicate that elevated methane levels occurred during warm episodes, but the absolute methane level appears to be modulated on a longer time scale by orbital forcing.

Sowers, Dr. Edward J. Brook, post-doctoral researcher and Joe Orchardo of the graduate school of oceanography, University of Rhode Island, Narragansett, worked with the Greenland Ice Sheet Project 2(GISP2) ice core to develop a methane record for the past 110,000 years.

In today’s wetlands, wetter conditions and warmer temperatures increase methane production. It is likely that the same conditions held in the past and that increased methane in the ice cores reflect wetter and warmer climates in methane-producing areas, many of which are in the tropics.

The methane record confirms high methane during the early Holocene and the dramatic changes that occurred during the Younger Dryas some 12,000 years ago. The researchers note that within the uncertainty associated with dating gases to the ice surrounding the gas, the rapid concentration increases of the methane and the rapid warming events -- derived from variations in the heavy isotope enrichment of water -- are in phase.

While the methane concentration variations and temperatures tend to agree in nearly all cases, there appear to be times when methane concentrations and climactic temperatures were decoupled. In general, however, the researchers believe that there is a tight link between the beginnings of warmer periods and the methane budget.

“The rapidity and magnitude of methane shifts during warmer periods argues for large scale regional to global changes in terrestrial climate associated with these periods,” says Brook.

According to the researchers, besides causing increased methane production in the tropics, rapid warming events could have activated large areas of temperate wetlands which had previously been inactive methane-producing regions. These temperate wetlands, in areas like Siberia and Alaska, today contribute significant methane to the atmosphere, and these high latitude wetlands may have been significant factors in creating elevated methane levels in the past.
College News

New Head for Geosciences

Rudy L. Slingerland has been named the new head of the Department of Geosciences, succeeding Michael A. Arthur, who is returning to full-time teaching and research after serving as head since 1991.

Dr. Slingerland received his B.S. from Dickinson College and both M.S. and Ph.D. in geology from Penn State. He has been a member of the department faculty since 1977, and is an associate of the Earth System Science Center, where he received the Cray professorship award. He served as chair of the University's Marine Sciences program from 1981–83.

In the Department of Geosciences, he has has taught a wide range of graduate and undergraduate courses, primarily in aspects of sedimentary geology and mathematical modeling. He enjoys undergraduate teaching and recently developed an innovative course "Seven Curious Problems in Geology" for university-wide honors students, and in 1996 he was co-leader of the College-wide CAUSE project, "Natural Hazards in New Zealand." He is co-author of the text Simulating Clastic Sedimentary Basins, published in 1993 by Prentice Hall.

In 1996 Dr. Slingerland was awarded the College's Wilson Research Award for his development of new techniques for the analysis of sedimentary basins, which under the general title of quantitative dynamic stratigraphy or QDS, has gained a great deal of professional attention. In the same year he was honored as the Ludwig Memorial Lecturer in the Department of Oceanography at Old Dominion University.

He is very active in professional organizations and is currently serving as an associate editor of Geology, and of the Journal of Sedimentary Research, and as a member of the editorial board of Basin Research.

Parizek Named to Review Board

Richard R. Parizek, professor of geology, has been appointed by President Clinton to the national Nuclear Waste Technical Review Board. The board is charged with evaluating the scientific and technical validity of activities undertaken by the U.S. Department of Energy in its program to manage and dispose of the nation's spent nuclear fuel and high-level waste.

The board's current task is to evaluate DOE's site characterization work at the Yucca Mountain site in Nevada. In 1998, DOE intends to assess the viability of the site as a permanent repository for nuclear waste.

Dr. Parizek has served as an administrative judge for the Nuclear Regulatory Commission's Atomic Safety and Licensing Board Panel since 1990. He was a member of the Love Canal Litigation Team from 1983–85 and also served as a member of the Salt Modeling Task Force for the Office of Nuclear Waste Isolation.

Following the Chernobyl incident, he was invited to Russia to advise on the contamination of groundwater.

Erickson Named Vice President for Research

Rodney A. Erickson, dean of Penn State's Graduate School, has been named, in addition, vice president for research. He had been serving as interim vice president for research since December.

As vice president for research, Erickson will lead a $350 million a year research enterprise that is the largest among universities in Pennsylvania and tenth among all American universities. Penn State also ranks second in the nation, behind the Massachusetts Institute of Technology, in industry-supported research.

In addition to his administrative posts, Erickson is a professor of geography and business administration. He was head of the Department of Geography in the College of Earth and Mineral Sciences from 1990 to 1994. From 1981 to 1995, he served as director of the Center for Regional Business Analysis, and from 1984 to 1995 was associate director of the Division of Research in the Smeal College of Business Administration. He was appointed dean of the Graduate School on July 1, 1995.

Messing Named New Head of Intercollege Materials Research Laboratory

Gary L. Messing, professor of ceramic science and engineering in the Department of Materials Science and Engineering, has been named director of Penn State's Intercollege Materials Research Laboratory. Messing has served as director of the Particulate Materials Center for the past five years.

He received his B.S. in ceramic engineering from the New York State College of Ceramics at Alfred University and his doctorate in materials science and engineering from the University of Florida. He was a research scientist at Battelle Columbus Labs for two years before joining Penn State in 1980. He became a professor in 1989.

Messing has served as a visiting professor at the University of Paris and Research Fellow at Curtin University of Technology, Perth, Australia. The author of more than 140 papers on various aspects of ceramic processing and co-editor of nine books, he has also been a co-organizer of the International Ceramic Processing Science Conference since 1986. Messing is co-editor...
of the Journal of the American Ceramic Society and is on the editorial board of the Journal of Solid State Science and Technology.

He received the Wilson Research Award of the College of Earth and Mineral Sciences and the Richard M. Fulrath Pacific Award for his research on seedling of high-temperature transformations. He is a Fellow of the American Ceramic Society and currently serves on its board of trustees. He is a member of the Materials Research Society, American Ceramic Society, American Chemical Society and the American Institute of Chemical Engineers.

Faculty Awards

Peter Gould, Evan Pugh Professor of Geography, received the Anders Retzius Gold Medal of the Swedish Society for Anthropology and Geography, and presented the society's Vega Symposium on The Structure of Space(s), with three of his former students, Tony Gattrell, Ulf Strohmayer, and Matt Hannah, now faculty members in England, Wales, and Vermont.

Kwadwo Osseo-Asare, Professor of Metallurgy, received the James Douglas Gold Medal from the American Institute of Metallurgical Engineers (AIME) for his contributions to the fundamental understanding of interfacial phenomena.

Tarasankar DebRoy, Professor of Metallurgy, was awarded Penn State's Faculty Scholar Medal for Outstanding Achievement (in the engineering category).

Raja V. Ramani, Professor and Head of the Department of Mineral Engineering, received an honorary D.Sc. from the Indian School of Mines in April. In May he received the Hartman Award at the 6th International Mine Ventilation Congress in Pittsburgh, in recognition of his achievements in ventilation engineering.

Karl Spear, Professor of Ceramic Science and Engineering, received the Solid State Science and Technology Award of the Electrochemical Society and served as general chair of the Ninth International Conference of High Temperature Materials Chemistry, held at Penn State in May.

Suzanne Mohney, Assistant Professor of Metallurgy, received the 1997 Young Leader Award of The Minerals, Metals & Materials Society (TMS).

Richard Hogg, Professor of Mineral Processing, received the Arthur F. Taggart Award of SME, the Society for Mining, Metallurgy and Exploration, Inc. for a series of papers in the area of flocculation and dewatering

Christopher Bise, Professor of Mining Engineering, received the Faculty Award of the Old Timer's Club.

Robert Newnham, Alcoa Professor of Solid State Science, received the 1996 David Turnbull Lectureship Award from the Materials Research Society

Subhash Chander, Professor of Mineral Processing, was named a Distinguished Member of SME.

James Kasting, Professor of Geosciences, was named a Fellow of the American Association for the Advancement of Science

E. Willard Miller, Emeritus of Geography, has been selected to receive an honorary D.Sc. from Ohio State University, his alma mater, at its Autumn Commencement in December 1997.

Rustum Roy, Evan Pugh Professor of the Solid State, had an annual lecture named in his honor at the annual meeting of the American Ceramic Society. The lecture will be called the Rustum Roy Lecture in the Frontiers of Science and Society. The first lecture, "Can we plan for a millenium?" was presented in May by Dr. Alvin Weinberg, founder of the Oak Ridge National Laboratory.

As chair of Mining Engineering and the Penn State program in Industrial Health and Safety, Dr. Christopher J. Bise (right) accepts the 1996-97 H.L. Boling Award of the International Society of Mine Safety Professionals from Mr. Ben Sheppard, director, corporate loss control, Echo Bay Mines. The award citation reads: "To Penn State University for consistently going above and beyond the call of duty," and refers to Dr. Bise's successful efforts to establish a new interdisciplinary undergraduate major in Industrial Health and Safety.

Dr. Raja Ramani, right, accepts an honorary D.Sc. at the Convocation of the Indian School of Mines. Presenting the degree is Dr. B. K. Rao, Chair of the Governing Board. The Convocation Speaker, center, was Dr. R.A. Mashelkar, Director General of Council of Scientific and Industrial Research, and Secretary to the Department of Science and Technology.
College Honors
Faculty Achievement

A number of EMS faculty members were recognized for their achievements in teaching and research at the annual Wilson Awards Banquet, held this year at the Nittany Lion Inn in April. Richard Alley, professor of geosciences, Mark Klima, associate professor of mineral processing, and Darrell Schlam, assistant professor of materials science and engineering received the 1997 Wilson Award for Outstanding Teaching, and the Wilson Research Award was presented to Susan Brantley, professor of geosciences, and Digby Macdonald, professor of materials science and engineering. In addition, the Deike Research Grant was awarded to Kevin Furlong, and the Wilson Research Initiation Grant was presented to Ahmet Kocagil and Andrew Nyblade. Richard Tessler and Ian Harrison were recognized for their 25 years of service to the College.

Wilson Teaching Award

Student nominations for the Wilson Teaching Award show that the energy and contagious enthusiasm Richard Alley displays in his widely known research investigations on ice and climate change also light up his teaching. Students find his classroom down-to-earth, fascinating and fun, with an atmosphere that encourages them to ask questions and become truly involved in the material being presented. A few of them recognize that the apparent spontaneity of his lectures masks very careful preparation and organization. Students say that "he epitomizes a truly great teacher."

The student support for Mark Klima's award nomination was so widespread that the petition appeared to have been signed by every student in mineral processing and geo-environmental engineering. The students had extraordinary praise for Dr. Klima's dedication and the care he has for their welfare. They claim that his course in mineral process engineering in which he applies economic aspects and technology to practical design is the single best course they have taken. They said, "We feel that a student who wants to excel in this branch of scientific endeavor will feel blessed by the opportunity to have a mentor such as Dr. Klima."

They admire his dedication, and say: "his open door policy (his door is frequently open until after midnight) of helping students whenever he is in his office is a testament to his determination to offer students every possible opportunity to learn."

Wilson Research Award

Susan Brantley received the Wilson Research Award in recognition of her research on the weathering of rocks by water, which has made her a respected international leader in her field and one of the few acknowledged experts in theoretical, experimental and field aspects of mineral weathering. Leaders in her discipline consider her frontier research on dissolution rates of important silicate and carbonate minerals and accompanying field studies of tropical and temperate sites to have had a significant impact on the understanding of surficial geochemical processes. She has had many achievements since joining the Department of Geosciences in 1986 as an assistant professor, including both the David and Lucille Packard Award and the NSF Presidential Young Investigator Award, and continues to be involved with National Science Foundation projects to attract young people to science.

Digby Macdonald received the Wilson Research Award in recognition of his recent investigations of passive films on reactive metal surfaces. In this research, he examined the film growth and breakdown in contact with aqueous environments, and went on to develop a technique, damage function analysis or DFA, to help predict corrosion damage, and hence the residual life of engineering systems performing beyond an anticipated span. Damage function analysis has been widely discussed and acclaimed among corrosion engineers. Dr. Macdonald joined the EMS faculty in 1991 as director of the Center for Advanced Materials, when he was already a scientist with great breadth of achievement in basic electrochemistry and its application to many practical engineering devices and problems. In the past five years he has received numerous professional honors, and is cited by his peers as a world class scientist in both electrochemistry and corrosion engineering.

Research Grants

The Deike Research Grant is supported by the George H. Deike Jr. Research Endowment Fund and was established in 1992 to promote innovative research of high scholarly merit. The 1997 grant was made to Kevin Furlong, professor of geophysics, for developing a technique to observe the deformation of the Earth's mantle in plate boundary zones. Dr. Furlong already has a prototype for the technique, which he has successfully applied to the Tibetan Plateau collision zone. He now intends to further develop the method and apply it to existing data sets from several boundary zones, including the San Andreas plate boundary in California, the boundary along the South Island of New Zealand, and several relict plate boundary zones within the PreCambrian Canadian Shield.

The Wilson Research Initiation Grant was established in 1995 to assist new faculty members in initiating research agendas. The 1997 grant was made to Dr.
Ahmet Kocagil (Department of Energy, Environmental and Mineral Economics) who will investigate government incentives and their impact on corporate investment in new technology in the US mineral industry, and to Dr. Andrew Nyblade (Department of Geosciences) who will investigate the thermal processes of the rifted continental margin of western Africa and their implications for continental breakup.

Walker Receives the Hosler Medal

Philip L. Walker, Evan Pugh research professor emeritus of materials science has been awarded the College’s highest honor, the Charles L. Hosler Medal. The presentation was made at the 1997 Wilson Awards Banquet in the Nittany Lion Inn in April.

The Hosler Medal, named for Dr. Charles Hosler, Dean of the College from 1965 to 1985, is awarded to an alumnus who has made outstanding contributions to the development of science.

Philip Walker received his B.S. and M.S. degrees from Johns Hopkins University and his Ph.D. in fuel technology from Penn State in 1952. He joined the faculty as an assistant professor in that same year. Two years later he was promoted to associate professor and named head of the Department of Fuel Technology.

In 1959, when the College was reorganized, he became chairman of the Fuel Technology Division. When the decision was made to merge ceramics, metals and fuels as a single department, Dr. Walker was chosen to administer the new department. He served as head of the Department of Materials Science and Engineering from 1967 to 1978.

Concurrently, Dr. Walker established an international reputation in the field of carbon studies. Such was his domination of this field—through his 340 scholarly papers, his dedicated activities in the American Carbon Society and his long-standing editorship roles in the major journals in the field, Carbon and Chemistry and Physics of Carbon—that he became widely known as “Mr. Carbon”.

Dr. Walker was honored by Penn State in 1974, when he was named Evan Pugh research professor in materials science. He was honored by his peers, who presented him with the Henry Storch Award of the American Chemical Society for his distinguished contributions to the science and utilization of coal, and the George Skakel Memorial Award of the American Carbon Society for overall contributions and achievements that significantly influenced the process and science and technology of carbon materials. Over a long career, he also held a number of prestigious lectureships.

Since his retirement in 1984, Dr. Walker has continued to be a tremendous friend and supporter of the department and the College. He and his wife Virginia are members of the Obelisk Society, and established a professorship award and a student scholarship fund in the Department of Materials Science and Engineering.

1997 McFarland Award

Karl P. Kimmerling, vice president of the Timken Company in Canton, Ohio, has received the 1997 David Ford McFarland Award of the Penn State Chapter of ASM International. The McFarland Award is presented to a Penn State graduate who has achieved distinction in the field of metallurgy, and is named in honor of Dr. David Ford McFarland who joined the Penn State faculty in 1920 as head of the Department of Metallurgy, a position he held until his retirement in 1945.

Mr. Kimmerling is vice president for manufacturing—steel, responsible for all Timken's steel manufacturing operations, including four steel-making facilities and 3,000 employees. The Timken Company has annual steel sales of $1 billion.

He received his B.S. in Metallurgy from Penn State in 1979 and began his career with Timken's Harrison Avenue melt shop. While carrying out his metallurgical and managerial duties there, he attended Kent State in pursuit of an M.B.A., which he received in 1982. After receiving his J.D. in corporate law from the University of Akron in 1987, he was promoted to associate professor emeritus of the department and the College. He and his wife Virginia are members of the Obelisk Society, and established a professorship award and a student scholarship fund in the Division. When the decision was made to merge ceramics, metals and fuels as a single department, Dr. Walker was chosen to administer the new department. He served as head of the Department of Materials Science and Engineering from 1967 to 1978.

Concurrently, Dr. Walker established an international reputation in the field of carbon studies. Such was his domination of this field—through his 340 scholarly papers, his dedicated activities in the American Carbon Society and his long-standing editorship roles in the major journals in the field, Carbon and Chemistry and Physics of Carbon—that he became widely known as "Mr. Carbon".

Dr. Walker was honored by Penn State in 1974, when he was named Evan Pugh research professor in materials science. He was honored by his peers, who presented him with the Henry Storch Award of the American Chemical Society for his distinguished contributions to the science and utilization of coal, and the George Skakel Memorial Award of the American Carbon Society for overall contributions and achievements that significantly influenced the process and science and technology of carbon materials. Over a long career, he also held a number of prestigious lectureships.

Since his retirement in 1984, Dr. Walker has continued to be a tremendous friend and supporter of the department and the College. He and his wife Virginia are members of the Obelisk Society, and established a professorship award and a student scholarship fund in the Department of Materials Science and Engineering.

1997 McFarland Award

Karl P. Kimmerling, vice president of the Timken Company in Canton, Ohio, has received the 1997 David Ford McFarland Award of the Penn State Chapter of ASM International. The McFarland Award is presented to a Penn State graduate who has achieved distinction in the field of metallurgy, and is named in honor of Dr. David Ford McFarland who joined the Penn State faculty in 1920 as head of the Department of Metallurgy, a position he held until his retirement in 1945.

Mr. Kimmerling is vice president for manufacturing—steel, responsible for all Timken's steel manufacturing operations, including four steel-making facilities and 3,000 employees. The Timken Company has annual steel sales of $1 billion.

He received his B.S. in Metallurgy from Penn State in 1979 and began his career with Timken's Harrison Avenue melt shop. While carrying out his metallurgical and managerial duties there, he attended Kent State in pursuit of an M.B.A., which he received in 1982. After receiving his J.D. in corporate law from the University of Akron in 1987, he was promoted to associate professor emeritus of the department and the College. He and his wife Virginia are members of the Obelisk Society, and established a professorship award and a student scholarship fund in the Department of Materials Science and Engineering.

1997 McFarland Award

Karl P. Kimmerling, vice president of the Timken Company in Canton, Ohio, has received the 1997 David Ford McFarland Award of the Penn State Chapter of ASM International. The McFarland Award is presented to a Penn State graduate who has achieved distinction in the field of metallurgy, and is named in honor of Dr. David Ford McFarland who joined the Penn State faculty in 1920 as head of the Department of Metallurgy, a position he held until his retirement in 1945.

Mr. Kimmerling is vice president for manufacturing—steel, responsible for all Timken's steel manufacturing operations, including four steel-making facilities and 3,000 employees. The Timken Company has annual steel sales of $1 billion.

He received his B.S. in Metallurgy from Penn State in 1979 and began his career with Timken's Harrison Avenue melt shop. While carrying out his metallurgical and managerial duties there, he attended Kent State in pursuit of an M.B.A., which he received in 1982. After receiving his J.D. in corporate law from the University of Akron in 1987, he was promoted to associate professor emeritus of the department and the College. He and his wife Virginia are members of the Obelisk Society, and established a professorship award and a student scholarship fund in the

1997 McFarland Award

Karl P. Kimmerling, vice president of the Timken Company in Canton, Ohio, has received the 1997 David Ford McFarland Award of the Penn State Chapter of ASM International. The McFarland Award is presented to a Penn State graduate who has achieved distinction in the field of metallurgy, and is named in honor of Dr. David Ford McFarland who joined the Penn State faculty in 1920 as head of the Department of Metallurgy, a position he held until his retirement in 1945.

Mr. Kimmerling is vice president for manufacturing—steel, responsible for all Timken's steel manufacturing operations, including four steel-making facilities and 3,000 employees. The Timken Company has annual steel sales of $1 billion.

He received his B.S. in Metallurgy from Penn State in 1979 and began his career with Timken's Harrison Avenue melt shop. While carrying out his metallurgical and managerial duties there, he attended Kent State in pursuit of an M.B.A., which he received in 1982. After receiving his J.D. in corporate law from the University of Akron in 1987, he was promoted to associate professor emeritus of the department and the College. He and his wife Virginia are members of the Obelisk Society, and established a professorship award and a student scholarship fund in the Department of Materials Science and Engineering.

Mr. Kimmerling returned to Penn State in April, to receive the award at the annual banquet of the Penn State Chapter of ASM International and present the McFarland Lecture. His presentation focused on the Timken Company's highly successful Faircrest Steel Plant. This plant was built in the mid-80s, when many U.S. steel plants were being shuttered due to foreign competition—it is now operating at 66% over its original design capacity, making it the world's lowest-cost producer of alloy steel bars for bearings, aerospace and other high-tech applications.

EMS Welcomes New Faculty

Douglas Burbank has joined the faculty as professor of geosciences. Dr. Burbank comes from Los Angeles, California, where he was a professor in the Department of Geological Sciences at the University of Southern California. He received his B.A. in literature from Reed College in Oregon; his M.S. in Geology from the University of Washington; and his Ph.D. in Geology from Dartmouth College.

His research interests and extensive number of publications include tectonics and geomorphic problems; active tectonics; structural and stratigraphic evolution of fold-and-thrust belts and foreland basins; physiographic evolution of mountain ranges; kinematics of folding; basin analysis and modeling; analysis of digital topography; sedimentology; magnetostratigraphy; fission-track dating; Quaternary paleoclimatology; and glacial geology. His academic honors include a NATO Postdoctoral Fellowship, the Crosby Distinguished Lectureship at MIT, and a visiting professorship at Victoria University in Wellington, New Zealand. Currently, he is editor of Basin Research.

Lorraine Dowler has joined the
College, her M.L.A. in Landscape Architecture from the State University of New York, and her Ph.D. in Geography from Syracuse University. Her research interests include social, political, urban and feminist geography and ethnography. She has done considerable field work in Belfast, Northern Ireland, and has based several presentations and papers on that work. Dowler will teach part of the introductory human geography sequence and work in collaboration with the Deasy GeoGraphics Laboratory to develop a new course, World Regional Geography. Her honors include a teaching fellowship in the Future Professoriat Program sponsored by the Pew Charitable Trust and the U.S. Department of Education. Her professional affiliations include Association of American Geographers; Institute of British Geographers; and American Society of Landscape Architects.

William Easterling has been appointed associate professor in the Department of Geography. Previously Easterling served as associate professor and graduate faculty fellow in the Department of Agricultural Meteorology at the University of Nebraska-Lincoln. He also was interim director of the National Institute for Global Environmental Change (1996-1997), and director for the Great Plains Regional Center for Global Environmental Change, University of Nebraska-Lincoln from the Institute of Agriculture and Natural Resources. Easterling received B.A. degrees in Geography and History from the University of North Carolina, Chapel Hill, his M.A. degree in Economic Geography from the University of North Carolina, Chapel Hill, and his Ph.D. in Geography-Climatology also from the University of North Carolina at Chapel Hill. He has organized many conferences, workshops, and lectures, and served on many committees including the Review Panel for the Methods and Models for Integrated Assessment for the National Science Foundation, and served as U.S. Delegate to the joint U.S.-Japan conference on Global Change and Land Use. Easterling has numerous publications and has given many talks at regional and national levels.

Alumnus receives Mining Award

George R. Desk67 Mining Engineering, of Lurbo received the 1997 Robert Stefanko Distinguished Achievement Award in Mineral Engineering. The award was established by the mineral engineering faculty in 1992 to honor the memory of Robert Stefanko, '48 '57 '61, a man who served his colleagues, college and profession with distinction, great productivity and professionalism and lasting benefits. The award recognizes individuals for their achievements and leadership which further the advancement of the mineral engineering profession.

Desk6 is the owner and chairman of Canterbury Coal Company, the largest privately owned coal company in Pennsylvania. Canterbury Coal produces 1.5 million tons annually and employs more than 230 people. He previously established Descoas, Inc., a mining engineering consulting company, Millers Cove Energy Company, and Straight Creek Coal Processing Company.

Desko was founding president of GEMS, the EMS alumni society, and served from 1990 to 1995 as chairman of the GEMS board and member of the Penn State Alumni Council. He is now a permanent member of the GEMS past president council. Desk6 is a member of the Nittany Lion Club.

In 1996, he received the Philip Philip Mitchell Alumni Service Award from the Penn State Alumni Association in recognition of his outstanding support of the department, college, and university. In the same year he was named a Centennial Fellow of the College of Earth and Mineral Sciences. Desk6 co-founded the Jesse F. Core Memorial Scholarship Fund for mining engineering students, and works with many of those students as a mentor. His professional affiliations include the American Mining Congress and the American Institute of Mining Engineers' Society of Mining Engineers.
A New Center Focuses on the Impact of Environmental Change on People

The Center for Integrated Regional Assessment (CIRA) was founded in 1996 as an inter-college and inter-University research group supported by a grant from the National Science Foundation Program on the Human Dimensions of Global Change and operating in collaboration with the College's Earth System Science Center and the Latin American Area Center of the University of Arizona.

Research in CIRA focuses on the potential impact of global climatic change at the regional level. It is concerned with creating new methods and models that will help regional planners and business leaders to assess alternative strategies for coping with future environmental changes.

CIRA's core project is a five-year interdisciplinary project called MIRA, Methods for Integrated Regional Assessment. The research team includes Penn State geographers and agricultural, business and environmental economists, together with researchers working with Dr. Diana Liverman, now professor of geography at the University of Arizona. The principal investigator is Dr. C. Gregory Knight, professor of geography and associate director of the Earth System Science Center. Considerable graduate and undergraduate student research is supporting this effort.

Team researchers will study the vulnerability of specific regions to changes in water resources and climate, the impact of such changes on agriculture and regional economics, potential public, institutional and corporate responses to climate change, and relevant environmental policies. They are especially concerned with developing fundamental methods for assessing impacts and responses. The MIRA team will concentrate its research in three areas: the Susquehanna River Basin of Pennsylvania; the Mexico-US Border; and Bulgaria.

Among the many projects over past months are:

- work in Bulgaria on the development of a hydrological model for the Struma Basin to be linked to socio-economic databases. This research by Knight and Marieta Staneva and 13 Bulgarian colleagues led to a special issue of GeoJournal on Bulgarian water resources.
- work on an integrated model of the San Pedro River in southern Arizona, with related studies on impacts of the 1996 drought in the southwestern United States, and drought impacts and perceptions in Sonora, Mexico.
- studies of drinking water supplies in the Susquehanna Basin including regional health impacts of floods, vulnerability to contamination, supply variability, and the impact of regulation.

The earth and social scientists that make up the MIRA team include:

C. GREGORY KNIGHT, principal investigator, professor of geography, associate director of the Earth System Science Center

DAVID G. ABLER, associate professor of agricultural economics

ERIC J. BARRON, professor of geosciences, director of ESSC

ROBERT G. CRANE, professor of geography, associate dean for education

ANN FISHER, senior scientist of agricultural economics and rural sociology

AMY K. GLASMEIER, professor of geography

JEFFREY K. LAZO, assistant professor of mineral economics

DIANA M. LIVERMAN, professor of geography, University of Arizona

STEPHEN A. MATTHEWS, research associate, the Population Research Institute

GORDON P. RANDS, assistant professor of Business Administration

ADAM ROSS, head of Energy, Environmental, and Mineral Economics

JAMES S. SHORTLE, professor of agricultural economics and rural sociology

BRENTON M. YARNAL, associate professor of geography

Community Water Systems Using Surface-Water Sources

Susquehanna River Basin Integrated Assessment
Cartographer: Peter Pascale

Source: Pennsylvania Department Of Environmental Protection, November 1996
Learning Opportunities Break Free of Classroom Constraints

Timothy Robinson, instructor, instructional technology

Three nationally recognized trends are having a large effect on instruction in the College of Earth and Mineral Sciences. First, the pool of potential students, the "customers" of our College, are increasingly likely to be older than was typically the case in the past, and are increasingly likely to be employed and have family responsibilities. They are less likely to be able to drop everything to move to University Park as a full-time student. Second, the children of the Baby Boomers, the echo of the Baby Boom, are now beginning to swell the ranks of the college-aged. Substantially more students than usual are projected to graduate from the nation's high schools in the near future, and will strain the resources of Penn State and other institutions to house and educate them. Third, the communication revolution of the past thirty years has opened many more channels of communication among people. Television and more recently the Internet with its email and Web pages have probably received the most publicity, but other less obvious developments, such as corporate training and interactive multimedia for personal computers, have also had a tremendous impact on how people get information and develop knowledge.

The combination of these three trends is changing the way the Penn State and our College go about educating their students. At times, we are like surfers trying to ride these waves, these changes, and turn them to our advantage, and at times we are simply being lifted and carried along, unaware of the changes. One response to these changes has been a greatly increased emphasis on continuing and distance education. Prospective students who have a job and/or family, for whom moving to University Park or attending daytime classes is out of the question, are increasingly finding that they can learn what they need via distance education from Penn State. As a university, we are able to serve many more students without having to build and maintain dorms and classrooms for them. The professors now have their choice of several media in addition to blackboards, paper and pencil. They are finding that various crucial aspects of the face-to-face teaching/learning process can be replicated adequately via email discussions, interactive models of the processes to be learned, and video tapes that show highly visual materials.

Penn State President Dr. Graham Spanier recently announced Penn State's World Campus initiative - creating an educational institution with no boundaries, where learning happens via the Internet or other new technologies. This distinctive outreach campus will offer a broad spectrum of educational activities to the global community. By the year 2002, more than 300 Penn State courses may be offered online or via CD-ROM, in combination with video, audio cassettes and books. The Geography department in the College of Earth and Mineral Sciences is part of the first phase of World Campus development. By the summer of 1998, students worldwide will be able to enroll in a program of study in geographic information systems (GIS), a field in which we hold a leadership position. They will be able to complete all fifteen credits without ever coming to a class on a physical campus and will receive a certificate after having proved their knowledge and skill. The program is intended for adult learners who wish to learn about GIS, or to expand their existing GIS expertise, without having to disrupt their lives by enrolling in a conventional degree program. The program will begin with a general introduction to geographic information technologies, after which students may choose among several "tracks" focusing on GIS applications in business, environmental, or other application areas. The program will culminate in an advanced course in which students will learn fundamentals of computer programming for GIS. Course materials will be delivered via a combination of CD-ROM, the World Wide Web, and print.

Much of the development for this certificate program will be carried out by the Geography Department's Deasy GeoGraphics Laboratory. The Deasy Lab creates maps and multimedia materials for the Geography Department, the College and University, and also major publishers. College textbook publishers are beginning to offer CD-ROMs as companion items with their textbooks. These disks are typically packed with interactive exercises, video clips and series of images that parallel and supplement the text and its written exercises. The Deasy Lab team of developers and student interns is currently developing such a disk, titled "Geosciences in Action".

According to David DiBiase, the Director of the Deasy Lab, Geosciences in Action (GiA) is a collection of computer-based virtual apprenticeships that complement introductory physical geology texts including John Wiley and
Sons’ Blue Planet, Dynamic Earth, and the forthcoming Geology Today. Unlike other educational software products, GIA does not merely mimic the structure and animate the content of a textbook. Instead, it immerses students in applied and basic research problems confronted by professional geologists. GIA embodies a guided discovery approach to geology education in which the software coaches novice students on how to apply fundamental concepts and basic terminology as they work to fulfill concrete, practical objectives. For example, one exercise scenario, shown below, places the student in the role of the consulting geologist for a municipality where high levels of benzene have been discovered in the water well supplying the elementary school. The student has a budget of $30,000 and a set of tasks to perform, such as surveying the water table or drilling and sampling test wells, each of which costs money. The scenario can be played out successfully, resulting in identification and remediation of the pollution source, a raise and favorable publicity. It is also possible for the student to overspend the budget on unnecessary tests or to finger the wrong suspect, resulting in a lawsuit, loss of position and unfavorable press coverage.

The software is engineered for unsupervised student use on generic personal computers (Windows 95, 3.x, and Macintosh) outside of class. Scheduled for delivery for Fall 1998 classes, the CD-ROM will support approximately twelve hours of student work, and will provide direct access to the World Wide Web. Every exercise will culminate in a printed performance summary by which students can demonstrate that they have completed assigned work. With little or no preparation required of instructors, GIA will enable students to experience the excitement and challenge of real-world geology.

Geosciences in Action and the World Campus GIS program are just two of a long series of computer-based multimedia teaching and learning materials that are now helping to educate EMS students, both on campus and at a distance. The communication revolution and the increased numbers of off-campus students, along with the strong support of Penn State and EMS administrators, ensures that we will be seeing even more teaching and learning occurring outside the classroom.

Directions

Use the sampling tool to get the concentration of benzene in each of your wells and the pond. A pattern of values reveals a concentration gradient which narrows your list of suspects by pointing toward the source.

Pointer Tool

Sampling Tool

Total Budget: $20000
Actual Expenses: $10000
Scholarship Recipients

Jerome N. Behrmann Scholarship Award
Christopher L. Castro

George W. Brindley Award in Nonmetallic Crystal Chemistry
Andrea C. Lang

George W. Brindley/Jung-oock Cheo Graduate Fellowship in EMS
Seong-Hyeon Hong Seongae Kwon

Frances Hamilton Byers Scholarship
Victor R. Jakobkow

John C. and Mary Anne Schrott Cahir Scholarship in EMS
Rachel L. Brown

H. Beecher and Mildred Charmbury Scholarship in Geo-Environmental Engineering
Shawn C. Modar Deborah A. Walker George B. Wright

Chevron Scholarship
Brett R. Beaver Danette F. Woensel

C. Philip Cook, Jr. Memorial Scholarship in Ceramic Science and Engineering
Dana M. Lemesh Marc N. Palmisano Peakong Tan

Jesse F. Core Scholarship
Michael J. Barish

Richard P. and John N. Davis Scholarship in EMS
Robert L. Goetsch Venon E. Shoemaker

Dean's Freshman Scholarship


Michael and Dorothy Deutsch Scholarship in EMS
Laura L. Belicka Rebecca L. Wolfson

Edwin L. Drake Memorial Scholarship

Patrick N. Walsh Micah A. Weirmer Joy E. Wise Matthew R. Yarnell

John A. Dutton Award in Atmospheric Dynamics
Michael A. Kistler Robert J. Much

Earth and Mineral Sciences Alumni Scholarship

Donald L. and Ellen Eberly Endowed Scholarship in Meteorology
Robert J. Much

General Motors Undergraduate Minority Scholarship

Glass Container Industry Research Corporation Scholarship
David A. Scrymgeour Mark D. Waugh

George Gleason Memorial Scholarship
Benjamin S. Markel Keith A. Whitmore

Michael and Dorothy Deutsch Scholarship in EMS
Laura L. Belicka Rebecca L. Wolfson

Edwin L. Drake Memorial Scholarship

Patrick N. Walsh Micah A. Weirmer Joy E. Wise Matthew R. Yarnell

John A. Dutton Award in Atmospheric Dynamics
Michael A. Kistler Robert J. Much

Earth and Mineral Sciences Alumni Scholarship

Donald L. and Ellen Eberly Endowed Scholarship in Meteorology
Robert J. Much

General Motors Undergraduate Minority Scholarship

Glass Container Industry Research Corporation Scholarship
David A. Scrymgeour Mark D. Waugh

George Gleason Memorial Scholarship
Benjamin S. Markel Keith A. Whitmore

Paul D. Krynine Memorial Fund

E. Willard Miller Award in Geography
Michael H. Carlin M. Telaza Cavazo David L. Gregal Nathaniel C. Hersh

John G. Miller Memorial Scholarship
Kristina L. Banovac Beth A. Miller Adam R. Levin Kelly L. Ward

Miscellaneous Departmental Scholarships
James D. Baca Maxwell W. Borella Bryan D. Brooks
Hiroshi and Koya Ohmoto Graduate Fellowship in Geosciences
Kosue Yamaguchi

Hans A. Panofsky Scholarship
Evan M. Bookbinder
David A. Call
Christopher R. Carlson
Bradley J. Clark
Andrew J. Decandis
Amelia C. Erck
Joseph M. Garback
Guy A. Hagen
Andrea M. Hambrecht
Scott P. Heath
Eric E. Hebble
Thomas J. Hervin
Kevin M. Koeng
Andrew J. Linler
Derrick J. Ometz
Jeremy D. Ross
Michael W. Smith
Darren D. Sokol
Stephen G. Strum
Eric S. Visconti
Shawn M. Weagle

Penn State Metallurgy Alumni Scholarship
Theodore A. Inniss
Kevin L. McHenry
Bryan A. Mikula
Christina A. Reynolds
Nicholas A. Ricci
Keith A. Whitmire

Pennsylvania Ceramics Association Scholarship
James A. Bradic
Nancy A. Kaltenbach

Anthony J. and Alberta L. Perrotta Scholarship in Materials Science and Engineering
Edwin P. Chan

Joseph and Anna Rubash Fellowship in Petroleum and Natural Gas Engineering
Eric N. Gourley

Frank and Lucy Rusinko Graduate Fellowship in Materials Science and Engineering
Christopher A. Frye

George Schenck Award in Mineral Economics
Lisa D. DeMarchi

E. F. Schulze Scholarship
Steven D. Minnick
Melissa B. Saccoy

Robert Stefanko Memorial Scholarship
Michael C. Long
Elizabeth A. Balsweider
Jason V. Waitelewski

Dean Edward Steidle Memorial Scholar Award
Jennifer A. Langer
Maria L. Mock

Ellen Steidle Achievement Award
Anthony J. Demark
Joshua S. Smith

John and Elizabeth Holmes Teas Scholarship
Curis R. Alexander
Elizabeth A. Balsweider
Anne W. Bausseng
Enrico G. Bellomo
Jason A. Bennis
Howard I. Berger
Evan M. Blaisdell
Bryan D. Brooks
Timothy T. Creysa
Lisa D. DeMarchi
Philip E. Dennison
David M. Falkenstern
Brian W. Flannigan
John Franko
Joseph M. Gafio
Valerie S. Gamble
Joseph M. Garback
Scott A. Gay
Robert L. Goedert
Paul N. Hagen
John M. Hayes
Nathanial C. Hersh
Thomas J. Hervin
Matthew J. Hostetler
Christopher N. Hyde
Rebecca A. Jacobstein
Geena Joys
Hilary L. Just
Timothy R. Kempisty
Michael A. Kistler
Kathryn A. Laukonen
Laura E. Leis
Christopher W. Leitz
Dana M. Lemesh
Stephen M. Leyton
Christopher J. Liller
Shawn C. Modar

Christina M. Monhollan
Robert J. Much
Shawn W. Musselman
Kevin M. Myer
Thomas J. Owens
Marc N. Palmisano
Kenneth S. Pelman
Sarah E. Petrov
Scott A. Pezzano
Shannon N. Plummer
Steven V. Pristivali
Steven D. Rees
Jody C. Robinson
Theodore Sandomenico
Michael J. Saunier
Matthew W. Schroeder
Joshua S. Smith
Eric B. Steiner
Drew B. Stolar
Stephen G. Strum
Yi Tang
Troy R. Taylor
Keith E. Van Houw
Alison M. Vargari
Damon C. Verhees
Deborah A. Walker
Mark D. Waugh
Shawn M. Weagle
Catherine L. Webber
Joel C. Widner
Richard A. Wolf
Elizabeth C. Wood
Briana L. Woodward
Robert A. Zilloni
Brian T. Zink

P. Stuart Tholan and Marilyn B. Tholan Endowed Scholarship
Matthew T. Hubbard
Gina Travagnini

George E. Trimble Scholarship in EMS
Shawn T. Potts
Vetton E. Shoemaker

Virginia S. and Philip L. Walker, Jr. Scholarship in Materials Science and Engineering
Melvin R. Gotschalk, Jr.

Edmond A. and Eleanor M. Watts, Jr. Scholarship
Mathew Hisa

Anne C. Wilson Graduate Fellowship
Eric N. Gourley
Robert E. Hart
Daniel B. Haug
Earth and Mineral Science Exposition 1997

EMEX

The College sponsored The College of Earth and Mineral Sciences Exposition 1997 (EMEX) April 5, 1997 in conjunction with the College of Engineering Open House. Unlike previous EMEX events which were directed to the local community, this year’s event was held to familiarize Pennsylvania high school students with the different programs and majors of the college. Professors Mark Klima and John Hellman, together with seniors Tony Demark and Colleen Stryker and junior Beth Yaeger (president of the EMS Student Council), were responsible for much of the planning. Students and professors from each major were on hand to run demonstrations and answer questions.

Meteorology exhibits included tours of the weather station, a weather balloon launch, and a presentation by Paul Knight and Fred Gadomski on hurricanes, blizzards and tornadoes. Geoscience exhibits included displays of rocks, minerals and fossils, and a presentation on current research in geology. Geo–environmental engineering held demonstrations of environmental remediation; exhibits included froth flotation, gravity separation, and coal cleaning. Geography had demonstrations of the application of computer mapping and geographic information systems. Materials Science and Engineering exhibits included demonstrations of a scanning electron microscope, electroplating, and advanced materials for things such as superconductors, computer chips and biomedical materials. Energy, Environmental and Mineral Economics displayed a wide array of posters presenting information on research issues and career opportunities, and showed a video on the relationship between energy and the environment. Mineral Processing analyzed the size of common materials. Mining Engineering opened the Mining Ventilation Laboratory for tours of the experimental mine. Petroleum and Natural Gas Engineering opened the Fluid Rheology Laboratory to demonstrate the uses of natural resources.

In addition to major specific activities, several EMS facilities were open. The student center answered general questions about enrollment; the library was open for browsing and gave away free posters and maps; and the museum was open for browsing of rock and mineral collections, the art collection, and hands–on exhibits.
1997 Student Marshal

Colin Heitzmann was the EMS student marshal at the 1997 spring commencement. Heitzmann, a son of Dr. Dennis Heitzmann, director of the University's Center of Counseling and Psychological Services, and Marcia Heitzmann of State College, received his B.S. in Geo-Environmental Engineering with highest distinction. He was a member of the University Scholars Program and received a number of awards for academic achievement, including the University's top undergraduate honor, the Evan Pugh Scholar Award, which he received in both his junior and senior years. In 1996 he received the Dean Edward Stelde Memorial Scholar Award, the college's highest honor for its top undergraduate student. He was named to the Dean's List ten times and received prizes in the 1996 and 1997 William Grundy Haven Student Paper Writing Competition. He will continue his studies in geo-environmental engineering at the University of Michigan, Ann Arbor.

THESIS LIST

A total of 176 degrees were granted by the College of Earth and Mineral Sciences at the University's 1996 Spring Commencement in May. 128 bachelor of science degrees, 48 advanced degrees. Following is a list of the advanced degree recipients and titles of their theses or papers.

Requests to borrow these may be made through the borrower's community company or University library. Libraries should address requests to Interlibrary Loan Service, Pattee Library, The Pennsylvania State University, University Park, PA 16802.

Geography — Timothy Paul Denham, M.S., Understanding the Kalam, Understanding Ourselves: Reflections on the Re-Presentation of the Kalam, Bamar Mountain Range, Papua New Guinea; John David Draves, M.S., Syncopated Controls on Streamflow and Surface-Water Chemistry; Nicolas Hogarth Huffman, M.S., paper; Can't Get Here from There: Reconstructing the Relavancy of Map Design in Postmodernism; Joanna Elizabeh Lavigne, M.S., The Geography of Departure: Regional Variation in Central European Sources of Mass Migration, 1815 to 1914.

Geosciences — Chi-Yan Chin, Ph.D., Application and Comparison of EPA Wellhead Protection Definition Methods for Karst Aquifer, Centre County, Pennsylvania; John Correy Crann, M.S., Diversion Well Treatment of Acid Water, Lick Creek, Tioga County, Pennsylvania; Mark Terrence Gibbs, Ph.D., Glaciation, Chemical Weathering and the Carbon Cycle; Jennifer Marie Mangal, M.S., Global Vegetation Patterns, Past and Present, as Predicted by the Genesis Climate Model; James Souss, Ph.D., Nonlinear Regression Modeling and Forecasting of Accelerating Slope Deformation; Jeraldie Stalkier, M.S., The Utilization of Bacterial Sulfate Reduction for the In-Situ Abatement of Acid Mine Drainage Using Waste Organic Matter; Gregory Ernest Tucker, Ph.D., Modeling the Large-Scale Interaction of Climate, Tectonics, and Topography; Angad Ibrahim Younes, Ph.D., Fracture Distribution in Faulted Basement Blocks, Gulf of Suez, Egypt; Reservoir Characterization and Tectonic Implications; Ping Zhao, M.S., Telesismic Waveform Analysis of a Deep Crustal Earthquake Associated with the Rukwa Graben, Tanzania.

Materials — Christopher Patrick Bowen, Ph.D., A Study of Dielectric Phosphor as a Means to Assemble Ceramic-Polymer Composite Materials; Heather Therese Hawkins, M.S., Design and Synthesis of [N2P] Radiphosphate for the Immobilization of Ruptrocessed High-Level Commercial Waters; Katsuho Kuwano, M.S., A Study of Sputtered Indium Tin Oxide (ITO) and Silicon Interfaces; Naesung Lee, Ph.D., Microwave Plasma-Assisted Chemical Vapor Deposition and Characterization of (001) Homoslitwa Diamond Films; Gang Qi, Ph.D., Interface Reactions of Polymer Derived SiC Fiber in Glass-Cermamic Matrix Composites; Christopher David Theis, M.S., Investigation of Growth and Domain Structure of Epitaxial Lead Tismate Thin Films; Timothy Francis Walsh, M.S., Penetration Failure Mechanisms of Woven Textile Composites — An Experimental and Numerical Investigation.

Materials Science & Engineering — Claudia Alinca Fournier, M.S., An Investigation of Co-Crystallization of Polystyrene Using Temperature Rising Elution Fractionation (TREF) and Differential Scanning Calorimetry (DSC); Nicole Marie Goray, M.S., A Mechanism of Fiber Fracture in Metallic Matrix Composites (MMC's); Anuray Gupta, Ph.D., New Aspects in the Oxidative Stabilization of Polycyclofulerene-Based Carbon Fibers; Srinam Madhavan, M.S., Growth and Characterization of Epitaxial SrRuOx Films; Jon-Paul Maria, M.S., Deposition and Measurement of Epitaxial Barium Titanate Thin Films with Conductive Epitaxial Oxide Electrodes by Pulsed Laser Deposition; Daniel Edward McCueley, M.S., Structure-Property Relations in BaTiO3-(Mg1/3-Nb2/3)iO-Based Glass-Cermamics; Stephen Augustine Newcomb, Ph.D., High Temperature Oxidation of Silicon Carbide Reinforced Alumina; Haris V. Venugopalan, Ph.D., Fundamentals of the Directed Oxidation Process for Synthesis of Alumina Aluminum Composites; Emily Min Yoon, Ph.D., Exploratory Screening and Development of Potential Jet Fuel Thermal Stabilizers Over 400 Degrees C; Ching-Len Yu, Ph.D., Ching-Len Yu, Ph.D., Chemical Kinetics of Reaction Systems CO + OH and CH3 + O2.


Mining Engineering — Bhrusht Kumar Bette, M.S., Evaluation of a Two-Phase Spray System for Dust Suppression; Jihan Liu, Ph.D., Numerical Studies Toward a Determination of Longwall Mining Impacts on Ground Water Resources.


Polymer Science — John Chung-Shih Chen, M.S., Nylon-Polystyrene Blends for Potential Use in Long Duration Balloon Films.
The Crystal Mill. Originally known as the "Dead Horse Mine", the picturesque Crystal Mill is the most-photographed mine in Colorado. In recent years the mill had been shored up and reroofed but it is still much the same as when it was operating. The Crystal Mill is located near the old towns of Marble and Radcliffe in western Colorado.