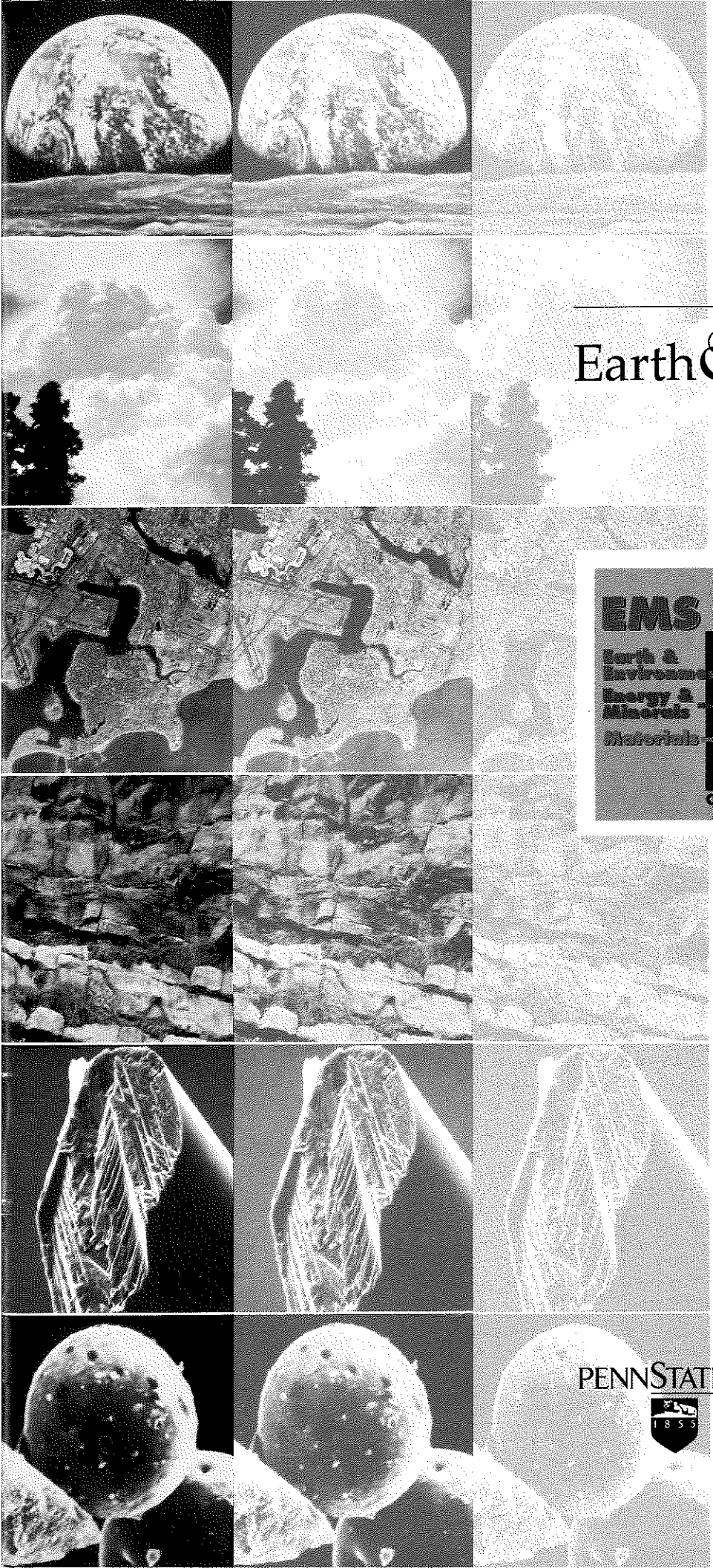

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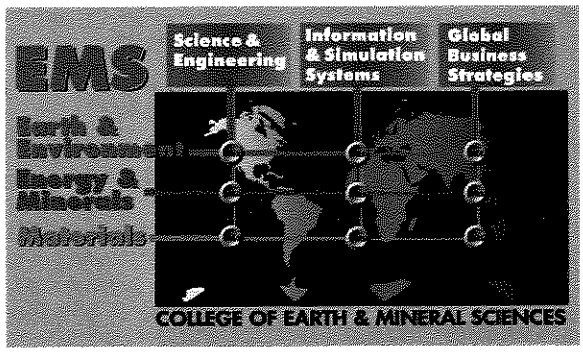

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Editorial Director: John A. Dutton
Editor: Judy Kiusalaas
Editorial Assistant: Colleen Swetland
Design: Cathy Zangrilli

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EDITORIAL

EVOLUTION FOR A NEW ERA

John A. Dutton, Dean of the College

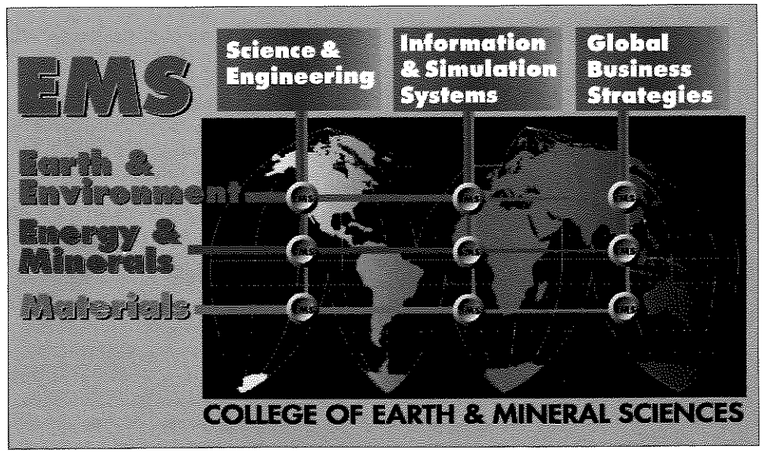
One of the most rewarding results of the EMS centennial celebration in 1996 was the opportunity to renew and strengthen relationships between the College and our most successful alumni. The informal interactions that have continued since then with these accomplished individuals have given us new insight into the sweeping changes taking place beyond academe in the commercial, industrial and financial worlds. They have stimulated a broader view of the challenges and opportunities for EMS research and education as they take advantage of an accelerating revolution in information and global communication.

Thus the the latest version of our Strategic Plan [1999-2002] incorporates specific emphasis on two new areas: INFORMATION AND SIMULATION SYSTEMS and GLOBAL BUSINESS STRATEGIES. We are in the process of creating minors in both these areas so that our graduates will be better prepared to advance rapidly to leadership positions in science, technology, and business.

Computer simulation and information systems have been an important part of EMS activities for more than 25 years. Today, the astounding new capabilities in computer and communication technology are forcing changes in our approach to teaching and learning as well as in the curriculum. We are creating an EMS e-Education Center to assist both faculty and students to take advantage of technological and conceptual developments in information science and technology. At the same time, we intend to create a new minor and new research initiatives in information and simulation systems that will emphasize visualization and computer modeling of complex physical and economic systems, both to advance scientific understanding and enterprise decision making.

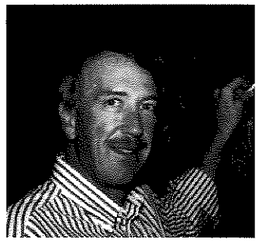
We are collaborating with the Smeal College of Business Administration to develop the minor in global business strategies that involve EMS-related private sector enterprises ranging from energy through materials to information intensive business focusing on the environment. As the collaboration proceeds, we will also be creating courses and specialized sequences for Smeal students interested in environmental issues and EMS related businesses.

These new directions are combined in the EMS emblem shown above, an emblem that embodies an exciting vision for the College at the start of a new century.



CLIMATE CHANGE AND AMERICAN AGRICULTURE: THE GREAT PLAINS
LESSONS LEARNED FROM A DECADE OF RESEARCH

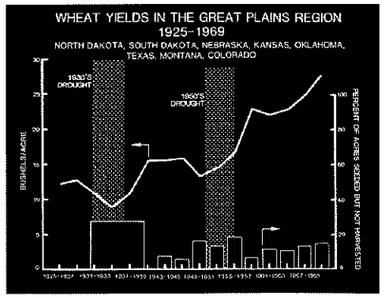
William E. Easterling, Associate Professor of Geography



This article is based on the Walter Orr Roberts Memorial Lecture on Global Environmental Change delivered by Professor Easterling at the Aspen Global Change Institute in August 1997. The lecture commemorated the tenth anniversary of the start of a major federally-sponsored assessment of possible impacts of global climate change on the renewable resources of the United States. It also helped launch a new U. S. National Assessment of the Consequences of Climate Change for the Nation. In the ten years since the last assessment, intensive research has revealed considerable insight into the vulnerability of U. S. agriculture to future climate change. As the debate sharpens over which path this country should take in dealing with global warming, it is time to take stock of these insights.

INTRODUCTION

Climate is an important natural resource for U. S. farmers. Adequate rainfall, solar radiation and nurturing temperatures are required for farming to succeed. The benevolent climate and fertile soils of the U.S. Midwest help to make the region one of the most productive agricultural areas of the world. When the climate resources of an agricultural region are disrupted, as in times of drought, hail, and killing frosts, crop yields are diminished, as is the income to farmers. Dependable climate is a necessary condition for successful agriculture.



For the purpose of this presentation, I take as given that climate changes from a strengthening greenhouse effect are likely to occur, and that such changes are certain to affect U. S. agriculture. Even without climate changes, U. S. farmers will face major challenges in the coming decades. Rising global demand for food and fiber will pressure farmers and their supporting agricultural institutions to raise global production. In the U. S., though, farmers will also be held increasingly responsible for off-farm environmental damage from their operations (degraded water quality, soil erosion, and loss of wildlife habitat). Unless research can provide technologies for reducing such damages while at the same time increasing productivity, the real costs of production will rise. The real prices (adjusted for inflation) farmers receive for their crops are projected by most experts to hold steady or even decline slightly over the coming decades. Should production costs for U. S. farmers rise relative to prices for outputs, U. S. farmers will struggle to compete with global neighbors whose agricultural resources (land, labor, capital) rival those of the U. S. Climate change, especially if it disadvantages production in the U. S., could be the straw that breaks U. S. farmers' backs and causes a severe erosion of the U. S. comparative advantage in global food production.
The potential for climate change to disrupt U. S. agriculture has been a topic of research for nearly two decades. In this article, I review some of the earliest research (from the 1970s and early 1980s) on the agricultural effects of climate change. I then focus on research results of the last ten years that have made a significant difference in answering the question: Will climate change cause American farmers to lose comparative advantage in the crops they wish to grow? I focus on Great Plains agriculture because it is one of the few regions in the U.S. where agriculture remains a principal source of employment and income.

EARLY RESEARCH ON CLIMATE AND AGRICULTURE

The pace and magnitude of future climate changes from greenhouse warming are expected to be unprecedented in human history. Nature has provided no examples of global climate change during the time of modern agriculture from which to reason to the future. However, there have been temporary excursions from historic climate averages that can serve as analogs or metaphors of climate change. These include the effects of recurrent droughts in the Great Plains in this century, which have caused serious disruptions in crop yields. The Dust Bowl droughts of the 1930s and the drought events of the 1950s in the Great Plains caused wheat yields to depart from their technologically-spurred upward climb through time.

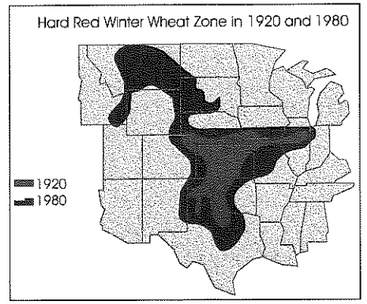
They also caused farmers to abandon a substantial amount of acreage that had been planted to wheat, but was uneconomical to harvest. At their worst, the 1930s droughts, combined with economic depression, forced numerous farm failures in the Great Plains, and drove desperate farmers to seek non-farm employment in other parts of the country, especially California. These drought and depression refugees were known as "Okies"—their lot graphically depicted by John Steinbeck in the *The Grapes of Wrath*.

An important difference between past excursions from climate means and the future climate seen by scientists is that future climate changes will continually accumulate with no apparent return to "normal." Furthermore, the changes are likely to become rapidly more severe than any climate events of the recent past. These differences dull the insights learned from the past. They make it necessary to use numerical simulation models to try to glimpse what the climatic future holds for agriculture.

The earliest attempts to model the effects of climate change on U. S. agriculture focused on crop yields (the amount of edible feed or food produced either in total, or per acre of cropland). Using a simple statistical model of the historic relationship between observed crop yield and average growing season climate, a 1983 National Academy of Sciences (NAS) study projected that a 1°C increase in mean temperature accompanied by 10% decrease in precipitation would cause as much as a 12% reduction below current levels of North Dakota spring wheat yields. Such a reduction would erase profits. Studies done similarly showed the Corn Belt shifting from its current location northeastward into southern Canada.

Although informative, this early NAS study (and many contemporaries like it) was misleading. No account was taken of the adaptive response of farmers and their institutions (i.e., Cooperative Extension, Land Grant university research). In the past, farmers have proven to be extremely adaptable and resilient in the face of environmental and economic challenges that resemble climate change. Why should climate change be any different? Furthermore, these early studies failed to take into account the possible ameliorative effects of rising atmospheric CO_2 levels on crop photosynthesis and on crop water use efficiency. These effects are reasoned to partially offset some of the negative impacts of climate change, and enhance some of the positive ones (not all of the climate changes need necessarily be bad for farming!). Hence, the early studies of the impact of climate change on U. S. agriculture tended to overstate the negative.

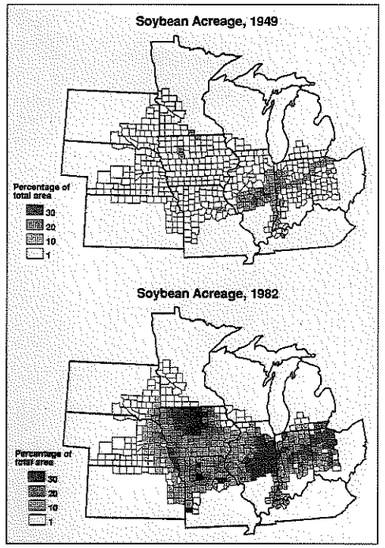
Research over the past decade has greatly increased our fundamental knowledge of how future climate change may affect future agricultural production, allowing more realism in the estimated future effects. Some insights enabled by this new knowledge include: i) the likelihood that the "direct" effects of rising atmospheric CO_2 levels on crop productivity may modify some of the effects of climate change; ii) farmers are capable of adjusting their operations to cope with climate variability; iii) global markets are likely to soften the impact of climate-induced supply disruptions on prices by directing trade flows to production regions not disadvantaged by climate change; iv) changes in the frequency of extreme climatic events (droughts, heat waves, severe storms) over small geographic areas (counties to parts of states) will be more important to agriculture than large-scale changes in average temperature and rainfall; and v) agriculture is vitally linked to other sectors (e.g., water, energy, transportation, natural ecosystems) that are also likely to be affected by climate change. In the sections that follow, I briefly review how application of this new knowledge has changed our thinking about the potential consequences of climate change for Great Plains agriculture.



NEW KNOWLEDGE THAT HAS MADE A DIFFERENCE

CO_2 Direct Effects

Atmospheric carbon dioxide is a necessary ingredient of photosynthesis. The biochemical pathways of carbon are more efficient in some classes of plants than others. In terms of carbon use in photosynthesis, the world's biota is divided mainly into two categories of species: C3 and C4. C4 species, such as tropical grasses (e.g., corn) are relatively efficient



users of carbon, while C3 species, such as legumes (e.g., soybeans), are relatively inefficient users of carbon. C4 species use carbon so efficiently that any additional carbon concentration in the atmosphere (i.e., CO_2) will have very little effect on photosynthesis in those species. However, C3 species use carbon inefficiently enough that photosynthesis in them should benefit from increasing CO_2 concentrations. Furthermore, increases in atmospheric CO_2 concentrations have been shown to increase the efficiency of plant water use (the ratio of water used per unit of plant biomass produced by photosynthesis), giving all plants greater drought resistance.

Experiments have demonstrated that increased atmospheric CO_2 concentrations have increased crop yields and decreased climate stress in many C3 and C4 crop species, with C3 species being more responsive than C4 species. Uncertainties remain over how much response there is when less than perfect experimental conditions prevail, as is the case on most real farms. Nonetheless, when incorporated in models of crop growth these experimental CO_2 effects have helped offset some of the deleterious effects of climate warming and drying on crop yields. For example, in a study of the effects of climate change on the Missouri-Iowa-Nebraska-Kansas (MINK) region (in which I was a participant), a simulated 75% increase of atmospheric CO_2 above current levels neutralized most (but not all) of the dryland corn yield loss due to a simulated contemporary recurrence of the Dust Bowl droughts in the eastern Great Plains. If you ignore the direct effect of CO_2 on crops, estimates of the negative effect of climate change will be greatly overstated, and estimates of the positive effect will be greatly understated.

On-Farm Adaptation

No farmer will watch crops fare poorly year after year without taking action to avert further loss. "Dumb farmers" are methodically weeded out by their own economic collapse. The incorporation of *adaptation* into modeling strategies has led to greatly improved realism in estimates of climate change impacts on farm-level production. Simple strategies that cost very little and are readily available to farmers today, such as adjustments to planting dates, the use of hardier crop strains, and moisture-conserving tillage practices, are the farmer's first line of defense against the earliest stages of climate change.

In the MINK study mentioned above, the incorporation of such adaptations (earlier planting to take advantage of warmer springs, use of longer season strains to take advantage of longer growing seasons, conservation tillage to conserve soil moisture) into crop simulations almost completely offset dryland corn yield losses due to climate change, particularly when combined with the direct effects of rising atmospheric CO_2 concentrations. If we also assume that new experimental technologies which add even greater resilience to climate (e.g., drought-resistant crop varieties, highly efficient irrigation systems) become widely economically available in the next few years, then crop losses from climate change could be effectively eliminated.

Off-Farm Adaptations

Eventually, climate change may overwhelm the capacity of Great Plains farmers to rely on readily available, cheap adaptive techniques. At such time, agricultural support institutions like the Cooperative Extension Service, federal crop production stabilization programs, and, most importantly, the agricultural research establishment, will need to provide farmers with new information and technologies.

The history of U. S. agriculture is replete with examples of the resilience and resourcefulness of farmers working together with support institutions to overcome environmental and economic constraints and to take advantage of similar opportunities. Some of these examples are analogous to the constraints and opportunities afforded by climate change. The case of crop migration histories is illustrative. The locus of hard red winter wheat production (the main source of bread flour) in the 1920s was centered on Kansas and Oklahoma. Its geographic extent was constrained by the climate-tolerance of the wheat strains then in use. The profitability of hard red winter wheat relative to other wheat strains provided a strong inducement to expand its production. Today, hard red winter wheat is grown as far north as the Canadian prairie provinces and as far south as the Rio Grande River. The natural temperature gradient (8°C difference in annual average temperature) that wheat crossed in its 70-year northward and southward expansion was at least as great as the anticipated warming from climate change at any given location in the Great Plains. What enabled such a dramatic expansion to occur? The answer is that improved temperature- and drought-hardy wheat strains along with innovative moisture-conserving land management practices (e.g., stubble-mulching, fallowing) were developed by the Land Grant universities and rapidly disseminated to farmers to aid the expansion.

How rapidly might farmers and their institutions overhaul production systems in order to produce and market a new mix of crops that is more adapted to emerging climate conditions than the old one? The historic case of the rapid adoption of soybeans in the U. S. Midwest provides insight to this question. Immediately after World War II very little Midwestern cropland was devoted to soybeans. By the 1980s (little more than 30 years later) soybeans had replaced wheat as a major crop. This required a rapid change in on-farm know-how and equipment, together with changes in transportation and marketing systems. Such a change is not unlike the changes that could be required by a climate change that forces a rapid switch to more climate-hardy crops than the ones grown at present.

The Role of Markets

Climate changes are not expected to be uniform around the globe. Some agricultural regions are likely to be advantaged (e.g., Canada and Russia, whose agriculture is currently cold temperature-limited) while other regions are likely to be disadvantaged (perhaps the U. S. Great Plains). Whether it is for better or worse for Great Plains farmers, global markets will continue to regulate trade flows as climate changes. The global markets will direct buyers to the most productive regions where food supplies are cheapest. This brokering by global markets will seek to hold stable the prices paid to farmers. Early agricultural studies took no account of how global markets could influence the prices U. S. farmers might receive for their crops as climate changes.

In a study led by NASA scientists in collaboration with other scientists from all over the world, a global economic model was used to show that scenarios of climate change and the resulting configuration of global crop yields (including "winners" and "losers") did not appreciably change crop prices from current levels, as long as agronomic adjustments like those described above were implemented. Stable crop prices combined with worsening climate conditions would be extremely bad for Great Plains farmers. This situation would be much worse than worsening climate conditions combined with rising prices.

Frequency of Extreme Climate Events

Early studies often pondered the question: what might the agricultural effects be of a change in the average climate conditions, as if those changes were to occur uniformly over areas larger than several states. But agricultural production is much more vulnerable to extreme climate events (e.g., droughts, heat waves) than it is to changes in average climate conditions. Research by scientists at the National Center for Atmospheric Research showed that a 2°C increase in mean temperature above current temperatures, but no change in the variance of temperature (meaning no change in the frequency of extreme events independent of that caused by increasing the mean), reduced wheat yields simulated at Topeka, Kansas by 0.5 mT/ha below current yields. But when the mean temperature was increased by 2°C and the variance was doubled (meaning a greater frequency of extreme events independent of that caused by increase in the mean), Topeka wheat yields decreased by 1.5 mT/ha.

Climate modeling is becoming much more proficient at skillful simulation of small-scale regional changes in the frequency of extreme climate events. Regional climate models, which have the ability to resolve climate features at scales that are meaningful to agricultural production (a few tens of kilometers), may now be "nested" within their larger "parent" global climate models (general circulation models). General circulation models are well-configured to simulate large-scale climate changes from greenhouse warming, while nested regional climate models are able to take those large-scale changes and refine them to smaller regions. In some of my research, I have demonstrated that crop yields losses simulated with climate changes generated by a general circulation model are transformed into crop yield gains when simulated with climate changes further filtered through a regional climate model to gain more realistic regional detail.

Linking Agriculture to Other Sectors

Will water resources be adequate to allow agriculture to resort to increased irrigation if this is required to adapt successfully to climate change? In earlier studies, agriculture was examined in isolation from water resources and other sectors (e.g., energy, transportation) that complement agricultural production—sectors that may, themselves, be affected by climate change. These early studies suggested that Great Plains agriculture could easily adapt to climate change by simply applying more irrigation water than is used currently. Such a strategy would more than make up for yield losses inflicted by warming and drying. However, in the MINK study, groundwater in the western Great Plains for irrigation was determined to become too scarce to be used economically in a few decades, even if the climate were not to change. Increased irrigation demand caused by climate change would deplete the groundwater resources even more rapidly, raising

the possibility that high rates of irrigation application could not be sustained under climate change.

SUMMARY

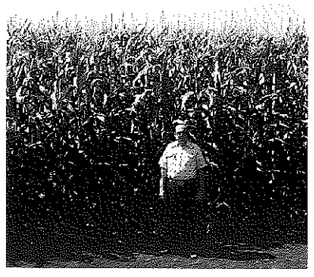
In light of the new knowledge of the last decade, what can be said about the prospects for Great Plains agriculture with a changing climate? Based on the evidence at hand, I believe that Great Plains agriculture could maintain enough comparative advantage to continue to grow the current suite of crops. Farmers and their supporting institutions will be challenged to develop new technologies and knowledge apace with climate changes, but if history is a reliable guide, this should not be an insurmountable task. There are, however, some unknowns that, once revealed, might cause me to be less sanguine about the prospects for Great Plains farmers under a climate change regime.

First, should the climate changes themselves prove to be more rapid and/or severe for the Great Plains than most of the climate models currently predict, then farming may be more challenged to adapt than my reckoning suggests. As argued above, farming systems in this country have great capacity to absorb environmental challenges when the challenges accumulate gradually. However, were the climate changes to outpace, for example, the time it takes for new crop strains to be developed, tested, and marketed (approximately 10 years by historical performance), then farmers could be left behind.

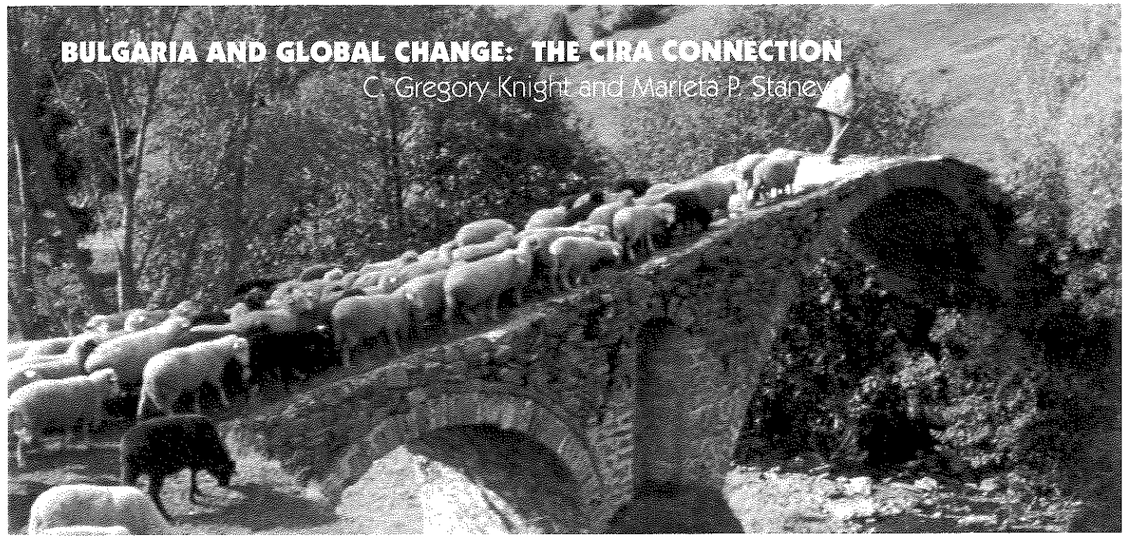
Second, the possible effects of climate change on agricultural pests and pathogens is not well-known. Experimental research has shown that certain Great Plains C3 weedy species (e.g., honey mesquite) are advantaged relative to C4 forage species (e.g., little bluestem grass) by rising atmospheric CO_2 concentrations. With yet higher atmospheric CO_2 levels in the offing, weedy species could rapidly gain the upper hand on desirable forage species. The ability of pests to overwinter in the warmer temperatures that are expected with climate change may greatly increase harvest losses. Pests and pathogens whose ranges are currently limited by cold temperatures could find their ranges expanding into the Great Plains under climate change. Pesticide costs and harvest losses caused by newly arriving pests and pathogens would be borne by the farmers.

Thirdly, the unpriced environmental costs of farming in the Great Plains could rise as farmers attempt to adapt to the effects of climate change. Any increase in irrigation water use will lead to further problems of runoff-induced lowering of water quality. As alluded to above, increased pumping rates on slowly recharging underground aquifers (such as the Ogallala Aquifer in the western Great Plains) will exacerbate already declining groundwater levels. Looking ahead, the possibility exists that U. S. farmers may be required to take steps to reduce greenhouse gas emissions from their operations (e.g., by reducing fossil fuel combustion and fertilizer application). Environmental regulations will require Great Plains farmers to deal with these environmental damages, thereby internalizing them as real costs. If the research establishment is not forthcoming with new technologies for dealing with the environmental damages, the real costs of production may rise. Rising costs of production, whatever their cause, would undermine agricultural comparative advantage.

Farming will survive in the Great Plains under any of the above situations. However, if we assume the worst, and each of the above unknowns comes down on the negative side of the ledger, then the loss of comparative advantage will be large enough to force major structural changes in Great Plains agriculture. Undoubtedly, farm failures would rise, the best farmers on the best land would survive using the land much differently from today, and the specter of the Dust Bowl would once again rear its head.



William E. Easterling is an associate professor of geography and faculty associate of the Earth System Science Center. Prior to coming to Penn State, he was an associate professor of agricultural meteorology at the University of Nebraska-Lincoln where he also directed the Great Plains Regional Center for Global Environmental Change. He was a fellow at Resources for the Future and recently completed an appointment as the acting director of the U. S. Department of Energy's National Institute for Global Environmental Change. He received his B.A., M.A. and Ph.D. degrees from the University of North Carolina at Chapel Hill. He has published widely on the interactions of agriculture, land use and climate change, and has served on numerous national and international scientific boards and panels.



BULGARIA AND GLOBAL CHANGE: THE CIRA CONNECTION

C. Gregory Knight and Marieta P. Staney

On a typical day, Professor Todor Nikolov Hristov walks from his home in the eastern part of Sofia to his office in the Institute of Water Problems on the nearby campus of the Bulgarian Academy of Sciences (BAS). An active man in his mid-sixties, he is a respected researcher and outspoken commentator on water resource issues. In his office, with its southern view to Vistosha Mountain relieving a congestion of desks and computers, much of his time is spent coordinating a team of younger colleagues working in collaboration with Penn State's Center for Integrated Regional Assessment (CIRA) in the College of Earth and Mineral Sciences. At the end of the day, he will retreat to his small home office—in reality a closet—where late in the evening he answers same-day Penn State e-mail (we are seven hours earlier) and perhaps moves our research forward step-by-step by sending along data or documents to CIRA colleagues he has met at Penn State or as visitors to Bulgaria. How did this CIRA-Bulgaria collaboration emerge? Here we want to give colleagues and friends insight into the human processes that underlie international research collaboration.

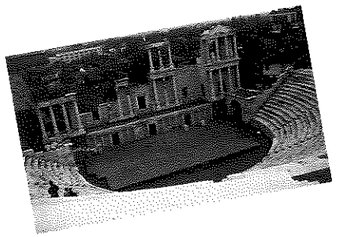
FIRST, BULGARIA

Bulgaria is a country on the Balkan Peninsula of southwestern Europe almost exactly the size of Pennsylvania, with a shape familiar yet less geometrical. Where Lake Erie pulls Pennsylvania northwest, the Danube beckons Bulgaria. Bulgaria's New York border is Romania, with the meandering Danube replacing the 42nd parallel. Her Delaware River shore is the Black Sea coast; her equivalent of the curved border centering on New Castle, Delaware is the border with Turkey; and her Mason-Dixon line is the watershed between north- and south-flowing streams on the Greek border. West Virginia and Ohio are Macedonia and Serbia, respectively.

Although Bulgaria and Pennsylvania occupy almost the same latitudes, their landscapes and climates are significantly different. Turn Colorado 90 degrees counterclockwise and put it where Iowa is and you about have it: dry agricultural plains to the north, a forested mountain range across the middle, and mountain blocks and arid valleys in the south, with a Colorado dependency on high mountain rain and snow for water resources. Bulgaria north of the east-west Stara Planina Mountains is as harshly continental as Nebraska; in the far south and southwest, almost Mediterranean.

Bulgaria sits at one of the most important crossroads between Europe and Asia. She can proudly claim the Thracians, who were the world's earliest gold metallurgists, but suffers the ignominy of five centuries of domination by the Ottoman Empire, ending finally in 1913. In 1989 the peasant nation of Bulgaria emerged from five decades of Communist rule industrialized, urbanized, and polluted. Protests and demonstrations of concern over transboundary air pollution in Ruse on the Danube were signal events leading to the formation of Ecoglasnost and end of communism. Succeeding years have set challenge after challenge—for political stability, for recovery from a record period of drought, and for economic stability and progress.

The political changes in Bulgaria after 1989 created a see-saw pattern of democratic and

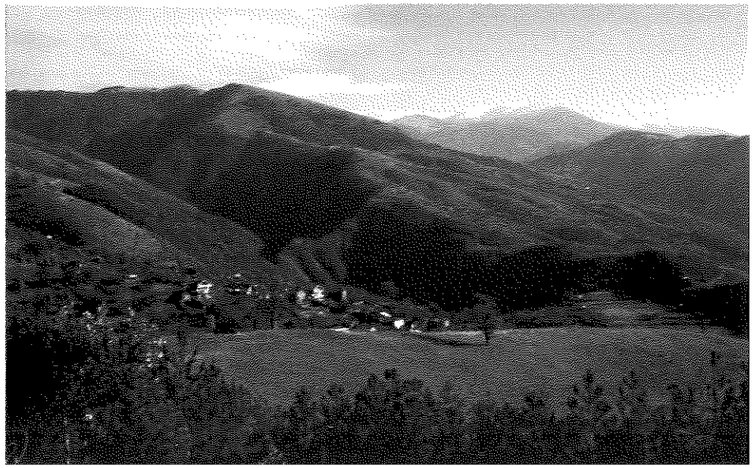


socialist domination of government, making the development of a coherent long-term development strategy problematic. Within the economic system of the former communist countries, Bulgaria was assigned both an agricultural and heavy industrial production role. The agricultural system came increasingly to rely on irrigation, which at its peak brought nearly 10% of the nation's area under irrigation. The industrial system focused on heavy metal production and fabrication, leaving a legacy of soil pollution around industrial complexes from aerosol deposition. The premature promise of rural land restitution led to a collapse of the agro-industrial complexes which were the core of agricultural production, and along with this collapse, the loss of irrigation as well. Equipment was sold off, irrigation structures neglected, and energy became too costly for pumping. Today, there are some positive signs of agricultural restructuring, including emergence of corporate farming systems. Similarly without the protected markets of the Soviet bloc, a substantial portion of the industrial sector could not compete and fell disused. Some industry remains operating with government subsidy. Privatization of industry has moved slowly, and political and policy vagaries have discouraged foreign investment. Monetary stabilization has been achieved, with the Bulgarian *leva* linked to the German *mark*. Nevertheless, income levels in Bulgaria remain low, with much disguised unemployment and poverty.

There is little linking Bulgarian history with Pennsylvania history—except the presence in Pennsylvania of substantial numbers of Bulgarian immigrants and of a marvel we almost take for granted—the computer. Arguably, the most important Bulgarian in American history was almost a Pennsylvanian —John V. Atanasoff (1903-1995), the inventor of the digital computer and son of Bulgarian immigrant Ivan Atanasov, was raised in upstate New York. It is appropriate that his invention should play so large a role in the Penn State-Bulgaria collaboration.

THEN, THE COLLABORATION

In 1987, Penn State geographer Ronald F. Abler (then on leave as Program Officer for Geography and Regional Science at the National Science Foundation) together with Andrew Isserman (then at the Regional Research Institute of West Virginia University) and George Hoffman (then at the Wilson Center's East Europe Program) coordinated an exchange between the Association of American Geographers and the Institute of Geography at the Bulgarian Academy of Sciences and Faculty of Geography at the University of Sofia that brought a number of Bulgarian geographers to the U. S. [Abler and Isserman, 1990]. A reciprocal visit of American geographers to Bulgaria in 1989 included Penn State faculty members Brent Yarnal and Knight, as well as Penn Stater John Pickles '83 Ph.D. Geography. Staneva, then at Veliko Turnovo University, was a participant on the Bulgarian side. Subsequently, Pickles and Yarnal were leaders of a joint Bulgarian-American team receiving support from the MacArthur Foundation for a three-year research program on environmental implications of the economic transition in Bulgaria [Paskaleva et al., 1998]. Later, Yarnal received a George H. Deike Research Grant from the College to pursue an investigation of greenhouse gas emissions in Bulgaria.



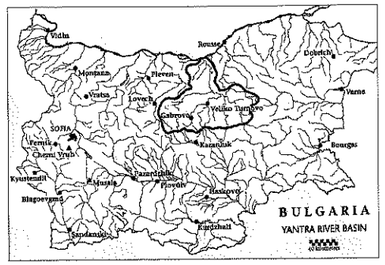
In 1994-95, we (Knight and Staneva) went to the recently-founded American University in Bulgaria (AUBG) with Fulbright support, undertaking research on Bulgarian water problems, including research on the Struma, an international river flowing from Bulgaria through Greece to the Aegean Sea. Late in our visit Knight was drafted, with agreement from the College and Penn State, to serve as acting dean to shepherd AUBG through its first graduation. By chance, we arrived in Bulgaria in the midst of the worst drought on record. Our initial research on the emerging drought [Knight, Velev, and Staneva, 1995] was expanded in summer 1996 with a team of Bulgarian colleagues to address water resource issues in the country in general [with support from the International Research and Exchanges Board; Knight and Staneva 1996a, 1996b].

Meanwhile, in 1995, a team of researchers back at Penn State, led by geographer Diana Liverman and Robert Merideth, had prepared a National Science Foundation research proposal on human dimensions of global change, which would have included a component on water issues and climate change in Bulgaria. After Liverman and Merideth left Penn State, a modified and more focused version of that proposal was funded for five years by NSF in 1996, creating CIRA as a global change research unit in EMS. Bulgaria would be one among three focal research sites, which also included the Susquehanna River Basin and the U. S.-Mexican border region, with continued collaboration with Liverman and Merideth at the University of Arizona. Bulgaria was selected as an example of nations with economies and political systems in transition, and a place particularly vulnerable to climate variability and change.

Our experience in Bulgarian water issues brought us to Todor Hristov, a structural civil engineer by training, who was then director of the Institute of Water Problems and prominent in local water resource debates. We found him to be a sound scientist, excellent organizer, and amiable individual; he consented to help us organize a workshop on global change research in Bulgaria. This defining event took place in June 1997 at AUBG under the auspices of the Bulgarian Academy and CIRA. Commissioned research papers were presented by interdisciplinary teams on scientific topics applicable to global change studies. In addition to the Bulgarian papers, Tereza Cavazos '98 Ph.D. Geography presented some of her early work on downscaling from general circulation models to regional climates.

At the end of the conference, the Bulgarian participants created a national global change research agenda and organized an *ad hoc* group that petitioned the President of the Academy to form a coordinating body on global change studies, an action that received response from the Academy in what must be record time. Within two weeks, the National Coordination Center for Global Change (NCCGC) was founded, in July 1997. Academician Dimitar Mishev (Solar-Terrestrial Influences Laboratory, BAS) was designated as chair and Todor Hristov, secretary. A first item for action was to be a joint project with CIRA using the impacts of the 1993-1994 drought in Bulgaria as a scenario for studying the human impacts of future climate change in Bulgaria, a project officially launched in 1998 under the direction of Mishev and Ivan Raev, director of the Forestry Research Institute (BAS). In July 1997, Penn State undergraduate Geography honors students Elizabeth Andrews and Jennifer Petullo joined a crew of AUBG undergraduate students in Bulgaria helping to reconcile Bulgarian and English versions of the papers in preparation for publication submission.

During this period, the international body START (Global Change SysTem for Analysis, Research and Training) based in Washington, D. C. was beginning consideration of a Central and East European (CEE) focus for regional studies of the causes and impacts of global climate change. In 1998 the first START-CEE workshop highlighted the Bulgarian work. Since no other nation in the region had such a body in place, the new Bulgarian NCCGC proved to be a forerunner



for interdisciplinary global change research in the region. In August 1999, the Bulgarian experience will again be highlighted at a second START workshop on regional global change, to be held in Budapest and coordinated by CIRA.

At the time preparation was taking place for the 1997 global change workshop, we were successful in a proposal in the NSF-EPA Water and Watersheds competition for modeling water pollution in the context of climate variability and change in the Yantra River basin of Bulgaria, with the collaboration of scholars associated with Penn State's Environmental Resources Research Institute (ERRI) and the Bulgarian Institute of Water Problems. This project would use ERRI's expertise on geographic information systems (GIS) and pollution, along with CIRA's interest in water resources management and experience in Bulgaria, and the Bulgarian Institute's on-site capabilities to build a modeling/decision-support framework that could be used elsewhere, including the U. S. A major element of our thinking was the benefit of the relatively (and regrettably) low cost of Bulgarian collaboration, the transferability of results, the opportunity to extend foreign research experience to colleagues, and the contributions we might make to underpinning the Bulgarian research community during the very difficult economic transition taking place. It helped that we had considerable personal experience in the basin, including presentations to a US-AID training course for the Yantra Basin Council in 1995, and that issues of climate variability and change in Bulgaria provided a clear link to CIRA goals. The unpredictable nature of fortuitous research opportunities is well exemplified by the Yantra River project: the initial concepts were framed with Hristov one evening at our family's summer cabin in the mountain village where, by chance, the U.S.-AID training course was held.

THE RESEARCH

The CIRA-Bulgarian connection has several on-going components: in roughly chronological order, we will mention the Struma river, climate variability and change, the Yantra basin study, and the retrospective investigation of the drought. We maintain an informal affiliation with the American University in Bulgaria, which graciously gives us office space, computer facilities, and most importantly access to unusually capable undergraduate interns. As an example, Deyan Kostov, an AUBG undergraduate computer science major who recently completed his M.S. in Environmental Sciences and Policy at Central European University (Budapest), developed our first GIS-based climate-runoff model of the Struma River Basin during the summers of 1995 and 1996. His work has been continued here by Geography doctoral student Heejun Chang, who is working with us to expand the Struma model into a framework that can be used to project the implications of climate variability and change using coarse temporal resolution data (monthly climate scenarios). This work is also contributing to the project WATERMAN funded by the European Union Copernicus Fund, headed by Agop Hachikyan of the Technical University-Sofia (Bulgaria) and Rudolf Scherer, University of Karlsruhe (Germany), with colleagues at the Istituto per la Matematica Applicata (Italy), Aristotle University of Thessaloniki (Greece), and St. Cyril and Methodius University (Macedonia) for management of common Balkan water resources: the Struma is the only river basin linking all three Balkan countries (Knight is an advisor to the Technical University, Sofia).

As part of the on-going CIRA-Bulgarian activities, Penn State researchers Robert Crane and Tereza Cavazos (now at the University of Cape Town, South Africa) have been undertaking analyses of downscaling from general circulation models (GCM) to regional climate models using neural nets. Initial investigations demonstrated significant problems with GCM GENESIS capture of the complex atmospheric flows over the Balkans, and with some gridded climate data being used as "truth" for downscaling, both issues calling for further study. However, in a submitted paper, Cavazos has been able to link important fluctuations in Balkan climate to the Arctic Oscillation. While the persistent winter droughts of the late 1980s and beginning of the 1990s in southern Europe and the Mediterranean have been linked to changes in the zonal flow associated with the North Atlantic Oscillation, droughts in the Balkans are more strongly coupled to changes in the zonal flow and to a deepening of the polar vortex typical of the high phase of the Arctic Oscillation. This work should make an important contribution to understanding the role of large-scale circulation patterns in Bulgarian climate variability.

The Yantra Basin study involves a large research team here and in Bulgaria. In EMS CIRA post-doctoral scholar Jeffrey Carmichael is working with us on the structure of an econometric decision-support model for pollution control. This model, in turn, draws upon new approaches to GIS modeling of point and non-point source pollutants developed by Barry Evans (ERRI) and James Hamlett (Agricultural Engineering). Hamlett is this year a Fulbright Professor in Bulgaria at the University of Architecture, Civil Engineering and Geodesy (Sofia), where he is also working with colleagues at IWP and the Pushkarov Soil Research Institute. The Bulgarian team under Hristov's direction is building a digital elevation model of the basin as well as digitized climate, soils, and land use data sets necessary for the Evans-Hamlett model. In January 1999, Ivan Nikolov (GIS) and Dimitar Dimitrov (decision modeling) of the Bulgarian team were resident at Penn State as part of the project. The result of this study will be a GIS-based decision support system that addresses these questions: If we invest in pollution control at a place, where and to what degree will the stream quality goals be achieved. And vice-versa, to attain certain quality standards for a given reach (or reaches) of the basin, what alternative strategies could be implemented under various probabilistic levels of stream flow resulting from climatic variability and with input from the local community? This project will conclude in 2000.

The most recently initiated collaboration with the Bulgarian Global Change Center is a two-year retrospective study of the 1993-1994 extreme drought and its socio-economic impacts, seen as an analogue for future climate change. Although climate change forecasts for the Bulgarian area remain ambiguous, there is agreement that significant warming will take place, accompanied by little if any increase in precipitation, perhaps even a decrease. The real climatic conditions of the early 1990s may therefore occur more frequently. What can this drought event teach us about coping with future events? A team of Bulgarian researchers will be assisted by CIRA colleagues to document the climatic, ecological, hydrological, sociological, economic, and political consequences of this period, the culmination of over a decade of increasingly dry conditions. We believe the analysis will substantiate the hypothesis that without the economic collapse after 1989 and consequent decrease in water demand, the drought event would have been truly catastrophic. From the 1993-94 analysis, the team will create two scenarios: the impacts of such a drought prior to 1989 when the economy was fully operational (prior to the 40-50% decrease in industrial activity and nearly 90% decrease in irrigated agriculture) and in 2020 when a recovered economy will again use larger water quantities.

The Bulgarian research connection has opened other doors for CIRA adding a new dimension to other projects. CIRA activity in Bulgaria has attracted sufficient international attention for us to interact with parallel global change research groups in other nations, as well as with international global change organizations. From the start, the Bulgarian connection has been professionally and personally rewarding for its participants, resulting in numerous publications, externally funded research activities, long-term professional relationships, and international research experience. Both the collaboration and research management depend on the descendants of Atanasoff's invention—the digital computer—and the world network of communications [Knight 1998]. There has been both design and serendipity in building the CIRA collaboration with Bulgaria, but the roots are now sufficiently deep that we believe it will prosper for years to come.

For further information on:

Atanasoff, see www.scl.ameslab.gov/ABC/Biographies.html

AUBG, see www.aubg.edu

CIRA, see www.essc.psu.edu/cira

START, see www.start.org

References:

Abler, R. F. and A. M. Isserman. 1990. "Bulgarian Geography and Geographers," *The Professional Geographer* 42, 3: 371-378.

Knight, C. G., Velev, S. P. and Staneva, M. P. 1995. "The Emerging Water Crisis in Bulgaria," *GeoJournal* 35(4): 415-423.

Knight, C. G. and Staneva, M. P. 1996a. "Water Resources of Bulgaria: Introduction to a Special Issue of *GeoJournal*," *GeoJournal* 40.4: 343-345.

Knight, C. G. and Staneva, M. P. 1996b. "Water Resources of Bulgaria: An Overview," *GeoJournal* 40.4: 347-362.

Knight, C. G. 1998. "Globalization and Global Change Research," GeoJournal 45,1:27-32.

Paskaleva, K. et al. 1998. *Bulgaria in Transition*.. Brookfield, Ashgate Publishing Company.

C. Gregory Knight is Professor of Geography and director of the Center for Integrated Regional Assessment in the EMS Environment Institute. He has been a member of the faculty since 1971. Marieta P. Staneva received her Ph.D. from the University of Sofia, Bulgaria. She teaches geography in the Division of Natural Sciences and Mathematics at Penn State Altoona and is an adjunct faculty member of the Department of Geography.

DECLINE IN THE MONONGAHELA VALLEY CITIES

E. Willard Miller, Professor Emeritus of Geography

E. Willard Miller served as Department Head of Geography from 1945-64. From 1965 until his retirement in 1980, he served as Associate Dean for Resident Instruction for the College of Earth and Mineral Sciences.

Table 1
Manufacturing Employment

	1940	1997
Munhall	13,583	17
Homestead	11,020	239
Duquesne	8,072	14
Monesssen	7,425	110
Braddock	6,247	542
Donora	5,225	658
McKeesport	4,468	1,320
Clairton	3,458	525
Charleroi	2,227	774
Glassport	1,672	390
Total	63,397	4,594

Source: Pennsylvania Industrial Directory

Table 2
Population

	1940	1997
Munhall	17,312	13,158
Homestead	20,141	4,179
Duquesne	21,396	8,525
Monesssen	20,268	10,367
Braddock	18,320	4,682
Donora	13,180	5,928
McKeesport	55,355	26,016
Clairton	19,652	9,996
Charleroi	10,784	5,014
Glassport	8,748	5,582
Total	205,156	93,447

Source: U.S. Department of Commerce, Bureau of the Census, Census of Population and Housing

In the 19th and early 20th centuries, the Monongahela River valley cities of Pennsylvania—Homestead, Braddock, Duquesne, Glassport, Clairton, Charleroi, Munhall, McKeesport, Donora, and Monessen—became the apex of the American iron and steel and associated heavy industries. These cities came to exemplify the one-industry cities of the American Industrial Revolution. For nearly a century, the iron and steel industry maintained its dominance. At its peak of employment in the early 1950s, the iron and steel industry had about 61,000 workers out of these cities' total work force of about 63,400 in manufacturing. The glass industry located in Glassport and Charleroi was the second largest industry with about 2,000 workers (Table 1).

Prior to the 1970s, while there was some loss of workers due to changing market demands, foreign competition, and increasing productivity, employment remained high. However, in the 1970s the iron and steel corporations began a planned program of downsizing. By the early 1970s the decline in employment became cataclysmic and when the initial 1882 plant of the U.S. Steel Corporation closed its doors at Homestead in 1986 only a fragment of the industry remained. Vast areas that had once been occupied by mills had been leveled or remained as rusting skeletons-reminders of a former time. As one mill worker stated on the last day of the Homestead mill, "I worked in that rusty mother for thirty-nine and one-half years. Now it's gone. Now it's gone. It's a goddamned shame."

ADAPTING TO DECLINE

In 1996 the Pennsylvania Industrial Directory listed an employment of about 5,600 manufacturing workers in the ten cities. Of this number, about 1,500 remained in the iron and steel industry in Braddock and the village of Allenport. While only a remnant of the iron and steel industry exists, the production of metallurgical coke in Clairton and Monessen remains. The USX Corporation coke works in Clairton is the largest in the United States. Its annual capacity is about 4.8 million tons about 26% of the U.S. total plant capacity. With about 1,700 workers, this is the largest employer in the Mon valley. The glass industry continues in Clairton and Glassport, but due to rising productivity and changing market demands, employment has declined to about 800.

A number of the cities have established industrial parks. A few small industries, such as plastics and light chemicals, have entered these areas but they remain insignificant in revitalizing manufacturing.

A basic question is, why has the availability of about 60,000 unemployed steel workers not provided a major inducement to attract new industry to the region? A number of negative factors are evident. First, the skills of the mill worker are not readily transferable to the modern high-tech industry of the late 20th century. Second, the increase of unemployed workers was so rapid that retraining programs have not developed in the region. Third, the wages of the steel workers were so high that new, lower wage paying companies have been repelled. Fourth, essentially all industrial land was owned by steel corporations. Although the land is now vacant, the price remains extremely high and, further, the corporations have not sold this industrial land. In these hill towns, there is little industrial land available outside the river fronts. Fifth, because the iron and steel industry based its transportation needs on railroads and river transportation, a modern highway system was not developed along the river. Route 83 on the left bank remains a two-lane road that has not been modernized in the past fifty years and there is no road on the right bank. Sixth, the past decade has seen a downsizing in the labor force in the total American industry. Under such restricting of the American industry, the Mon valley remains one of the least desirable areas in the United States to increase its employment in manufacturing.

THE EFFECTS OF DECLINE

The population of the 10 cities (Table 2) was about 205,156 in 1940. By 1990 the population of these cities had declined to 93,447, a decline of 111,709 or an average city decline of 54%. The decline, however, varied greatly from city to city. Homestead, whose population declined from a high of 20,141 in 1930 to a low of 4,179 in 1990, or 79.2%, had the greatest percentage decline. McKeesport had the largest absolute decline from 55,355 to 26,016, a decline of 26,357 or 53%.

The decline of population in the Mon cities has altered the age structure (Table 3). In 1960, the cities had an age structure similar to that of the state. By 1990, it was significantly different. In 1990, the 18 to 44 age group in the state made up 42% of the state's total population, but in the 10 Mon cities it was but 33% of the total population. This percentage varied only about 2% from city to city. This reflects the migration of the young people from this area.

This reduced number of people in the 18 to 44 age groups has consequently reduced the size of the total labor force. In 1990, 62% of the Pennsylvania population 16 years and older was in the labor force. In contrast, only 47% of the population 16 years and older were in the labor force of the 10 Mon cities. Within the cities, the percentage in the labor force varied from 41% in Monessen to 51% in Munhall. In contrast to the decline in the younger population, the older population, 65 years and older, has experienced a considerable increase. In Pennyslvania in 1990, about 15% of the people are over 65, but they averaged 25% in the 10 Mon cities, with variation from 29% in Monessen to 21% in Braddock. The older persons remain in the area for they have a home, usually without a mortgage, and most have a small pension and social security and are able to survive financially. Because of age, their chances of finding employment elsewhere is very small. Further, the iron and steel workers have developed a close community relationship, with friendships that are highly prized.

In spite of a massive decline in population, resulting in one of the smallest labor forces in Pennylvania (Table 4), the labor force still exceeds the modest employment demand. This results in excessively high unemployment rates. The average state unemployment rate in the state in the past decade has been between 5 and 6% while in the ten Mon cities, it has averaged about 13%. The rate has, however, varied considerably from city to city.

Table 3
Population and Age Structure Percentage

	Age 18-44	16 Years and Older in Labor Force	Over 65
Pennsylvania	41.1	61.7	15.4
Munhall	35.5	51.2	24.4
Homestead	35.5	44.1	23.4
Duquesne	35.5	46.5	22.8
Monesssen	30.3	41.6	29.3
Braddock	35.0	49.0	21.7
Donora	32.3	42.5	28.4
McKeesport	35.1	47.5	23.7
Clairton	35.5	47.5	23.0
Charleroi	34.8	46.8	28.4
Glassport	35.4	49.7	22.1

Source: U.S. Department of Commerce, Bureau of the Census, 1990 Census of Population and Housing

Munhall has been close to the state average while Donora's unemployment rate has been around 17%.

Two factors, however, appear to have reduced even these high unemployment rates. First, a large number of people in the Mon cities now commute to work in the more prosperous towns of the Pittsburgh region. Some estimates indicate that as many as 40 to 50% of the work force commute to work. Second, because there are so few jobs in the Mon cities, a significant number of people have dropped out of the work force. There are many reasons for dropping out of the work force. For example, compared to the wages received in the iron and steel industry, many of the service jobs have extremely low wages. These individuals exist on government welfare, aid from family and friends, and an occasional odd job. This remains a chronic problem.

Due to high unemployment and the availability of only low-paying service jobs, the household income is among the lowest in the state (Table 5). In 1990, the medium household income for the state was $29,064 while for the ten cities it was about $17,253. Within the cities, the median household income varied from a low of $11,390 in Homestead to a high of $23,883 in Munhall. A number of factors contribute to the low household income. Because manufacturing has essentially

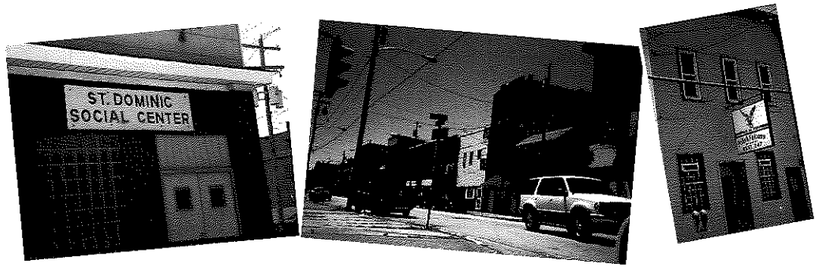


Table 4
Unemployed Labor Force 1996

	Percent Unemployed
Pennsylvania	6.0
Munhall	5.7
Homestead	11.3
Duquesne	14.7
Monesssen	14.9
Braddock	12.1
Donora	16.4
McKeesport	13.7
Clairton	10.3
Charleroi	12.8
Glassport	10.3

Source: Compiled from various sources. The Pennsylvania Department of Labor and Industry

Table 5
Household Income 1990

	Median	Mean
Pennsylvania	$29,069	$36,684
Munhall	$23,069	$26,982
Homestead	$11,390	$16,199
Duquesne	$15,801	$20,126
Monesssen	$18,131	$22,115
Braddock	$17,340	$19,850
Donora	$16,620	$20,888
McKeesport	$16,427	$21,661
Clairton	$17,396	$25,186
Charleroi	$15,789	$21,509
Glassport	$20,146	$23,539

Source: U.S. Department of Commerce, Bureau of the Census, Economic Characteristics, Pennsylvania, 1990

Table 6
Median Value of Housing 1990

	Median Value
Pennsylvania	$69,701
Munhall	$42,300
Homestead	$25,300
Duquesne	$27,000
Monesssen	$36,500
Braddock	$16,700
Donora	$24,900
McKeesport	$27,800
Clairton	$27,600
Charleroi	$28,300
Glassport	$22,500

Source: U.S. Department of Commerce, Bureau of the Census, Econornic Characteristics, Pennsylvania, 1990

disappeared in the Mon cities, service industries dominate employment. The unemployed mill worker is poorly prepared for these jobs and is able to secure only the lowest paying ones. Because many men cannot secure employment, women, in order to support their family, work in the lower paying jobs. The strong steel workers union is gone and no new unions have entered the area to support the wage demands of the workers.

Because wages are low, the buying power is also at a low level. Consequently, retail sales are minimal and thus limited to necessities. Specialty stores have essentially disappeared. As a result, the Central Business Districts are largely abandoned. It is common to have an entire block of abandoned stores. A few malls have developed on the edge of the cities but these are small and are dominated by such basic stores as grocery or hardware. Because the malls are larger with a greater variety of stores in nearby towns, many people in the mill towns shop in these areas.

THE CULTURAL IMPACT OF DECLINE

The Mon cities appear as if they have been stopped in a time warp. They reflect the appearance of the early 20th century. This is most evident in housing.

Because the mill workers wanted a private house, there are few apartments in the cities. As a result, much of the housing is about 60 years old. Most of the homes were middle-class residents of the period. In 1989, the average price of a house in Pennsylvania was $69,701 compared to an average price of about $27,890 in the ten Mon cities(Table 6). The price varied considerably from city to city with Braddock having the lowest average house price of $16,700 and Munhall the highest at $42,300. Because of age, some houses have been torn down, but there are few vacancies. Although the population over 65 is larger, there are few senior citizen homes. The older people want to remain in their homes and are normally supported by their children. Because of the low cost, many young couples are able to afford a home and with the expenditure of a few thousand dollars modernize it.

In the city landscape, churches are a conspicuous feature. As was typical in the 19th century, the neighborhood church provided religious services within walking distance from home. The churches were normally small but very substantial, stone structures. As the population has declined and the neighborhood grown older, the small congregations are no longer large enough to financially support the neighborhood churches. Many of the neighborhood churches are now closed. Some remain vacant. Others have been converted into recreational centers for youths and/or senior citizens. Most parochial schools have closed in recent years.

The ethnic clubs were also a cultural feature of the early mill towns. They were cultural centers where the workers could find ethnic foods and newspapers. These clubs persist, primarily for the older population. They provide a place for social gatherings at a very reasonable cost. They have become a haven for those who have time to spend but little money.

In the Mon valley, a great industrial society disappeared within a decade. The area has responded to the financial shock in a number of ways. Most significant was the migration out of the area, resulting in a massive decline in population. Since there has not been a replacement of the original industrial economy and there has not been sufficient time to develop a modern economy, commuting to work in nearby towns has grown significantly. As a result, the Mon cities have increasingly become bedroom communities. At the present time, there is little indication that their role will change in the near future.

EMS NEWS

WELCOME EGEE!

The Department of Mineral Engineering has officially transformed into the **Department of Energy and Geo-Environmental Engineering**. The new Department, known as EGEE, was "signed into law" by the Board of Trustees on November 13, 1998.

The event was marked by the transfer of Fuel Science from MatSE to EGEE, plus an internal reorganization and the dramatic renovation of suites of offices in Hosler Building.

The new department thus deals with the entire energy and minerals sector from the recovery of fuels and raw materials to their processing and utilization, together with the protection of human and environmental resources. There are degree programs in research in Mining Engineering, Petroleum and Natural Gas Engineering, Mineral Processing, Fuel Science, Geo-Environmental Engineering, Mineral Engineering Management, and Industrial Health and Safety.

EGEE currently has 282 students enrolled in its degree programs:

UNDERGRADUATE	
Geo-Environmental Engineering	132
Industrial Health & Safety	23
Petroleum & Natural Gas Eng.	31
Mining Engineering	15

GRADUATE STUDENTS	
Fuel Science	33
Petroleum & Natural Gas Eng.	26
Mineral Processing	16
Mining Engineering	6

Essentially the administration of the department has been simplified by combining the former program administrative offices. The entire department is now administered by a new Department Head, Alan Scaroni, Associate Department Head, Turgay Ertekin and the combined faculty and staff. Some staff people have changed their responsibilities, most faculty and staff members have relocated their offices.

Clarification can be found at the new EGEE website: http://www.ems.psu.edu/egee/index.html The information officer for the Department of Energy and Geo-Environmental Engineering is Kelly Henry, telephone: 814-865-3439.

ALAN SCARONI HEADS EGEE

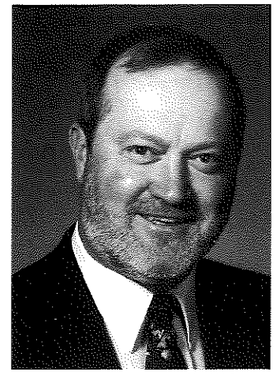
Alan W. Scaroni, professor of fuel science, has been appointed as head of the newly reorganized Department of Energy and Geo-Environmental Engineering in the College of Earth and Mineral Sciences. He succeeds Raja V. Ramani, head of the former Department of Mineral Engineering, who has assumed the George and Anne Deike, Jr. Chair of Mining Engineering.

Scaroni served as chair of the Fuel Science Program from 1996 to 1998, director of the Energy Institute from 1992-98, and director of the Combustion Laboratory from 1988 to 1996. He has been a member of the Penn State faculty since 1981.

For the past 15 years his research has focused on both fundamental and practical aspects of coal combustion, including studies of coal water fuels and of limestones as sorbent materials. He served as director of the Consortium for Coal Water Slurry Fuel Technology, and director of the National Center of Excellence for Coal Utilization. His work has been recognized by the Pennsylvania Aggregates and Concrete Association and the American Society of Highway Engineers, and the American Chemical Society.

He has held a number of positions with the American Chemical Society's Division of Fuel Chemistry including division chair and trustee, and served as chair of the Pittsburgh Coal Conference in 1998-99.

He holds a B.E. (Hons) in chemical engineering from the University of New South Wales (Australia), and M.S. and Ph.D. in fuel science from Penn State.

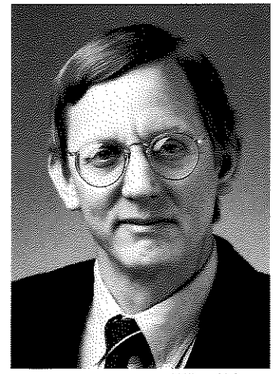


Alan W. Scaroni

METEOROLOGY HAS NEW DEPARTMENT HEAD

William H. Brune, professor of meteorology, has been appointed as head of the Department of Meteorology, succeeding Dennis Thomson, who is returning to full-time teaching and research after leading the department since 1992.

Brune, an atmospheric chemist, has been a faculty member of the Department of



William H. Brune

Monty Mitchell (L) presenting the first Innovative Teaching Award to Professor Alistair Fraser.

Meteorology and the Earth System Science Center since 1988. He came to Penn State from Harvard University, where he was a research scientist in chemical physics.

He is widely known for his research on air quality and ozone destruction, and has served as a mission scientist for a number of NASA airborne Arctic and Antarctic research investigations of Earth's protective ozone layer. At Penn State, he has developed a state-of-the-art instrument for measuring atmospheric trace constituents that has been deployed by helium-filled balloons in different locations of the globe to obtain profiles of carbon dioxide and other gases in the stratosphere. He currently serves as principal scientist for a NASA observational program to assess the potential for ozone loss by proposed supersonic aircraft.

In 1994 Brune received the College of Earth and Mineral Science's Wilson Research Award for his fundamental contributions to the measurement and interpretation of atmospheric trace gases and their role in atmospheric chemical processes. He has in addition received eight NASA group achievement awards during the period 1989 to 1998. He serves as associate editor of the *Journal of Geophysical Research, D*, and will serve as co-chair of the 1999 Gordon Conference on Atmospheric Chemistry.

Brune holds a B.S. in physics from Southwestern University and M.A. and Ph.D. in physics from Johns Hopkins University.

Brantley appointed CECG Head

Susan L. Brantley, associate professor of geosciences, has been appointed as the new director of the Center for Environmental Chemistry and Geochemistry in the Environment Institute, succeeding Dr. Patrick Hatcher who is now at Ohio State. The Center has faculty affiliates from many Penn State departments, and promotes joint research projects, shared research facilities and student support and recruitment for fields related to environmental chemistry. For additional information on CECG see: http://www.essc.psu.edu/CECG/index.htm

Green New ACerS Editor

David J. Green, professor of ceramic science and engineering, has been appointed Editor of the *Journal of the American Ceramic Society*. The position was previously held by Penn Stater Gary Messing and earlier by Bob Newnham.

New EMS Teaching Award Established by PNGE Alum

Obelisk Society members Monty Mitchell and his wife Peggy have established a new award in the college to recognize EMS faculty members who develop teaching methodology and demonstrate high performance in innovative teaching.

The first G. Montgomery & Marion Hall Mitchell Award for Innovative Teaching in Earth and Mineral Sciences was presented to Meteorology Professor Alistair B. Fraser at the 1998 Obelisk Society Dinner at the Penn Stater in September. The award is expected to be presented annually at the discretion of the Dean. Professor Alistair Fraser is widely known for his pioneering achievements in the computer-aided teaching of atmospheric science and his use of Internet resources. His Web pages on science, meteorology, and other topics have received numerous Internet awards.

Monty Mitchell received a B.S. in Petroleum and Natural Gas Engineering in 1949. He retired as Senior Vice President from Stone & Webster Management Consultants in Houston.

Miller Lectures Established in Geography

A new Lecture Series designed to bring eminent geographers to Penn State has been donated to the Department of Geography by Professor Emeritus E.W. Miller, a former department head and associate dean emeritus in the College of Earth and Mineral Sciences, and his wife Ruby, a retired University librarian and map librarian. They previously endowed an award program that recognizes outstanding achievement by undergraduates and graduate students in geography. The inaugural lecture in the E. Willard and Ruby S. Miller Lecture Series in Geography was presented by Dr. Lawrence A. Brown, distinguished professor of geography at Ohio State University. He spoke on "Change, Continuity and the Pursuit of Geographic Understanding: the Lesson of Innovation Diffusion Broadly Conceived," a retrospective of his 25-year research program on the adoption and geographic spread of new products and techniques. Brown, who is department head of geography at Ohio State, has received several professional awards for his teaching and research. He served as president of the Association of American Geographers in 1996-97.

Ertekin Wins SPE Accolade

Turgay Ertekin has received the 1998 Distinguished Achievement Award for Petroleum Engineering Faculty from the Society of Petroleum Engineers. Dr. Ertekin is professor of petroleum and natural gas engineering and Quentin E. and Louise L. Wood Fellow, and currently serves as associate head of the Department of Energy and Geo-Environmental Engineering.

The award was presented at the annual meeting of the society in New Orleans. Ertekin was cited for "his personal standards of professionalism and service," his research in reservoir modeling and engineering, and "especially for his excellence in teaching and his counseling with current and former students."

Parizek Honored

Richard R. Parizek, professor of geology, has received the M. King Hubbert Science Award of the National Ground Water Association in recognition of his major contributions to knowledge of ground water. The award was presented at the association's 1998 annnual convention and exposition, held in Las Vegas, Nevada in December 1998. Parizek established the College's program in hydrogeology in the early 1960s and is especially well-known for his work on water problems of mined land. He is currently serving as an appointed member of the national Nuclear Waste Technical Review Board, focusing on the Yucca Mountain Project.

Freeman Wins Her Second Young Scientist Award

Katherine H. Freeman, associate professor of geosciences, has been named 1999 recipient of the James Lee Wilson Medal from SEPM, the Society for Sedimentary Geology. The award is for "Excellence in Sedimentary Geology by a Young Scientist" and will be awarded at the SEPM annual meeting in San Antonio, TX, in April 1999. She receives the award for her work in compound specific isotope analysis.

In 1998 she received the Peter Schenk Award in Organic Geochemistry presented biannually by the European Association of Organic Geochemists to a young scientist. Freeman was recently appointed to the National Research Council committee on Basic Resarch Opportunities in the Earth Sciences

Fossil Organisms Named for Roger Cuffey

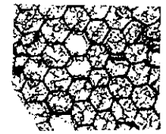
Two newly discovered fossil organisms have been named after Roger J. Cuffey, professor of paleontology at Penn State. It's an honor not many people can boast of. It recognizes Cuffey's sustained research contributions to the study and understanding of bryozoans. A geosciences faculty member, Cuffey is an expert in both fossil and living bryozoans—small sea-dwelling, polyp-type invertebrates that construct colonies resembling miniature corals. These colonies sometimes build up to form reef mounds that later serve as reservoirs for petroleum and natural gas.

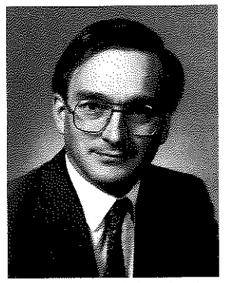
The two fossil types named after Cuffey are *Cuffeyella arachnoidea* and *Deplotrypa cuffeyi*. They are found in 450 million year old sedimentary rocks deposited across North America and Europe. The names were chosen and published by scientists from the British Museum of Natural History and the Geological Survey of Canada.

Cuffey studies bryozoans and reefs in Pennsylvania, across the United States and Canada, in Europe, Asia, the Pacific and Caribbean. Besides being an expert on bryozoans, Cuffey also teaches popular courses on dinosaurs.

Cuffeyella arachnoidea

Diplotrypa cuffeyi

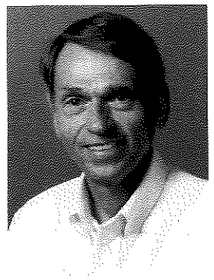




Richard R. Parizek

Allara Recognized by ACS

David L. Allara, professor of materials and chemistry, has received the Award in Spectrochemical Analysis of the American Chemistry Society, Division of Analytical Chemistry. The award was presented at a special symposium at the ACS national meeting in Boston in Fall 1998. Allara, a pioneer in the development of self-assembled monolayers, has had a profound impact on thin film and surface chemistry research for semi-conductors and molecular systems. He was elected as a Fellow of the American Association for the Advancement of Science in 1997.



David L. Allara

1998 Taylor Lectures

Alan G. MacDiarmid, Blanchard Professor of Chemistry at the University of Pennsylvania delivered the 1998 Nelson W. Taylor Lectures on 'Synthetic Metals': A Novel Role for Organic Polymers" and on "Polyaniline: Synthetic Metal for the 21st Century?"

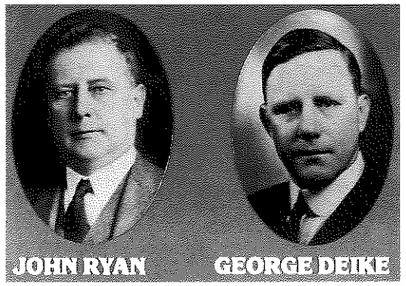
MacDiarmid is sometimes referred to as "The

Father" of the conducting polymers, or "synthetic metals," field. His collaboration in the 1970s with Dr. Hideki Shirakawa at the Tokyo Institute of Technology and Alan Heeger (then in the Department of Physics at the University of Pennsylvania) led to the discovery of metallic conductivity in an organic polymer. In 1977 he was responsible for the initial synthesis and chemical and electrochemical doping of polyacetylene.

He has received numerous national and international awards for his work.

The Nelson Taylor Lecture Series is sponsored by the Department of Materials Science and Engineering to honor the memory of Professor Nelson W. Taylor (1899–1965), head of Ceramics from 1933 to 1943.

Alumni Inducted in Hall of Fame



Two of the founding alumni of the College, George H. Deike, Sr. (1877-1963) and John T. Ryan, Sr. (1884-1941) were inducted into the National Mining Hall of Fame in October 1998, at a ceremony held in Phoenix, AZ. Deike '02 mining engineering and Ryan '08 mining engineering were honored as founders of the Mine Safety Appliances Company in Pittsburgh in 1914. The National Mining Hall of Fame and Museum is located in Leadville, Colorado.

Deike and Ryan's company grew into the largest mine safety equipment supplier in the world. Its most dramatic early accomplishment was elimination of the open-flame lamps then used by mining personnel. Ryan approached inventor Thomas Edison and asked if he would consider redesigning his electric battery so that it would be small enough to be worn by miners. Initially, Mr. Edison was reluctant to take on the task, but Ryan and Deike shared with him their first-hand recollections of mine tragedies and Edison was quickly convinced. Ryan worked closely with Thomas Edison during the development of the new battery. Their efforts resulted in an electric miners' lamp that greatly reduced fatal explosions in coal mines. Ryan was later honored for his work with membership in the Edison Old Timers' Club, a group of developers who worked with Edison during his early years. Mr. Edison himself noted later in his life that of all his inventions, the one that did the most for humanity was the miners' lamp.

Deike and Ryan became pillars of the Pittsburgh civic community. George Deike was a long-time Penn State trustee and strong supporter of the School of Mines.

The nomination was made by Jan Mutmansky, professor of mining engineering.

Scenes from the reception celebrating the formation of the Penn State Astrobiology Research Center held at the EMS Museum.

EGEE and GeoSci Join in Petroleum Geosystems Initiative

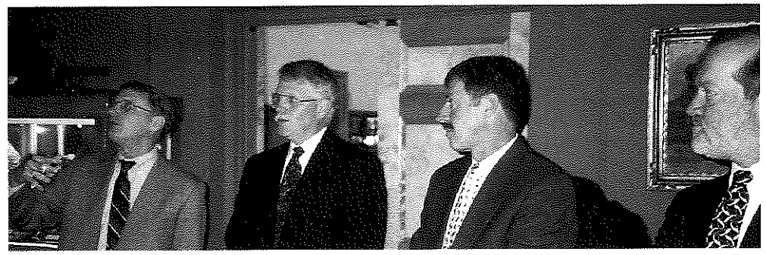
The close professional ties between the College and industry have rarely been demonstrated more effectively than in the development of a new EMS graduate program that has been dubbed *Petroleum Geosystems*. This M.S. program grew from the academic recognition that many fundamental research problems lie at the interface between geosciences and petroleum engineering, and from the growing need of industry for interdisciplinary scientists trained in problem-based collaborative research.

Turgay Ertekin, professor of petroleum and natural gas engineering, and Peter Flemings, associate professor of geosciences, who led the initiative, have designed *Petroleum Geosystems* as an integrated program in geology, geophysics, and petroleum engineering that combines specialized study in one of these disciplines with intensive interdisciplinary training.

Graduate students will become members of an interdisciplinary team consisting of a petroleum engineer, a geophysicist, and a geologist. They will share common office and lab space and participate in common courses and collaborative research. They will hold summer internships with the corporate sponsors and use company resources to pursue their individual theses. Fellowships for graduate study are provided by the sponsors.

The first *Petroleum Geosystems* team is sponsored by the Shell Oil Company and Shell Foundation. The program is also supported by IBM, Landmark Graphics, Texaco, and Chevron.

The initial team for Petroleum Geosystems is now being recruited. For further information, see http://hydro.geosc.psu.edu/geosystems.html or write to Dr. Flemings at 543 Deike Building, University Park, PA 16802.



(L to R) Peter Fleming, Michael Baranovic (Shell Oil), Rudy Slingerland, and Alan Scaroni announce the initiative.

Penn State Astrobiology Research Center Established

The Penn State Astrobiology Research Center [PSARC] has been created in EMS as a member organization of the NASA Astrobiology Institute, a 'virtual' institute that will conduct research on the issue of life in the universe and its cosmic implications.

Penn State is one of 11 academic and research organizations selected by NASA as initial members of the Institute. PSARC is an interdisciplinary center directed by Dr. Hiroshi Ohmoto, professor of geochemistry, that includes Penn State representatives from the Departments of Geosciences, Meteorology, Biochemistry and Molecular Biology, Biology and Chemistry. Researchers from the University of Pittsburgh and the State University of New York, Stony Brook are also center members, and associate members come from across the U.S. and around the world.

A five-year, $4.5 million grant from NASA will allow PSARC researchers to carry out investigations into the origins of oxygen and evolution of marine and terrestrial organisms. One project at PSARC will try to characterize the environment before there was life on Earth and use a theoretical and experimental approach to understanding the origins of life. Another will work on deciphering the time scale for the early evolution of life using a molecular evolutionary approach. Still another project will try to determine the role of metals in the origin and evolution of life.

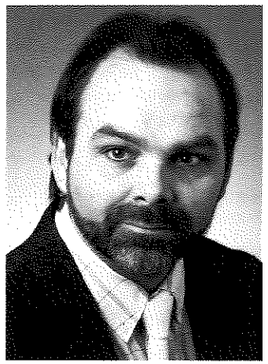
Researchers at PSARC are not just interested in the origins of life, but they also want to know what made some life forms disappear. One group will look at the diversification and extinction of early life forms including six Cambrian and Ordovician extinction events and the organisms existing 850 to 520 million years ago.

The formation of the Penn State Astrobiology Research Center was celebrated its formation on September 24 in the Earth and Mineral Sciences Museum. NASA representatives met with students and faculty members and toasted the health of the new organization. The reception was attended by University President Graham Spanier and EMS Dean John A. Dutton.

For additional information about PSARC, the NASA Astrobiology Institute, and about the discipline of astrobiology, see: http://www.ems.psu.edu/psarc/

THE WORD SHOP: The Story of the EMS Writing Center

Joe Schall, Giles Writer-in-Residence



Let us begin our story with the tales of three students.

First, there is Joanna, a geography major who has a diagnosed learning disability. In the process of visiting me for writing tutorials over 40 times in one year, Joanna finds that she can relish the act of writing and attack her writing assignments confidently for the first time in her life. As our tutoring sessions progress, Joanna shyly admits that her dream job would be studying the mating habits of the leatherback sea turtle. Joanna begins the year with a sneer and ends it by baking me Christmas cookies.

A second student, Adam, enters college as an average writer in his freshman year, but perseveres, visits me frequently for writing tutorials, and reaches the point where he receives "A's" on nearly all of his papers. His first professional paper, an article co-authored with one of his professors, is published in *Cartographic Perspectives*. After graduation, Adam serves as a 2nd lieutenant in the Air Force and writes me a jaunty e-mail: "Three months ago I got nauseous at the smell of jet fuel, but last week I flew solo in fingertip formation only three feet from my wingman, and in 90 degrees of bank."

Alicia, a final example, begins college as an "A" writer, but consistently comes to me for tutorials and uses her writing ability to achieve other successes. Before graduation, Alicia receives a technical writing minor along with her bachelor's degree, writes a script for a short documentary film that airs on a local television station, wins some student writing competitions, and earns several academic scholarships that include strong essay components. Now a graduate student and teaching assistant at Yale, Alicia writes me warm, chatty e-mails, marveling that her students scribble down her words and hang out after class to ask her questions about salt marsh cord grass.

The common thread these three tales share is that writing changed these students' lives. With all three students, as I coaxed forth writing progress, I witnessed striking personal growth. After a decade as a writer-in-residence and writing tutor for the College's Writing Center—"The Word Shop," as some students call it—I've worked with thousands of EMS students on everything from term papers to resumes to academic petitions. With the proper attitude and focus, my students find that a writing task is transformed from a chore to a challenge, that writing is a learnable skill, and that they can peddle their writing skills to employers.

For many years, the College heard complaints from employers about the dearth of effective communication skills in students graduating from technical disciplines. In addition, our graduates began to report that some companies required writing samples from applicants who made their short lists, or even asked candidates to write a short, impromptu essay as part of the interview process. Such reports reinforced for us that the post-graduate world was supporting—even demanding—internal efforts by the College to improve student writing. Thus, the College established the Earth and Mineral Sciences Writing Center in 1988, hiring me as a writing tutor and writer-in-residence.

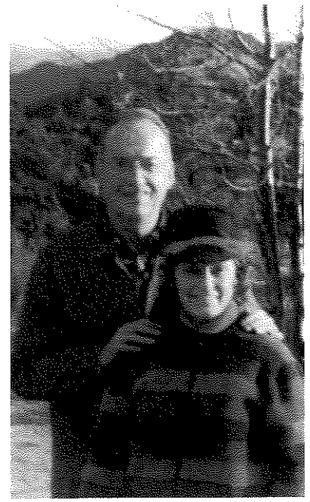
In short order, the story of the Writing Center's influence grew into our classrooms. Since 1990, we've introduced over 20 writing-intensive courses—courses where writing is used as an instrument to help students learn the subject matter—into the College's curriculum. Even in courses not designated as writing-intensive, writing visibility and emphasis have grown. At the front end of their college years, our students are now required to take a freshman seminar course, where they develop, research, write about, and orally present their views on environmental problems. During their senior year, our students complete a senior thesis or a capstone writing-intensive course, often involving a year of original research, and sometimes resulting in publication. Based on their writing assignments from coursework and internships, some of our students even develop writing portfolios that they can carry with them to job interviews.

Interestingly, one of the most positive initial responses to the Writing Center was from our professors, who realized that they could hold students to high writing standards because of the tutorial assistance available. Using industry standards and guidelines from academic journals, professors now expect students to produce high-quality papers that have a life beyond the classroom. For instance, in a writing-intensive course in petroleum and natural gas engineering, both the assignments and student papers are presented in professional memo format, with the student assuming the role of a professional consultant. In a nutshell, the College's writing program is built on the tenet that good writing reflects good thinking, and that the critical thinking skills and professionalism of our students are best demonstrated by their written work.

One of the most visible signs of the writing program's presence, *Style for Students: Effective Writing in Science and Engineering*, is a 190-page writing manual given to all undergraduates in the College. Over the years, I wrote the manual by culling from the best writing samples produced by students in the College, and tailored the manual's content to the specific writing challenges that our undergraduates face. Despite this specific focus, we discovered that the style manual had a broad appeal. Shortly after the manual was first published, we received scores of requests for copies from sources including a dozen universities outside of Penn State, the Engineering Division of the Department of the Army, and the Department of Mining Engineering at the University of Auckland, New Zealand. Currently, *Style for Students* is in use as a style aid in schools throughout the country, in disciplines ranging from nutrition to electrical engineering.

The most recent installment to the Writing Center's story came in the form of a $500,000 endowment earmarked to support Writing Center activities. The gift of Robert "Bart" ('48, Petroleum and Natural Gas Engineering) and Patricia Giles, the Giles endowment underscores the Writing Center's success and helps to secure its future. Bart Giles' career included 36 years with Amoco, and he spent many years serving as an expert witness for the oil industry in state and federal courts. In addition to providing us with the financial means to help operate the Writing Center, the Giles endowment serves as a highly visible sign that effective communication is a skill that students should view as a necessary part of their professional development.

For me, the story of the EMS Writing Center demonstrates that writing impacts students well beyond the classroom. It enriches their personal lives, builds their confidence, demonstrates their acumen, and earns them professional recognition. In short, writing serves as a qualitative measure of their maturity and success. Through an integrated writing program, a College style manual, and the support of the Giles endowment, the Writing Center can continue its mission: to help students become writers for life.



Bart and Patricia Giles

As part of its major initiative in geographic visualization, the Department of Geography has established the Penn State Geographic Visualization Science, Technology and Applications Center, to be known as GeoVista.

GeoVista is directed by Dr. Alan MacEachren, professor of geography. MacEachren, a faculty member in the College of Earth and Mineral Sciences since 1985, received the College's 1998 Wilson Research Award for his pioneering work in visualization. He is widely recognized for his analysis of cartographic representation in his recent book, *How Maps Work*, was a co-author of the recent National Research Council book, *Rediscovering Geography: new relevance for science and society,* and currently serves as chair of the International Cartographic Association Commission on Visualization.

The GeoVista research team is composed of faculty and students who are interested in visualization theory and techniques from Penn State's Departments of Geography, Psychology, Computer Science and Engineering, and the Center for Academic Computing, the Population Research Institute, and the Earth System Science Center. There are close ties between GeoVista and the Deasy GeoGraphics Laboratory in the Department of Geography. A number of projects are under way and graduate students are being actively recruited to participate in GeoVista research.

GeoVista research emphasizes the integration of scientific visualization with GIS (Geographic Information Systems), spatial analysis, virtual reality, data mining, and process modeling. The goal is to explore new ways to represent multi-scale, multi-variate, time-varying, and geo-referenced information in maps, diagrams, and multi-media presentations that will be helpful in decision making, industry, education, and science.

Detailed information about the new center and its members and projects can be found at: http://www.geovista.psu.edu

FACULTY NEWS

Dennis W. Thomson, professor and Head of the Department of Meteorology, has been elected as an Institutional Trustee of the University Corporation for Atmospheric Research, UCAR. Established in 1959, and now including 65 member universities, UCAR is the nation's leading research and service organization for the atmospheric sciences. UCAR manages, principally for the National Science Foundation, the National Center for Atmospheric Research in Boulder, CO, provides a variety of research-supporting capabilities to the member universities, and contributes facilities and personnel to almost every ongoing national and international science program involving weather and climate. A member of Penn State's faculty since 1970, Thomson will continue also his advisory responsibilities at both Lawrence Livermore National Laboratory and in the U.S. Department of Defense.

Jenni Evans, associate professor of meteorology, has been appointed as chair of the AMS Committee on Tropical Meteorology and Tropical Cyclones. She chaired the program committee for the 23rd AMS Conference on Hurricanes and Tropical Cyclones, and co-chaired the 25th Anniversary GATE Symposium.

Mku T. Ityokumbul, associate professor of mineral processing and geo-environmental engineering, was nominated to serve a two-year term as Environmental Division Representative on the SME Accreditation and Curricular Issues Committee.

Carlo Pantano, professor of materials science and engineering and director of the Materials Research Institute, has been elected to represent the United States for the International Commission on Glass. He will hold this position for three years. Pantano also serves as a member of the board of trustees of the American Ceramic Society.

Leonard G. Austin, professor emeritus of fuels and mineral engineering, presented a paper "The Modeling of Dry Grinding Quartz in Tumbling Media Mills" co-authored with K. Yildirim and H. Cho, at the 9th European Symposium on Comminution. He also chaired one of the sessions of the meeting held in Albi, France, and visited several universities in Spain, France, and England.

The Miner Health and Safety Training Program in the Department of Energy and Geo-Environmental Engineering recently garnered two first-place awards at the U.S. Dept. of Labor (MSHA) innovative training material competition. The awards were for a product called the ABC's of Safety Tool Box Talk Series. Program personnel were awarded a first place for the entries, titled, "Guarding", and "Slips and Falls", (non-coal entry) and a 1st place for "lifting", and "Industrial Slings" (coal entry). The program is directed by Mark Radomsky.

Ian R. Harrison, professor of polymer science, spent three months at MTEC, the National Metals and Materials Center of Thailand. During his stay he gave three week-long short courses on polymer science topics and made a lecture tour of government institutions and universities. His stay in Bangkok was supported by a sabbatical Fulbright Award.

Chunshan Song, associate professor of fuel science, gave a plenary lecture on "Synthesis, Characterization and Catalytic Application of Novel Mesoporous Aluminosilicate Molecular Sieves" at the 14th National Catalysis Society Conference in Chennai, India in December 1998. He was elected to serve on the advisory board of the International Pittsburgh Coal Conference, and as co-chair of an American Chemical Society Symposium on CO_2 Conversion and Utilization in Refinery and Chemical Processing to be held in San Francisco in March 2000.

Richard B. Alley, professor of geosciences, chaired a session on Global Climate Change organized by Geoscience Professor Susan Brantley at the National Academy's Frontiers of Science symposium in Irvine, CA, in November 1998.

Ender Suvaci, a Ph.D. candidate in Materials Science and Engineering, received a Graduate Student Fellowship from the Southern California Section of the American Ceramic Society at the Pacific Coast Regional Meeting in Irvine, CA, for his paper "Reaction-based Processing of Textured Alumina Ceramics." Mr. Suvaci also received the Best Poster Award at the IVth Turkish Ceramics Congress at Eskisehir, Turkey, for a poster on the same topic. He also gave a presentation on "Texture Development and Properties of Reaction-based Alumina by Templated Grain Growth" at the NASA workshop on "New Developments in High Temperature Ceramics" in Istanbul, Turkey.

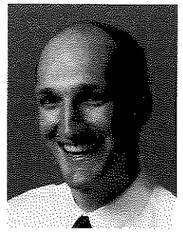
Gary L. Messing, professor of materials science and engineering, served as the chairman of the 1998 Gordon Research Conference on Tailored Ceramics: Fundamental Challenges in Processing-Microstructure-Property Relations. The meeting was held August 2-6 in Meriden, NH. **Clive Randall** gave a presentation on "Scaling and Interfacial Issues in Electroceramic Materials and Devices" and **James Adair** gave a presentation on "The Role of Chemical and Colloidal Manipulation in the Chemical Synthesis of Tailored Ceramic Particles."

Gary L. Messing,director of the Materials Research Laboratory, **Rodney Erickson**, dean of the Graduate School, and **William Taylor**, represented Penn State recently at the 2nd Academic Summit Meeting held in Kaiserslautern, Germany. Representatives of the Shonan Institute of Technology and Universität Kaiserslautern also attended. The three institutions are involved in a student exchange program.

Robert Newnham, Clive Randall, and Susan Trolier-McKinstry of material science and engineering, attended and gave presentations at the International Symposium on Applications of Ferroelectrics, Montreux, Switzerland, August 24-27, 1998. Dr. Newnham gave the plenary lecture on "Electroceramics in the 21st Century."

Ralph H. Colby, associate professor of polymer science, presented two lectures. "Miscible Blend Dynamics," at the Institut Laue Langevin in Grenoble, France, and "Polyelectrolyte Solution Rheology," at the College de France in Paris, and again at C.E.N. in Saclay.

David J. Green, professor of ceramic science and engineering, presented the paper "Residual Stresses in Alumina-Zirconia Laminates," in Istanbul, Turkey at the New Developments in High Temperature Ceramics conference. The conference was jointly sponsored by the Air Force Office of Scientific Research, the European Office of Aerospace Research and Development, the Turkish National Research Lab, and NASA Lewis Research Center. Green is also the author of a new textbook, *Introduction to the Mechanical Properties of Ceramics*," published by Cambridge University Press.



Darrell G. Schlom, associate professor of materials science and engineering has been selected to receive the 1999 Bradley Stoughton Award for Young Teachers from ASM International. The award is given to encourage young teachers in the materials science, engineering, and design and processing fields by rewarding them for their efforts and their enthusiasm in imparting knowledge to students. He also presented an invited lecture on "Epitaxial Growth and Properties of Perovskite Thin Films," at the joint 12th International Conference on Crystal Growth and the 10th International Conference on Vapor Growth and Epitaxy, held in Jerusalem, Israel.

Richard E. Tressler, professor and head of the Department of Materials Science and Engineering, was an invited speaker at the conference on New Developments in High Temperature Ceramics in Istanbul, Turkey. His paper was titled "Creep of SiC/SiC Composites." The conference was jointly sponsored by the Air Force Office of Scientific Research, the European Office of Aerospace Research and Development, the Turkish National Research Lab, and NASA Lewis Research Center. Tressler was also an invited speaker at the Engineering Ceramics '98 and HT-CMC 3 joint international conference in Osaka, Japan. His lecture was titled "Creep and Fatigue of Ceramic Matrix Composites."

OBITUARIES

Laxman N. "Bal" Mulay, professor emeritus of solid state science, died Wednesday, August 19, 1998. He was born March 5, 1923, in India and received his doctorate from the University of Bombay, and continued research in his field at Harvard University. He was a professor at the Department of Materials Science and Engineering and at the Material Research Laboratory, and chaired the solid state science program for four years. He conducted pioneering research in the area of magnetism, NMR and catalysis, and was a well-known international authority in these areas. He was a Fellow of the Royal Society of Chemistry and a member of the Physical and Chemical Society and the nominating committee for the Nobel Prize. He published several hundred papers and wrote authoritative books in his field. At the time of his death, he was writing a book about magnetism.

Richard R. Klimpel '64 Ph.D. Fuel Technology, adjunct professor of mineral processing, died November 4th 1998 in Midland, Michigan. Dr. Klimpel worked for more than thirty years for Dow Chemical, where his work in the development of new flotation reagents and grinding additives gained him international recognition and 40 patents. He received the Dow Chemical Inventor of the Year Award in 1989 and in 1991, the Richards Award of AIME in 1988, the Taggart Award of SME in 1992, and the Gaudin Award of SME in 1994. He was a recent past president of SME and was serving on the board of AIME. At the time of his death he was president of RK Associates LLC and a part time professor of materials science and engineering at Florida University.

RETIREMENTS

L. Barry Phelps, associate professor of mining engineering and a specialist in surface mining and environmental protection techniques, retired in 1998 with emeritus rank. In recent years he has been the principal investigator at the Kauffman demonstration site for environmentally enhanced mining procedures, a project honored by Renew America and listed in the Environmental Success Index. The son of a professional engineer, Phelps was born in Guatemala and lived in South America and Southeast Asia where he was home schooled through high school. He served in the US Army with the 101st Airborne Division. He received a B.S. in Mining Engineering from the University of Idaho and M.Eng. and Ph.D. degrees from Penn State. He joined the faculty in 1977, having previously worked as a mining engineer in Colombia, with Alcoa in Surinam and Dow Chemical in Texas. In the Department of Mineral Engineering, he directed and taught the courses dealing with surface mining and was responsible for the success of the student coop program. In the late 1980s he developed the computer program REMINE as an evaluation tool for remining sites; the program was adopted for use by Pennsylvania, Kentucky and Virginia. For many years Phelps coordinated the large and successful Pennsylvania Blasting Conference; he was recognized for his service to the explosives industry at the 1995 conference. In 1996 he served on the national Acid Mine Drainage Prevention Initiative to establish research priorities based on the current state of the art. He served for many years as a member of the board of Pennsylvania Mining Professionals, as a member of the National Stone Association Operations Committee, the SME Surface Mining Committee, and in 1990 as Governor's representative on the Mineral Resources Committee of the Interstate Mining Compact Commission.

Anthony V. Williams has retired as associate professor emeritus of geography. He has been a member of the faculty since 1966. He was responsible for introducing many of the Department of Geography computer applications and programs, and initiated the department's participation in the Operations Research Program, and later chaired the program for five years. He taught pioneering classes in computer mapping, geographic data systems, and computing for the earth and social sciences. In the 1980s he served the University as a trustee and committee member for the John von Neumann Center-Consortium for Scientific Computing and as a PSU liaison for the Pitt/CMU Supercomputing Center. He had research and teaching interests in political geography, and served as associate director of the PSU Center for Research in International and Strategic Studies. In 1975 he received support from the Rockefeller Foundation to spend a sabbatical leave at the University of Ibadan, Nigeria, and in 1986 he served as Senior Fulbright lecturer at the University of Yaounde and the Ecole Normale Superieure in Cameroon. He received an A.B. (Honors) degree in geography from Wayne State University, M.A. from Ohio State University, and Ph.D. from Michigan State University.

Faculty Promotions

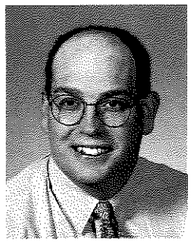
To professor: **Brenton M. Yarnal** (Geography); **Ljubisa R. Radovic** (Fuel Science)
To associate professor: **Cynthia A. Brewer** (Geography); **Long-Qing Chen** (Ceramic Science and Engineering); **Jenni-Louise Evans** (Meteorology); **Mku T. Ityokumbul** (Mineral Processing); **Darrell G. Schlom** (Materials Science and Engineering); **Susan E. Trolier-McKinstry** (Materials Science and Engineering).

Faculty Changes

Jeffery L. Kohler, formerly associate professor of mining engineering, is now director of the Pittsburgh Research Laboratory of the National Institute for Occupational Safety and Health. His email is: jtk4@cdc.gov

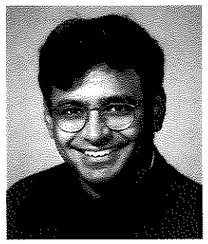
Thomas P. Ackerman, professor of meteorology, will be the ARM Chief Scientist at Pacific Northwest National Laboratory for the calendar year 1999.

NEW EMS FACULTY

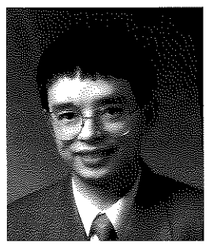


Colin Flint has joined the EMS faculty as assistant professor of geography, specializing in political geography. He comes to Penn State from the Sam Nunn School of International Affairs at the Georgia Institute of Technology, where he had been an assistant professor for three years. He received his B.A. in geography from the University of Newcastle -Upon-Tyne, UK in 1990, and M.A. and Ph.D. degrees at the University of Colorado. He is author of *A Political Geography of the Nazi Party Vote*, published by University College London Press, and coeditor of the recent *Political Geography: World-Economy, Nation-State, and Locality*, 4th edition, and *Transforming American Government: Implications for a Diverse Society* (1997). He is author or coauthor of a number of papers and other scholarly publications and has given invited presentations on his research at the universities of Cambridge and Buffalo and at the Social Science History Association. He is currently serving a two-year term as secretary/treasurer of the Political Geography Specialty Group of the Association of American Geographers.

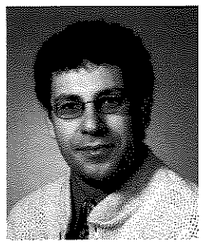
Tanya Furman has been appointed as Assistant Professor of Geosciences. She joins us from the Department of Environmental Sciences at the University of Virginia, where she was assistant professor and also founding director of the University of Virginia branch of the Virginia Museum of Natural History. She has taught a wide range of courses and has research interests in the tectonic and magmatic evolution of individual volcanic systems, continental and oceanic rift zone magmatism, and weathering processes in forested watersheds. Among her awards are the Lilly Teaching Fellowship (UVa), Seven Society Recognition for Excellence in Teaching and Mentoring, Alumni Association Board of Trustees Distinguished Young Teacher Award, National Science Foundation CAREER Program award, and her selection among Faculty for the 21st Century of Project Kaleidoscope. Furman received a B.S.E. in civil engineering (magna cum laude) from Princeton University, and Ph.D. in geochemistry from the Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program.



Venkatraman Gopalan recently came to Penn State as an assistant professor of materials science and engineering and research scientist in the Materials Research Laboratory. Gopalan received his M.S. and Ph.D. in materials science and engineering from Cornell University. Before joining EMS he held several postdoctoral research positions, and was most recently a director-funded postdoctoral fellow at Los Alamos National Lab in the Center for Materials Science. He plans to continue his research on non-linear optics, photonic materials, and designing and fabricating integrated optical devices.



Zi-Kui Liu joined the EMS Metals Science and Engineering Program as an assistant professor of materials science and engineering. He comes to Penn State from his former position as a research associate at the University of Wisconsin-Madison. Liu received his M.S. in materials science from the University of Science and Technology in Beijing, China, and his Ph.D. in physical metallurgy from the Royal Institute of Technology in Sweden. Liu's research has focused on computational thermodynamics and numerical kinetic modeling of alloys. At Penn State Liu will focus on developing thermodynamic data bases for polymers and electronic, nuclear, and refractory materials to be used in performing realistic thermodynamic calculations of multicomponent systems, which is also useful in simulating microstructural evolution.



Evangelos Manias is joining the College as an assistant professor of materials science and engineering. He received his M.Sc. in physics from the Aristotelian University of Thessaloniki in Greece, and his Ph.D. in polymer physical chemistry from the University of Groningen in The Netherlands. Manias was a postdoctoral research associate at Cornell University prior to accepting the position at Penn State. He is particularly interested in self-assembled monolayers, thin polymer films, polymer-inorganic composite materials and nanocomposites, confined polymer systems such as polymer silicate intercalates and polyelectrolytes in layered inorganic hosts.

New Books

David Green, professor of ceramic science and engineering, is author of *Introduction to the Mechanical Properties of Ceramics* published by Cambridge University Press. Over the past 30 years ceramics have become key materials in the development of many new technologies, as scientists have been able to design these materials with new structures and improved properties. Within this process, an understanding of the factors that control mechanical behavior and reliability is essential, particularly in identifying means to reduce brittleness. The book is a comprehensive introduction to the field, including the most recent innovations, and is designed primarily for undergraduate and graduate students in materials science and engineering. It will also be useful for industrial scientists and engineers who are involved in the development of ceramic-based products, materials selection and mechanical design.

E. Willard Miller and **Ruby M. Miller** are co-authors of *Indoor Pollution*, published by ABC/CLIO. The volume begins with a perspective on indoor pollution. Initially it provides a background on factors affecting it, health effects, and the development of standards for indoor air quality. This is followed by a discussion of the sources of indoor pollutants, including ambient air pollutants, bio-aerosols, radon, asbestos, heavy metals, particulates, and volatile organic chemicals, and concludes with a discussion of noise pollution. Federal legislation is limited to radon, lead paint, and asbestos due to the fact that "a man's home is his castle" and is beyond federal legislation. There is also a major section on organizations, a bibliography of books and journals, and audiovisual aids. *Indoor Pollution* presents material on a worldwide problem affecting millions of home sites. E. Willard Miller is professor emeritus of geography and associate dean emeritus; Ruby Miller is associate librarian, retired.

Willard Miller is also editor, with **S. K. Majumdar and F. J. Brenner of** *Ecology of Wetlands and Associated Systems*, published by the Pennsylvania Academy of Sciences. This volume of 41 chapters is divided into five parts. Part One provides a classification and basic ecology of wetlands around the world. This section is followed by seven chapters addressing wetland environments and ecosystems. Discussions on the special adaptations of plants and animals inhabiting wetlands and their use in determining wetland quality comprise Part Three. A total of seven chapters in Part Four address the use of wetlands for remediation of pollutants. The text concludes with ten chapters concerning the national and international perspectives on the value, management, and restoration of wetland ecosystems. Penn Staters represented in this volume include faculty in the Department of Biology and School of Forest Resources.

The Energy Institute

http://www.energyinstitute.psu.edu/ 814/863-7432 (fax)

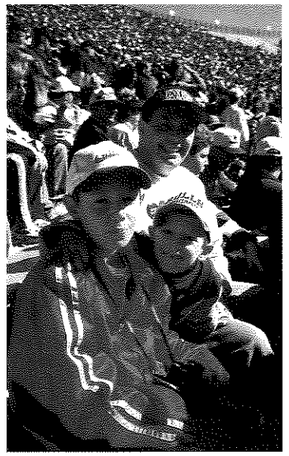
DIRECTOR: Harold Schobert
814/863-1337

ASSOCIATE DIRECTOR: Bruce Miller
814/865-3093

CENTER	DIRECTOR	CONTACT	FOCUS
Applied Catalysis in Energy Laboratory	Chunshan Song	814/863-4466 csong@psu.edu	Environmentally benign processing in energy and chemical industries.
Carbon Research Center	Frank Ruskinko, Jr.	814/863-8085 fjr4@psu.edu	Graphite, coke, activated carbon, anthracite, pitch and high-value carbon products from coal.
Center for Electrochemical Studies	Serguei Lvov	814/863-8377 lvov@essc.psu.edu	Use of electrochemical probes and systems.
Center for Fuel Utilization	Alan Scaroni Bruce Miller	814/865-3093 aws1@psu.edu bgm3@psu.edu	Utilization of clean fuels: coal-water slurry fuel, biomass, micronized coal, emission reduction, and boiler hardware development.
Center for the History of Fuel Science and Technology	Sharon Falcone Miller	814/863-8893 sfm1@psu.edu	History, education, preservation.
Coal and Organic Petrology Laboratories	Gareth Mitchell	814/865-6544 n8h@psu.edu	Organic microscopy and Penn State Coal Sample Bank.
The Combustion Laboratory	André Boehman	814/865-7839 boehman@ems.psu.edu	Diesel engine test facility, diesel fuel formulation, engine combustion, exhaust aftertreatment, and bio-derived fuel and lubricant research.
Laboratory for Hydrocarbon Process Chemistry	Semih Eser	814/863-1392 seser@psu.edu	Production, analysis, processing, and end use of hydrocarbons.

DEVELOPMENT NEWS

John L. Dietz, director, EMS Development



Nittany Lion fan John Dietz with his sons Brett and Tyler.

Joel Myers, founder and president of Accu-weather and member of the PSU Board of Trustees, pledged funds for scholarships in Meteorology.

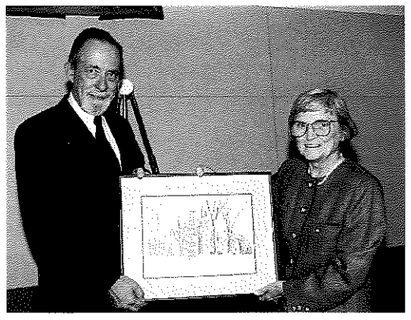
William and Estelle Turney have endowed two scholarships: one in Ceramic Science and the other in the College. Bill is a 1965 graduate of ceramic science and engineering and retired from Harbisan Walker Refractories.

Tax-Saving Charitable Gifts: How to do Well by Doing Good.

Have you often thought that you'd like to make a substantial gift to the College of Earth and Mineral Sciences but are reluctant to do so because you may need the money for future use? Or perhaps you are uncertain how to best make such a gift? Well, there is a way to make this kind of gift and maybe strengthen your retirement income as well.

Chosen correctly, planned gifts can help increase your income, build tax-deferred savings, or meet other financial goals while ensuring a gift to the College. I have information I can send you that describes a number of strategies you can use to save taxes while providing for EMS.

I have outlined a program for making a gift to EMS that also strengthens your retirement income. Allow me to offer an explanation. To start, you donate cash, or stocks or land that have increased in value to EMS. You receive a substantial tax break. Penn State invests your money for growth, so that now or in the future, we start paying you (and your spouse or another beneficiary) a lifetime income. When the last beneficiary dies, EMS receives the remaining money. Finally, you can, if you want, replace some of the money you gave away by using tax savings to buy life insurance to leave to your children.



Dorothy Pate Enright '48 M.S. Ceramic Science was inducted into the Obelisk Society in September 1998. Enright, who recently retired as a research consultant in Houston, has endowed a scholarship for undergraduates in CerSE.

While this all sounds good, there is one thing you need to understand. These gifts are irrevocable. You cannot get your principal back. But, there are tax benefits. For starters, you do not pay capital gains tax on the appreciated property. For example, let's assume that you made a substantial profit in stocks but now want to switch to a more conservative investment. If you sell, you have to pay capital gains tax. But, if you give the asset to Penn State (or a charitable trust), no capital gains tax is due. We can reinvest the money and pay you an income for life.

The second tax benefit is that you create an immediate tax write-off. The size of this deduction depends on a number of factors, including your age and the payout amount. However, you do receive a tax deduction. Finally, a charitable gift reduces the size of your estate, saving taxes if your net worth exceeds $660,000 in 1999. This number may increase to $1 million by 2006.

Without going into much detail, I will briefly describe a few options for you to consider. I will also note that we always suggest that you work with your financial advisors – lawyers, accountants, trust managers, etc. – before making any final decisions regarding your philanthropic plans for Penn State. However, there are a number of planned gift options that may work best for you.

Favored by older retirees, a gift annuity pays a fixed income, guaranteed for life. Some of the income is tax-free. The payout is dependent upon your age. Charitable remainder unitrusts are another popular choice. Your income varies, depending on how the investment grows. Payout rates are based on the market value of the trust and rates typically range from 5 – 8 percent. We recommend lower payout rates because these give the donor the largest tax write-off plus bigger payouts over time because more money stays in the trust to grow.

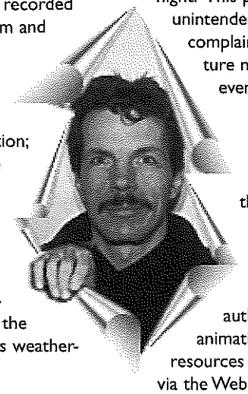
There are other ways to give to Penn State through solid estate planning. Charitable bequests are also always welcome. Bequests provide a charitable tax estate deduction and allow the donor to retain control of the assets during their lifetime. The bottom line is that we can help you be creative in how you can make a philanthropic gift to EMS. I'd be very happy to discuss these opportunities with you.

WEB NEWS

Tim Robinson, EMS Webmaster

Unseen Visitors

They are not visible, but they are here. They come, they look around and ask questions, and they leave as noiselessly as they arrive. Most people in the College are totally oblivious to their presence. The only trace of their visits are electronic records on a disk by a computer on the second floor of the Deike building. Every visit to the Earth and Mineral Sciences World Wide Web site is recorded on that disk, including where the visitor is from and what he or she looked at.



Our College hosts many thousands of such visitors every day. About a third come from Penn State or some other educational institution; about a fourth of the remaining visitors come from outside the United States.

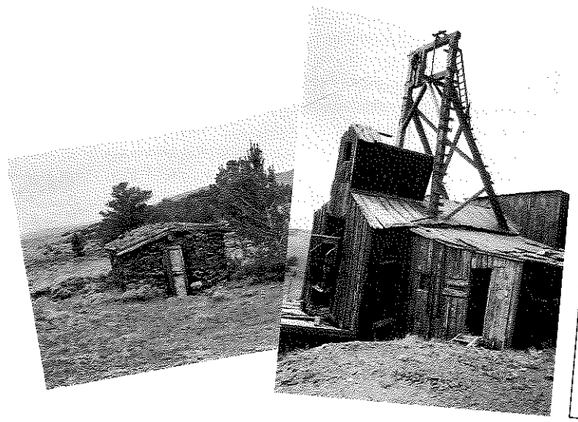
Mostly people come for the weather... not our lovely Happy Valley springtime, but the raw meteorological data, the weather maps, the computer models of current weather systems, the forecasts. Roughly three fourths of the information delivered to our unseen visitors is weather-related.

Sometimes, these folk actually leave messages that let us know a little bit about them. We've met many school teachers taking advantage of our educational materials. Yacht racers out on the Great Lakes have connected via modem and cell phone to collect the latest wind speed and direction from our tables of data from nearby buoys. Prospective graduate students from China have found information and application forms here.

Penn State students use the site's many course pages to find information about a particular course they are taking or might want to take. Scores of faculty have created pages about their courses and find them a convenient place to post the syllabus, the lecture schedule, assignments, the authorized versions of lecture notes, images, and directions for extra credit projects. Students can view and print any of the material at any time of the day or night. This popular use of the College Web site has its unintended consequences - students have started complaining to professors when Wednesday's lecture notes are not available on the Web Tuesday evening for preview!

A few faculty have even gone so far as to put so much of each lecture's material on the course Web pages that they bring them to class themselves. They use a computer and projector in the classroom, with the course Web pages taking the place of transparencies on an overhead projector. They thus supply the students with authoritative lecture notes, computer-based animations of key concepts, and links to related resources - all in one tidy package which is available, via the Web site, around the world and around the clock!

You are welcome to join our daily parade of visitors by pointing your Web browser at http://www.ems.psu.edu. All the Earth and Mineral Sciences weather pages are on the list at http://www.psu.edu/weather. And of course, we'd love to have you visit in person as well! Just remember - you're not alone!



Prize winning photos of the Duncan Gold Mine, Wyoming, from the *Pay Dirt* photo contest and the *Mining Engineering* photo contest, taken by Andrew Sicree, EMS Museum Curator.

Earth & Mineral Sciences Museum
4th Annual Symposium

The Mineralogy of Gems and Precious Metals

May 21, 22, 23, 1999

Open House: Friday, May 21

Lectures, Benefit Mineral Auction, Minerals Banquet
Saturday, May 22

Collecting Field Trip: Sunday, May 23

information: Andrew Sicree, Curator
phone (814)865-5427 sicree@geosc.psu.edu

SCIENCE NEWS

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

CLEAN AIR ACT REDUCES ACID RAIN IN EASTERN U.S.

Thanks to the Clean Air Act of 1990, acid rain levels have decreased as much as 20% over a large region of the Eastern United States, according to James A. Lynch, professor of forest hydrology in the School of Forest Resources.

"Pennsylvania has long been recognized as the acid rain capital of the country," he says. "The pollutants that cause acid rain come from local sources and sources located in the Midwest, and affect a wide region up into New England. However, since implementation of Phase One of Title VI of the Clean Air Act of 1990, acid rain concentrations in the Northeastern U.S. have decreased."

Acid rain is caused by sulfur dioxide and nitrogen oxides produced when fuels burn. The source of most sulfur dioxide is high-sulfur coal burned in power plants, and controlling this source of sulfur dioxide production can have a major impact on acid rain in Pennsylvania and other regions of the Northeast. It is much more difficult to control and regulate nitrogen oxides—only 30% of the nitrogen oxides causing acid rain come from power production. Automobiles generate 30% and the agricultural sector contributes an additional 25% to 30%. Lightning strikes and biological processes produce the remaining nitrogen naturally.

In 1995, Phase One of the Clean Air Act Amendments of 1990 took effect for 110 electrical utilities. Most of these power plants were in the Eastern United States with a few plants located west of the Mississippi River. The act specified a reduction of sulfur dioxide emissions of 10 million tons, based on 1980 levels. Reduction at the 110 utilities affected by Phase One was set at 2.3 million tons; the actual reduction was about 3.9 million tons. "Some companies are actually making money by increasing their reduction because they can sell their excess emission permits to other sulfur dioxide producers," says Lynch. Reduction of nitrogen oxides began in 1996, but a reduction of only two-tenths of a million tons was expected and realized. Because of the wider variety of sources of nitrogen, nitrogen oxides are more difficult to regulate and reduce.

Lynch calculated the pre-1995 baseline for acid deposition using data from the National Atmospheric Deposition Program. His baseline includes precipitation samples collected weekly between 1983 and 1994 from approximately 200 sites across the U.S. NADP measures samples for acidity, sulfate and nitrate concentrations. Lynch compared this baseline data with data collected in 1995 and 1996. "Looking at sulfate concentrations, there is a 20% to 25% reduction of sulfate in precipitation samples over a wide region of the Northeastern United States," says Lynch. "There is also a 20% to 25% reduction in the acidity of rainwater over this same region."

The almost one-to-one correlation between sulfate deposition and acidity is too strong to be a coincidence, according to Lynch. The Clean Air Act Title VI appears to have reduced acid rain levels in the Northeast, though some reductions in acidity in northern New England are probably a direct result of similar environmental controls in Canada's southeastern provinces. In 1995 and 1996 a severe drought in some portions of the Southeast apparently caused higher sulfate and nitrate concentrations. With less precipitation, concentrations increase, but do not necessarily suggest an increase in total sulfate or nitrate deposition. Lynch is currently looking at 1997 data to determine if sulfate and nitrate deposition remains at 1995 and 1996 levels.

BACTERIUM FOUND IN SURFACE WATER

A research team at Penn State Harrisburg has found the cause of chronic gastritis, peptic ulcer disease and certain types of stomach cancer—Helicobacter pylori (H. pylori) bacterium—in river, creek, and lake water in central Pennsylvania. The study represents the first report of live H. pylori in surface water in the United States, demonstrating a major reservoir for this organism outside the human body. Although H. pylori infects a vast number of people, surface water as a primary source of infection was previously unknown. Although the organism only causes disease in a small percentage of individuals, it is found in the stomachs of around 50% of the population in developed countries, and almost universally in developing countries. It is now accepted that this bacterium is the cause of most duodenal ulcers and 70-80% of gastric ulcers.

Normal testing procedures do not identify the presence of live H. pylori in water, so the Harrisburg researchers had to develop a method combining two staining techniques to enable them to count live H. pylori. The bacterium was found in more than 75% of the 36 tested surface water samples. It was found in surface water and in untreated well water from shallow wells where surface water contamination is likely to occur.

The research to date has been limited to untreated water sources; there is no evidence that H. pylori is found in municipal or treated water supplies, and research by EPA indicates that chlorine disinfection kills the bacterium. [written by Barbara Hale]

MAMMOTH MOUNTAIN CO_2 EMISSIONS

Since an earthquake swarmed beneath the volcano in 1989, carbon dioxide has been seeping out of the ground in areas of Mammoth Mountain, CA, killing trees and posing a health hazard in this ski resort area. Derrill M. Kerrick, professor of geosciences, who monitored CO_2 emissions in Italy in 1997, has more than passing interest in this carbon dioxide seepage on the slopes above Mammoth Lakes. This year he was able to send graduate student John Rogie to investigate. Rogie's continuous monitoring shows that the gas flow is much more complicated than previous measurements indicated.

"In the past, magmatic carbon dioxide degassing from the areas of tree kill was measured once a year," says Rogie. "If the gas flux was lower than the previous year, it was thought that the carbon dioxide degassing rate was continually decreasing." However, last year, Rogie monitored the area for a 24-hour period and found that the flux of carbon dioxide varied by up to a factor of three throughout the day.

"The 24-hour variation suggested that the system was very dynamic and that more than a single measurement was needed to tell us if the carbon dioxide rates were going up, staying the same or going down," says Rogie. "We would really like to know what the carbon dioxide flux is at any time," he told attendees at the fall meeting of the American Geophysical Union in San Francisco.

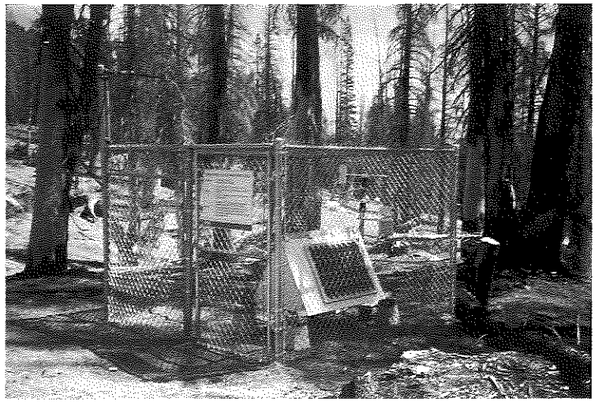
Working with Derrill M. Kerrick; Michael Sorey, USGS, Menlo Park; Giovanni Chiodini, Osservatorio Vesuviano, Naples, Italy; and Giorgio Virgili, WEST Systems, Pisa Italy, Rogie designed a plan to continuously monitor the rate of carbon dioxide degassing in the 35-acre tree-kill area near Horseshoe Lake. Using specially manufactured instrumentation produced by WEST Systems, Rogie took continuous measurements of carbon dioxide flux and other environmental variables from August until the equipment was removed in early November, when snow levels reached more than two feet.

"As the snow accumulates, the carbon dioxide concentration at the snow/ground interface, and in the snowpack itself, builds up enormously and overwhelms the sensors on the instrument," says Rogie. "This also increases the risk to visitors in the tree kill area during the winter." The tree kill areas on Mammoth Mountain are well posted, indicating they are not to be entered during the winter and are closed for camping even in the summer. These areas will also be off limits to skiing because of the dangers of carbon dioxide poisoning.

Rogie found that the average carbon dioxide flux at the instrument was 2,000 grams of carbon dioxide per square meter per day, but that levels could fall as low as 50 grams or go as high as 5,000 grams. The carbon dioxide flux showed a daily, cyclic pattern. "The flux was typically high in the afternoons and low in the mornings which would seem to follow the 24-hour temperature cycle, but we have ruled out temperature as the cause of the variation," says Rogie. "There was also a 12-hour cycle which may be linked to barometric pressure oscillations ." Kerrick adds, "Hopefully these measurements will help us determine how environmental factors like barometric pressure influence the degassing rate. We want to identify changes in the rate of gas ascent from depth by filtering out variation caused by weather related phenomena."

"This instrumentation and research will allow a better understanding of the dynamics of gas emission from volcanoes and provide an immediate warning device should the carbon dioxide emission rate suddenly increase," says Rogie. Besides measuring carbon dioxide flux, the monitoring equipment measured barometric pressure, air temperature, humidity, wind speed, wind direction, soil temperature and soil moisture. The data was sent by Freewave ultrahigh frequency radio-modem to the village of Mammoth Lakes where it was recorded. A 12-volt battery, recharged by solar energy, powers the instrumentation.

"Determining which variables are associated with the 12-hour and 24-hour cycles is difficult," says Rogie. "One possibility is barometric pressure and another is Earth tides." Earth tides are the effects of the moon's gravity on the solid portion of the Earth in the same way that ocean tides are the effects of the moon's gravity on the liquid parts of the Earth. Earth tides are very small, but do effect the width of fractures and faults, which could affect carbon dioxide degassing rates. "In all likelihood, the variations in gas flux depend on a combination of barometric pressure, wind speed, Earth tides and soil moisture, but we have not yet developed a model to simplify this complex system," says Rogie.



Mammoth Mountain is considered to be a dormant volcano, with its last eruption some 200 years ago, but it may produce as much carbon dioxide as the active volcano Kilauea in Hawaii. Because the daily variability of carbon dioxide degassing is large, it is currently impossible to know exactly how much carbon dioxide is being emitted from Mammoth Mountain, but it is thought to be in the range of 400 to 1,200 metric tons per day. Safety concerns in the area are based on the lethal effects of high concentrations of carbon dioxide. "Normally, the concentration of carbon dioxide in the air is very low, well below one percent," says Rogie. "The levels seen in the ground and snow within tree kill areas are much higher, up

to 99 percent, and very dangerous."

Rogie plans to reinstall his instrumentation before all the snow melts in the spring so that he can record the changes as the snow pack rapidly disappears. This research is supported by the National Science Foundation, Penn State and the USGS.

ENGINEERED GLASS TEMPERING HALTS CRACKS

Few things are as fragile as glass, but if a Penn State researcher has his way, some types of glass will be less fragile.

"Chemical and heat tempered glasses have been around for a long time," says Dr. David J. Green, professor of ceramic science and engineering. "These glasses can withstand more stress before breaking than untreated glass, but when they break, they usually break catastrophically."

Another problem with chemical and heat tempered glass is that while each individual piece of glass becomes stronger, the variability of strength between pieces of glass increases dramatically. Engineers choosing glass for specific purposes must account for this wider range of strengths. Working with Dr. R. Tandon of Caterpillar Inc., in Peoria, Illinois, and V.M. Sglavo of the University of Trento, Italy, Green developed a theoretical approach to designing strengthened glass. The team reported their work in the Feb. 26 issue of the journal *Science*.

Conventional tempering of glass alters the outer surface of the glass so that it is under compression. Glass under compression can withstand higher levels of stress before reaching the failure point. "Rather than simply altering the outside layer of glass, we would like to engineer the glass so that it has a specific compression profile making the final product stronger and less variable," says Green.

The researchers tested their theory using the chemical tempering process on sodium aluminosilicate glass, but believe that they could adapt the process to other tempering processes and other materials.

Surface of glass sample loaded to near fracture load. The surface shows an array of cracks that can act as a "warning" of failure.

In chemical tempering, potassium atoms are often used to replace some of the sodium atoms near the surface. These potassium atoms are slightly larger than the sodium atoms and they compress the layer in which they are substituted by crowding the other atoms. Chemical tempering usually occurs in the outer millimeter of the pane of glass.

"If we place the maximum compression layer beneath the surface, when cracks propagate from the flaws on the surface, they reach the layer and stop," says Green. The researchers created these internal compressed layers by subjecting the glass to chemical processing where potassium substituted for sodium, but then exchanged some of the potassium near the surface back to sodium. This created glass with an untempered surface, but with a tempered, compressed layer below. "Unexpectedly, glass made in this way exhibits multiple cracking," says Green. "Unlike untreated glass or conventionally tempered glass where a crack that begins progresses rapidly to catastrophic failure, small cracks begin to form in the untempered layer and then the cracks are arrested by the compressed layer."

Many cracks may form before the ultimate crack that propagates through the compressed layer and shatters the glass. This surface crazing can be used as a warning that the glass is approaching its breaking point and needs to be replaced. Creating glass that will only break at a certain, predetermined stress level may also be possible. "The strength range of a batch of conventionally tempered glass may be as broad as 25% on either side of the average strength," Green says. "However, the specially-designed glass we are looking at has a range of only 6% on either side of the average." This smaller range provides more consistency when manufacturing the glass.

Chemically tempered glass is used in eyeglasses and sunglasses and thermally tempered glass is used in automobile windshields. This new tempering method could allow thinner glass to be used in such things as photocopying machines, scanners and electronic displays that would make them stronger and lighter. Eventually, glasses could be designed with specific strengths and a higher reliability.

REMOVING POLLUTING COMPOUNDS FROM CRUDE OIL

Penn State researchers have discovered new properties of nickel, used widely for removing polluting sulfur compounds from crude oil, which could help chemists tailor the sulfur removal process for maximum efficiency and economy.

The research was conducted by Paul S. Weiss, professor of chemistry at Penn State, along with graduate student James G. Kushmerick. The chemists made their discovery with one of the most powerful and stable microscopes in the world — an instrument they designed and built themselves. Using the microscope, they examined two important materials in the catalytic process: nickel and molybdenum disulfide. Tiny molybdenum disulfide crystallites on an oxide base — with nickel or cobalt added to promote the reaction — are used by refineries worldwide as catalysts for removing sulfur-containing compounds from crude oil.

Weiss and Kushmerick found that the nickel atoms were amazingly mobile, even when well below room temperature. They suspect that nickel's surprising ability to glide around is one of the keys to promoting a more effective reaction in removing sulfur compounds from oil. After discovering these new properties of nickel, Weiss and Kushmerick realized that nickel atoms could act as a kind of sticky ball bearing in the sulfur-removal process. It could both capture sulfur-containing compounds from the oil and help them move around to find the sites, where catalytic reactions can lock the polluting compounds in place so they can be separated and chemically removed from the oil.

Scientists can now think about designing better catalysts by designing systems to enhance surface mobility for reacting molecules. "Every little bit of efficiency you can get out of these catalytic processes translates into a big effect in terms of results," says Weiss.

For more information, http://www.science.psu.edu/alert/Weiss12-1998.htm High-resolution images are available at http://stm1.chem.psu.edu/~jxk/Roles

GENE STUDY QUESTIONS CAMBRIAN EXPLOSION

A Penn State study using the largest data set of gene sequences found that the ancestors of major groups of animal species began populating Earth more than 600 million years earlier than indicated by their fossil remains.

The research suggests that animals have been evolving steadily into different species for at least 1200 million years, which challenges a popular theory known as the Cambrian Explosion that proposes the sudden appearance of most major animal groups, known as phyla, 530 million years ago. "Not only are all these genes telling us that a wealth of animal species in at least three phyla were already on Earth millions of years before their fossils start appearing," says S. Blair Hedges, associate professor of biology. "But they also are telling us when three of the major kingdoms of living things — animals, plants and fungi — first diverged from a common ancestor and began evolving down separate evolutionary paths."

That date — about 1.6 billion years ago — is the earliest yet obtained by gene studies for this evolutionary event, according to Hedges.

A paper describing the research was published in the the Proceedings of the Royal Society of London (Series B) by Daniel Y.-C. Wang, Sudhir Kumar, and Hedges, all of Penn State. To gauge the pace of evolution, the research team tested hundreds of gene sequences to find those that developed mutations at a constant rate over time. "Because mutations start occurring at regular intervals in these genes as soon as a new species evolves — like the ticking of a clock — we can use them to trace the evolutionary history of a species back to its actual time of origin," Hedges explains. By comparing individual genes in pairs of species, the researchers identified 75 nuclear genes that had accumulated mutations at a fairly constant rate relative to one another during their evolution. The genes were from species representing three major taxonomic groups, or phyla, of animals (arthropods, chordates, and nematodes), plus plants and fungi.

The scientists then calibrated these molecular clocks to an evolutionary event well established by fossil studies — the divergence of birds and mammals about 310 million years ago.

"A clock isn't any good unless it is calibrated to a time that everyone else agrees on," Hedges explains, "and just about everyone agrees on the date when reptilian ancestors of birds and mammals appeared because it is based on well-accepted studies of fossils."

Using this date as a secure calibration point — and the mutation rate for each of the constant-rate genes as a timing device — the researchers were able to determine how long ago each of the species originated. The Penn State team used more than twice as many genes to date the origin of the three major animal phyla as had been used in any other study since gene sequences first became available in the Genbank public databases maintained by the National Institutes of Health (NIH) during the 1970s. "We wanted to have so much data that the conclusions from our study of this controversial issue could be very robust," Hedges comments.

Earlier studies using many fewer genes were disturbing to some researchers because they yielded a wide range of dates for the origin of animal species, although all the gene studies agreed that the event occurred well before the Cambrian period.

"Our methodology and our larger data set should have had a stabilizing effect; and in fact, our study resulted in a date intermediate between the earlier estimates," Hedges says. If the results of his team's genetic study are correct, Hedges says the scientific question must change from "How did all these species evolve so suddenly early in the Cambrian period?" to "Why don't we see any fossils of these species long before the Cambrian period?"

Among the suggested answers are that changes in the Earth's atmosphere led to the development of hard external skeletons in animals that had only soft external skeletons before the Cambrian period. "Hard body parts like external skeletons are most likely to become fossils," Hedges explains. Species not likely to fossilize, like earthworms, typically live and die without leaving a trace of their existence—except in the genes of their descendants.

The Penn State biologist says his research might be useful for finding life on other planets. "If we can learn when different stages of life evolved on Earth, we can compare those dates to events in the chemical evolution of Earth's atmosphere and ocean, such as when oxygen and other important gases increased," Hedges explains. Research with this goal is an important focus in Penn State's Astrobiology Research Center. This research was supported by grants from the National Science Foundation and the National Aeronautics and Space Administration. See also: http://www.science.psu.edu/alert/Hedges1-1999.htm

SOUFRIERE HILLS ERUPTION

A study of the Soufriere Hills Volcano provides important clues to short-term prediction of and the mechanisms behind cyclic eruptions of the most common type of volcanoes, according to an international team of volcanologists.

"We had precisely the right equipment, in the right place, and at the right time, to monitor the changeover from a steady magma flow to one that was not steady but cyclical," says Barry Voight, who is both a professor of geosciences at Penn State and a senior scientist appointed by the British Geological Survey to work at the Montserrat Volcano Observatory. "No one before had documented these cyclic events nearly so well, or had monitored the additional background data necessary to understand the mechanisms behind them." In the Feb. 19 issue of the journal *Science*, the researchers note that their analysis of the Soufriere Hills Volcano, Montserrat, British West Indies, is applicable to other andesite volcanos, the predominant type of explosive volcano worldwide. The researchers monitored the seismic and deformation behavior of the mountain in real time, allowing both an improved understanding of the volcanic system and enabling prediction of when eruptions might occur and what areas they were likely to affect.

There were two types of dangerous eruptions at Montserrat. For the scorching-hot, block-and-ash hurricane-type eruption, caused by collapse of a growing lava mound over the volcano vent, the team could identify the time when their occurrence was probable, within a few hours, says Voight. "We could also identify the directions they would travel. However, we could not reliably say for a given cycle if, in fact, a major collapse, with an exceptionally-long-running ash hurricane, would occur," he notes. "But we could predict say 11 hours before hand, that if a collapse-generated ash hurricane were to occur, it would occur at a certain time and would probably

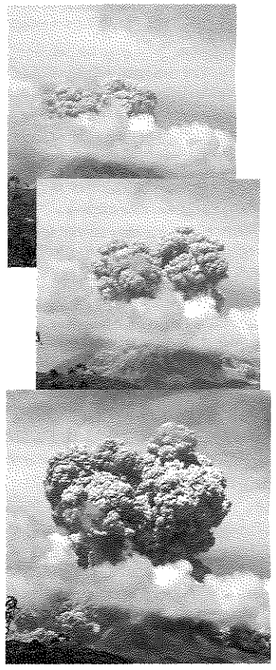
move in a general direction."

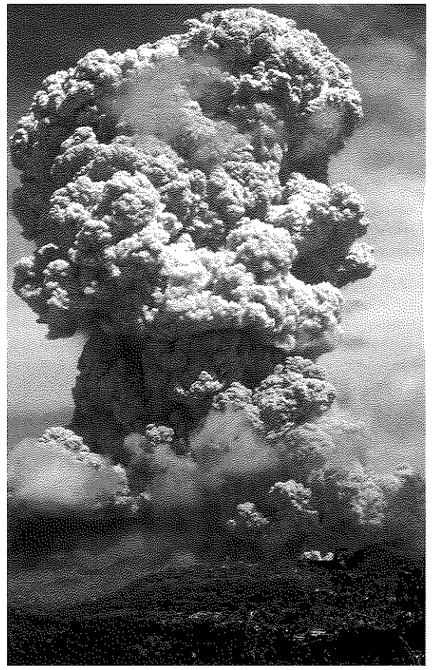
For the second type of eruption that involved large vertical explosions with nine-mile high eruption columns and ash hurricanes simultaneously in a number of river valleys, it became possible to forecast with some confidence each impending explosion. In general, this forecasting ability aided civil officials to define zoning and to carry out evacuation, and many lives were saved, says Voight. "The scientists could make predictions because the volcano had switched over to repetitive cyclic activity."

The magma inside the volcano contained water that was boiling off and trying to escape as the hot mass rose. When some of the water left the magma melt, the melt began to crystallize. Partially crystallized magma is much more viscous than uncrystallized magma. As a result, the thick, sticky magma plugged the upper part of the volcano's conduit. Then, pressure in magma underneath the plug built up, causing ground swelling and earthquakes, and eventually pushed the magma plug out of the way. Magma was then rapidly ejected and this commonly caused a collapse of the surface lava mound and ash hurricanes. Researchers monitored the cycles of sticking and slipping, using state-of-the-art monitoring equipment and software provided by the U.S. Geologic Survey, the BGS and others, that allowed real-time data collection and analysis.

The scientists could analyze events within minutes of their occurrence. Tilt meters high on the volcano indicated how much and where the pressure was building. As the lava dome grew, some large landslide collapses thinned areas of the dome, quickly reduced the external pressure inside and under the dome and made them more likely to be the site of vertical or horizontal explosions of hot ash and gases, says Voight. From these deep uncorked pockets, magma with fine bubbles of pressurized gas would explode outward causing hot ash hurricanes. These pyroclastic flows moved down toward the sea at speeds as fast as 70 m.p.h. The capital town of Plymouth was destroyed by these flows. "It was a sad moment to watch Plymouth burn," Voight said.

The pyroclastic flows happened right after the pressure peak in the stick slip cycle. Knowing the cyclic timing of the magma, the researchers could identify when eruptions might occur. Because they also knew where the lava-dome deformations and slope failures were occurring, they could define the flow direction.





The explosive eruptions in August 1997 happened because the magma corking the conduit became thin from a previous dome collapse and the underlying high pressure buildup popped the cork. The resulting explosions rose vertically as much as nine miles. Ballistic blocks a yard wide were shot out over a mile and ash hurricanes flowed in all sectors around the volcano, running to the sea.

"Because we were able to predict these eruptions, we were able to put teams in the field to document the explosive events by video, still photography and surveying. We are learning a lot from this data which is still being worked on," says Voight. He noted that this explosion destroyed his tilt meters.

At least for now, the Soufriere Hills Volcano is relatively quiet. The last very large eruption occurred on Dec. 26, 1997, in where the south side of the whole volcano collapsed, and an explosive blast completely destroyed the two towns on that side of the island. The communities had been evacuated and no lives were lost. It was extremely fortunate that the evacuation was maintained, because no one could have survived the blast, says Voight.

Magma is no longer rising to build the dome, but the volcano remains dangerous. The lava is still very hot — 1300° F — and its surface is unstable. Occasional gravity collapses still cause ash hurricanes that can run to the sea. However, it appears that this activity is winding down. The researchers have found clear links among the seismic and deformation data from the volcano, the volcano's behavior and the way that gas and ash eruptions occur. "Understanding these links advances our ability to interpret our data in terms of the physical processes and helps us to forecast the timing and, to a usable extent, the eruptive style of the volcano," says Voight. "These results, which can be of use elsewhere, improve our ability to mitigate the very dangerous effects of explosive volcanism."

The research team consisted of scientists from British Universities, the British Geological Survey, the Seismic Research Unit of the University of the West Indies, U.S.G.S. and Penn State. The members were Voight, R.S.J. Sparks, A.D. Miller, R.C.Stewart, R.P. Hoblitt, A. Clarke, J. Ewart, W. Aspinall, B. Baptie, T. H. Druitt, R. Herd, P. Jackson, A.M. Lejeune, A.B. Lockhart, S.C. Loughlin, R. Luckett, L. Lynch, G.E. Norton, R. Robertson, I.M. Watson and S.R. Young, all working through the Montserrat Volcano Observatory, Montserrat, British West Indies.

ALUMNI NEWS

ALUMNI RECEIVE AWARDS

The outstanding achievements of six of the College's alumni were recognized at the annual Obelisk Dinner that was attended by Obelisk Society members and members of the Board of Directors of GEMS. The 1998 Alumni Fellow Award was presented to meteorologist Raymond J. Ban, geographer David K. Nale, and geoscientist David M. Demshur, and the 1998 GEMS Alumni Achievement Award was presented to James W. Stratton, a financial analyst, Shelley A. Corman, a natural gas industry executive, and Robert Petcavich, a materials entrepreneur.

1998 ALUMNI FELLOWS

Raymond J. Ban received his B.S. in Meteorology from Penn State in 1973 and is now senior vice president for The Weather Channel. He worked for Accu-Weather, Inc. as an operational forecaster for several years, before becoming one of the first employees of The Weather Channel, joining the operation in 1982 as an on-camera meteorologist. He is now senior vice president for meteorological affairs and operations. In 1997 he was named a Fellow of the American Meteorological Society and currently serves as chair of the AMS Commission on Professional Affairs. He holds both the Television Seal of Approval and Radio Seal of Approval from the society. He is a Centennial Fellow.

David M. Demshur received his B.S. in Geosciences in 1977. He is president and CEO of Core Laboratories, a company with 70 offices in 50 countries that provides high technology laboratory and management services to the oil industry. He joined Core Labs in 1979 following two years with Gulf Oil Corporation. He supervised Core's operations in Europe, Africa and the Middle East before returning to corporate headquarters in Houston as senior vice president of petroleum services. He was named president in 1993. He is a strong supporter of the Department of Geosciences, and initiated the David Demshur Undergraduate Endowment in Geosciences in 1995. He also sponsors a reception for Penn State alumni at the annual meeting of the American Association for Petroleum Geologists. He is a Centennial Fellow.

David K. Nale received his B.S. in Geography in 1972 and holds an MBA from LaSalle University. He is president of Aerial Data Reduction Associates, Inc., the largest privately-owned GIS firm, with offices in California, Colorado, Connecticut, Florida, and Pennsylvania. As ADR's chief photogrammetrist, he has managed over two thousand photogrammetric and GIS projects across the nation and abroad. He was the first person to be titled Certified Mapping Scientist GIS/LIS by the American Society of Photogrammetry and Remote Sensing and now serves on the selection board for the society. He is a Centennial Fellow.

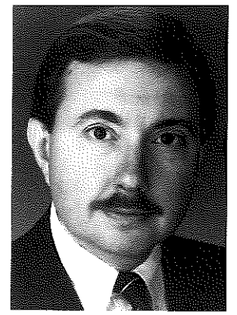
1998 GEMS ALUMNI ACHIEVEMENT AWARD

Shelley A. Corman '85 Mineral Economics, MBA and J.D. *magnum cum laude* from the University of Houston. She is vice president for regulatory affairs for the Enron Gas Pipeline Group, the natural gas pipeline unit of Enron, Inc. in Houston, Texas. She has been in the natural gas industry for 14 years and held a variety of legal, regulatory and marketing positions at Enron and its Florida Gas Transmission affiliate. She serves on the Gas Industry Standards Board Executive Committee and is a Director of the Enron Federal Credit Union. She is a Centennial Fellow.

Robert J. Petcavich '76 Chemistry, '77 Solid State Science, '80 Ph.D. Polymer Science is chairman and founder of Planet Polymer Technologies, Inc. and Alife Medical, Inc. in San Diego, California. These high technology start-up companies are involved in initiatives ranging from the development of degradable polymers for medical devices to the application of degradable polymers in metal injection molding. Petcavich has established a number of start-up companies over the past decade and subsequently marketed them successfully as profitable undertakings. He is a Centennial Fellow.

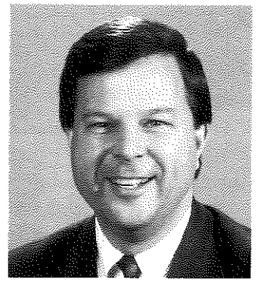
James W. Stratton '58 B.S. Geophysics and '60 MBA with high distinction Harvard Business School (Baker Scholar), founded Stratton Management Company and Stratton Growth Fund in 1972. He serves as CEO for these companies and is also president of FinDaTex, a privately owned financial services company. He began his career with Cooke & Bieler, a Philadelphia-based investment counseling firm and joined Drexel & Co. in 1965. He serves as a director of several publicly owned companies. He also served as chairman of the Board of Trustees of Thomas Jefferson University.

1998 ALUMNI FELLOWS



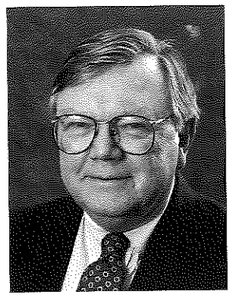
Raymond J. Ban

David K. Nale with Dean John A. Dutton



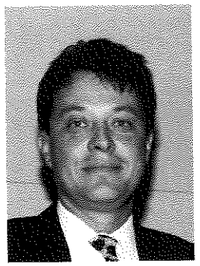
David M. Demshur

1998 GEMS ALUMNI ACHIEVEMENT AWARD RECIPIENTS



James W. Stratton

Shelley A. Corman with GEMS President Ronald A. Landon



Robert J. Petcavich

NEW MEMBERS OF THE GEMS BOARD OF DIRECTORS, 1998

Michael E. Starsinic '80, '82 M.S., '84 Ph.D. Polymer Science

Dr. Starsinic has been employed in Wilmington, Delaware, by Montell, Inc. since1990, and currently coordinates efforts to develop polymers for unique nonwoven and film applications for several of Montell's largest customers. Montell is the largest producer of polypropylene worldwide. Previously Mike spent six years at Allied-Signal Fibers in Petersburg,VA. working on a variety of development programs related to nylon carpet fibers as well as high strength polyester and polyolefin fibers. He holds five U.S. patents, with two pending. In 1994, he formed Gor-Star, Inc. with Bernard (Bronco) Gordon, a former Polymer Science faculty member. The company develops applications for hydrodegradable polymers. In 1995, he established the Mike Starsinic Award in Polymer Science, given annually to the undergraduate exhibiting outstanding leadership and dedication to the program. Mike is a Centennial Fellow of the College.

Keith Gwozdz '88 Mineral Economics, '94 MBA-Finance Pace University.

Mr. Gwozdz is a commodities broker in New York City for the London Metals Exchange subsidiary of Billiton, one of the largest mining companies in the world. Billiton is headquartered in London. Keith's responsibilities include new market development and providing market quotes and information to exisiting customers.He previously worked for Allied Signal Environmental Catalyst in Tulsa, OK as Manager of Noble Metals. He was responsible for the worldwide procurement and hedging of platinum group metals, also responsible for foreign exchange hedging. Prior to that and directly after graduation from PSU, he worked for another minining company, ASARCO. While there, he held numerous sales and trading positions.Whenever he has time he plays soccer and manages an indoor soccer team. Keith's wife's name is Kathleen.

David J. Michel '66 M.S. '68 Ph.D. Metallurgy

Dr. Michel is associate superintendent of the Naval Research Laboratory's Materials Science and Technology Division. He lives near Washington. He has been at NRL since 1972, and was head of the High Temperature Materials Section for ten years before assuming his present position in 1992. He is author of more than 100 scientific publications and co-editor of three books, and holds two U.S. patents. His work has been recognized by the Naval Research Laboratory in a research publication award, two invention awards, and performance recognition awards from 1988-1992. He was selected as Outstanding Young Member of the Washington, D.C. Chapter of the American Society for Metals International in 1977 and was elected as a Fellow of the Society in 1989. He recently received the George Kimball Burgess Memorial Award of ASM International for his outstanding contributions to research in elevated temperature deformation mechanisms and for his leadership qualities. He received the GEMS Alumni Achievement Award in 1995. He likes to race cars in his spare time. His wife is Linda.

Thomas R. Kleeb '73 Ceramic Science

Mr. Kleeb is beginning a new position with Harbison Walker Refractories Company as new product development manager. He has lived in Pittsburgh all his life and been with Harbison Walker for 25 years. He has served as facility manager of the Garber Research Center and manager of international licensing and technical services. In his new job he will be responsible for commercializing technologies developed at the Garber Center and identifying trends in the use of refractories in all industries. Tom holds 14 U.S. patents and was winner of the 1984 Dresser Industries Medal for Technical Creativity. At home, he is married to a Penn Stater, Linda (political science), and has daughter Kelli at Duquesne Law School and Talia, a freshman in biology at Penn State. He is also chair of Explorer Post 173 in Etna, Pa.

NEWS OF ALUMNI

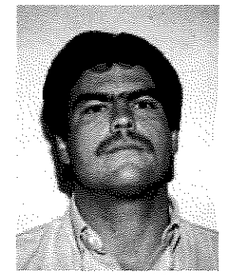
S. M. Farouq Ali '62 M. S., 64 Ph.D. Petroleum and Natural Gas Engineering, professor of petroleum engieering at the University of Alberta, Canada, has received the Kapitsa Gold Medal of Honour of the Russian Academy of Natural Sciences in recognition of his work in steam injection and enhanced oil recovery.The medal is named for a former head of the academy Peter Kapitsa, a Nobel Laureate, and it is given for work of Nobel Prize winning quality, in fields where there is no Nobel Prize. Of the 32 medals awarded, few have been given to scientists outside Russia. Professor Farouq Ali was a member of the Penn State faculty from 1960 to 1979 and maintains close ties to the PNGE program.

John MacChesney '59 Ph.D. Geochemistry, holder of the College's Hosler Medal, has received the 1999 John Tyndall Award of the International Optical Fiber Communications Conference. He was cited for the invention and development of the modified chemical vapor deposition (MCVD) process, which has been used to produce much of the world's optical fiber, and for co-inventing high-purity "sol-gel" overcladding for optical fibers. MacChesney is a researcher in the Photonics Materials Research department of Bell Labs, the research and development arm of Lucent Technologies.

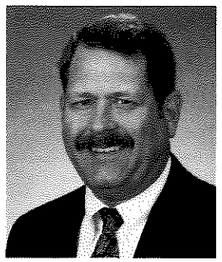
James C. Hower '78 Ph.D. Geology has been appointed as editor-in-chief of the *International Journal of Coal Geology*. His appointment as the journal's third editor-in-chief maintains the PSU connection in this editor position:the founding editor was William Spackman, professor emeritus of geological sciences, and his successor was Russell Dutcher '60 Ph.D. Geology, former member of the EMS Geology faculty. Dr. Hower is also co-author of AAPG Studies in Geology #45, the *Atlas of Coal Geology*, which was published in November 1998. The book is on compact disk, AAPG's first publication strictly in an electronic format.

Robert C. DeVries '53 Ph.D. Mineralogy and Petrology, a consultant retired from a career as research chemist with General Electric, has been elected as a member of the National Academy of Engineering. He was cited for his achievements in applications of phase equilibria to the synthesis and characterization of diamond, boron nitride, and related materials.

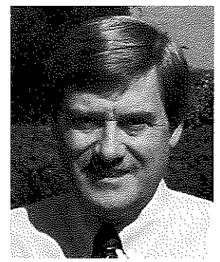
NEW MEMBERS OF THE 1998 GEMS BOARD OF DIRECTORS



Michael E. Starsinic



David J. Michel



Thomas R. Kleeb

Keith Gwozdz

GEMS Board Member Barbara Arnold organized a very successful "Careers in EMS" event at the New Kensington Campus of Penn State in Fall. Alumni Dawn Sawinski Herko (PLMSC), Craig Barras (Earth), Jerry Martz (Meteo), David McGhee (Metals) and Tom Kleeb (Ceramics) participated in the program.

THESIS LIST

Spring 1998

A total of 198 degrees were granted by the College of Earth and Mineral Sciences at the University's 1998 Spring Commencement in May: 158 bachelor of science degrees, 40 advanced degrees. Following is a list of the advanced degree recipients and titles of their theses or papers.

Fuel Science - Daniel Eric McKinney, Ph.D., *Use of 13C-Labeled Compounds to Trace Their Reactivity in Fossil Fuel Systems;* Irene Gennadyevna Nodelman, M.S., *Trace Element Partitioning Behavior during Pilot-Scale Combustion of Pulverized Coals and Coal-Water Slurry Fuel.*

Geography - Maria Tereza Cavazos Pérez, Ph.D., *Downscaling Large-Scale Circulation to Local Winter Climate Using Neural Network Techniques;* Wolfgang Rudolf Willi Hoeschele, Ph.D., *Land Degradation, State Power, and Peasant Livelihood in Attappadi (Kerala State, India).*

Geosciences - Lee Ann Colarusso, M.S., *The Miocene Radiation of Grasslands: Compound-Specific Isotope Evidence from Organic Matter from the Indian Subcontinent;* Jennifer Lynn De Lurio, M.S., *Global Comparison of Late Aptian Climate Simulations with the Geologic Record: An Investigation of the Glendonite Record for Cold Australian Climate;* David Michael Diodato, Ph.D., *FracFlow96: A Numerical Model for Simulating Multiphase Fluid Flow in Fractured Porous Media with an Application at Yucca Mountain, Nevada;* Jeffrey D. Lawlis, Ph.D., *High Temperature Creep of Synthetic Olivine-Enstatite Aggregates;* Richard David Pancost, Ph.D., *Organic Carbon-Isotopes as Indicators of Paleoclimate: The Impact of Organic Matter Source Variations;* Neal S. Suits, Ph.D., *Sulfur Diagenesis in Holocene Peru Shelf and Slope Sediments.*

Materials - Greg Daniel Barber, Ph.D., *Chemistry on the Diamond (111) Surface;* Murali Lakshman, M.S., *Rate Controlled Binder Burnout;* Xian Lu, M.S., *Structure-Property Relationships in Submicron X7R Dielectric Materials;* Thomas Edward Paulson, Ph.D., *Thermodynamic and Kinetic Investigation of High-Temperature Interactions between Float Glass and Tin;* Qing-Ming Wang, Ph.D., *Piezoelectric Ceramic Actuators for Composite Structure for Active Noise Control Applications;* Christoph Johannes Weber, Ph.D., *In-Situ Scanning Tunneling Microscopy Study of Morphological and Mechanistic Aspects of Electroless Copper Deposition.*

Materials Science & Engineering - David Joseph Ellerbrock, Ph.D., *Defect Characterization of Titanium Passive Films;* Mark Douglas Irwin, Ph.D., *An Investigation of Bias-Enhanced Nucleation of Diamond on SiO2 and ZrN Substrates;* Elena Vladislavovna Kazakova, M.S., *Structure-Thermal Stability Relationship during Pyrolysis of Pure Hydrocarbons;* Bing Lu, M.S., *Synthesis of New Maleic Anhydride Modified Polypropylene via "Reactive" Copolymers;* Richard P. Martukanitz, Ph.D., *Microstructural Evolution within the Heat Affected Zone of Al-Cu and Al-Cu-Li Alloys;* Neal Myers, M.S., *Achievement of Near 100% Dense M2 Tool Steel Via Injection Molding and Supersolidus Liquid Phase Sintering;* George Pehlert, Ph.D., *Functional Group Accessibility in Hydrogen Bonded Polymer Blends;* Andrzej Piotrowski, Ph.D., *Effects of Rank and Calcium Catalysis on Oxygen Chemisorption and Gasification of Coal Chars;* Mahesh Kimar Venkitachalam, M.S., *Phase Field Simulations of Grain Growth;* Maria Katherine Washko, M.S., *The Role of O2 Concentration and Crevice Geometry on the Stability of Crevice Corrosion of Iron.*

Meteorology - Rebecca Lynn Allen, M.S., *A Continuous-in-Space MOS System for Maximum Temperature Forecasts;* George Howard Bryan, M.S., *Discrete Frontal Propagation Induced by Convection;* Mark Patrick Fitzgerald, M.S., *Warm Season Statistical Verification of The Pennsylvania State University Real Time Mesoscale Model Version 5;* Seiji Kato, Ph.D., *Uncertainties in Modeled and Measured Surface Shortwave Irradiance;* Sara Ann Michelson, M.S., *Mesoscale Meteorological Structure of a High-Ozone Episode in the Northeast U.S.;* David Owen Miller, M.S., *Concentration Fluctuations Along Plume Centerplane within a Laboratory Convective Boundary Layer;* Jennifer Anne Miller, M.S., *A Comparison of Diurnal Motion Theories for the Quiescent Dryline Using a Shallow Water Model;* Daniel Thomas Pawlak, M.S., *Development and Evaluation of a New Spectral Planetary Boundary-Layer Architecture for the MM5;* Jeremy Parvin Rishel, M.S., *A Methodology for Objectively Identifying Coherent Structures within the Marine Atmospheric Surface Layer;* Bing Wu, M.S., *Dynamical and Microphysical Retrievals from Multi-Parameter Doppler Radar Observations.*

Mineral Economics - Michael Tobias Bussa, M.S., *Ecosystem Valuation: An Application Using Conjoint Analysis;* Amangeldy Jumatovich Mussayev, M.S., *Essays in: Econometric applications to Mineral and Energy Economics.*

Mining Engineering - Schichang Zhao, Ph.D., *Development of a Kinetic Geochemical Model and Its Application in the Prediction of Acid Mine Drainage Associated with Mining.*

Petroleum and Natural Gas Engineering - Hari Doraisamy, M.S., *Methods of Neuro-Simulation for Field Development.*

Summer 1998

A total of 61 degrees were granted by the College of Earth and Mineral Sciences at the University's 1998 Summer Commencement in August: 16 bachelor of science degrees, 45 advanced degrees. Following is a list of the advanced degree recipients and titles of their theses or papers.

Fuel Science -Jonathan P. Mathews, Ph.D., *Following Changes in the Constitution of Rapidly Heated Bituminous Vitrinites.*

Geography - Marco Alcaraz, M.S., *The Effects of Potential Carbon Dioxide Emissions Regulations on the United States Lime Industry at the National and Regional Scales;* James Habron, M.S., *The Global Political Economy of Information Technology Infrastructures;* Mark Allen Harrington, M.S., *Automobile Dependency and Neighborhood Form in the Portland, Oregon, Metropolitan Area;* Daniel Brian Haug, M.S., *Tools for Exploratory Analysis of Mapped Point Patterns;* Steven A. Kopecky, M.S., *Development, Culture, and the Environment: Rethinking Poverty on the Navajo Reservation;* Trudy Ann Suchan, Ph.D., *Categories in Geographic Representation;* Alys Wall, M.S., *Predicting Climate from the Tree Ring Data: A Comparison of Linear Regression and Neural Network Methodologies.*

Geosciences - Anna María Ágústsdóttir, Ph.D., *Abrupt Climate Changes and the Effects of North Atlantic Deepwater Formation: Results from the Genesis Global Climate Model and Comparison with Data from the Younger Dryas Event and the Event at 8200 Years BP and the Present;* Abdullah Ibrahim Al-Zarah, Ph.D., *A Management Model for the SAQ Aquifer in Tabuk City, Saudi Arabia;* Michal Jan Bystricky, Ph.D., *High Temperature Deformation of Clinopyroxene and Clinopyroxene-Plagioclase Aggregates;* Ken Stuart Gardner, M.S., *Formation of the Sage Breccia Pipe by Solution and Collapse Processes, Coconino County, Arizona;* Mark Pagani, Ph.D., *Miocene Atmospheric Carbon Dioxide Concentrations and Paleoceanography: Constraints from Organic Molecular Carbon-Isotope Compositions;* Leta Magendanz Slupik, M.S., *Sedimentology and Stable-Isotope Chemostratigraphy of Late Middle Ordovician Carbonates in Central Pennsylvania;* Ming Zhao, Ph.D., *Southern Africa Seismic Structure and Source Studies.*

Materials - James Vincent Bothe, Ph.D., *Phase Formation and Chemical Phase Equilibria in Aqueous-based Systems Pertinent to Waste-management: CaO-Al2O3-B2O3-H2O, CaO-PbO-P2O5-H2O, and CaO-As2O5-H2;* Craig Thomas Edwards, M.S., *Gelcasting of Macro Defect-Free Ceramics;* Brady J. Gibbons, Ph.D., *Real-time Spectroscopic Ellipsometry and its Application to the Processing of YBa2Cu3O7-8 Films by Molecular Beam Epitaxy;* Joohyun Koh, Ph.D., *Real Time Spectroscopic Ellipsometry Study for the Design and Optimization of Hydrogenated Amorphous Silicon-based Solar Cells;* Wilfredo Otano-Rivera, Ph.D., *Control of the Stabilization of Cubic Boron Nitride Thin Films Deposited by Unbalanced Magnetron Sputtering and DC Pulsed Substrate Biasing;* Kumar Vipin Pandya, M.S., *Synthesis and Properties of Ferroelectric Tungsten-Bronze PSKNN Solid Solutions.*

Materials Science & Engineering - Ritwik Biswas, M.S., *Measurement of Kinetic Parameters of Electrochemical Reactions in High Temperature Aqueous Solutions;* Caner Durucan, M.S., *The Formation and Properties of Hydroxyapatite-Biodegradable Polymer Biocomposites;* Sheng Hong, M.S., *New Ethylene-Propylene Copolymers Containing Reactive Para-Methylstyrene Synthesis and Functionalization;* Jon-Paul Maria, Ph.D., *Epitaxial Pb(Mg1/3Nb2/3)O3-PbTiO3 Thin Films;* Metin Ozgul, M.S., *Electrochemical Phenomena in Piezoelectric Ceramics Leading to Polarization Fatigue;* Koray Ozturk, M.S., *Diffusion Bonding of Zirconia Pieces Using Electrophoretically Deposited 3Y-TZP Particulate Interlayers;* Mario Edmundo Pastor, M.S., *Pore Formation and Determination of Parameters for Laser Welding Aluminum Alloys A1-5182 and A1-5754;* Joseph Francis Shepard, Jr., Ph.D., *The Investigation of Biaxial Stress Effects and the Transverse Piezoelectric (d31) Characterization of Lead Zirconate Titanate Thin Films;* Sean Michael Sweeney, M.S., *Green Density Effects in the Densification of Sub-Micron Oxide Ceramics;* Ruey-Fong Yan, Ph.D., *Effects of Point Defect Structures of the Reactive Element Oxides on the Oxidation Kinetics of Pure NI and NI-CR Alloys.*

Metals Science & Engineering - Sang-Beom Kim, Ph.D., *High Cycle Fatigue of Squeeze Cast Al/SiCw Composites.*

Meteorology - Brian Allen Cosgrove, M.S., *A Simplified Dynamic Vegetation Model Coupled to the Genesis GCM;* Joby Lee Hilliker, M.S., *An Observations-Based Statistical System for Hourly Probabilistic Forecasts of Low Ceiling at the San Francisco International Airport;* Christopher Anthony Juckins, M.S., *Examining the Potential Use of Statistics to Improve Cumulus Parameterizations;* Patrick Francis Maloit, M.S., *Variations in the Atmospheric Oxygen-To-Nitrogen Ratio Due to Air-Sea Exchange: Simulations with the Genesis General Circulation Model;* Natasha Lynn Miles, M.S., *Cloud Drop Size Distributions in Low-Level Stratiform Clouds;* Charles Marcus Patterson, M.S., *Review and Application of WSR-88D Algorithms;* Robert Fulton Rogers, Ph.D., *Amplification of Warm-core Vortices by Convective Redevelopment: A Key Component of Tropical Cyclogenesis.*

Mineral Economics - Rajnish Shripad Kamat, M.S., *Essays In: Analysis of Policy Initiatives in Climate Change and Electric Power in the U.S.*

Mineral Processing - Sushi Ranjan, Ph.D., *Modeling of Hyperbaric Filtration and Dewatering of Coal.*

Mining Engineering - Eric Richard Bauer, Ph.D., *The Impact of Extending Depth-of-Cut Mining on Coal Mine Ground Control and Worker Safety;* Eduardo Alexandre, M. Eng., *Planning and Control of Mine Health and Safety Issues with Particular Reference to Mozambique;* Amit Sharma, M.S., *Monte Carlo Estimation of Ground Water Inflow Into Longwall Panels Under Conditions of Uncorrelated Permeability Fields.*

Fall 1998

A total of 104 degrees were granted by the College of Earth and Mineral Sciences at the University's 1998 Fall Commencement in December: 69 bachelor of science degrees, 35 advanced degrees. Following is a list of the advanced degree recipients and titles of their theses or papers.

Geography - Robert Matthew Beaty, M.S., *Spatial and Temporal Variation in Fire Regimes and Forest Dynamics Along a Montane Forest Gradient in the Southern Cascades, California;* Brent Jason Frakes, Ph.D., *A Synoptic Climatology of Short- and Long-Term Relationships between the Atmospheric Circulation and Stream Flow;* Kurtis George Fuellhart, Ph.D., *Networks, Location and Information Acquisition: An Analysis of Small Manufacturing Establishments;* Christine Louise Jocoy, M.S., *Who Gets Clean Water? The Geography of Aid Allocation to Small Water Systems in Pennsylvania;* Colin Daniel Polsky, M.S., *A Hierarchical Conceptual Framework of Agricultural Land-Use Change.*

Geosciences - Beth Bishop Stump, M.S., *Illuminating Basinal Fluid Flow in Eugene Island 330 (Gulf of Mexico) through in Situ Observations, Deformation Experiments, and Hydrodynamic Modeling;* Seung Chul Yoo, M.S., *Ice Sheet Effects on Receiver Functions and Crustal Structure of the West Antarctica.*

Materials - Sylvie Eury, M.S., *Electrostriction in Low Permittivity Polymers;* Richard Joseph Meyer, Jr., Ph.D., *High Frequency (15-70 MHz) 1-3 PZT Fiber/Polymer Composites: Fabrication and Characterization;* Marc Nicholas Palmisiano, M.S., *The Effects of Processing on Glass Fiber Surfaces;* Christopher David Theis, Ph.D., *Adsorption-Controlled Growth of Titanates Containing Volatile Lead- or Bismuth-Based Components by Reactive MBE;* Jian Zhong Zhao, Ph.D., *The Influence of Operating Conditions on Properties of PZT and (1-x)PMN-xPT Ceramics*

Materials Science & Engineering - John Chung-Shih Chen, Ph.D., *Modification of Polyacrylonitrile (PAN) Precursor Fiber via Post-Spinning Plasticization and Stretching;* Sheng Hong, M.S., *New Ethylene-Propylene Copolymers Containing Reactive Para-Methylstyrene Synthesis and Functionalization;* Victor R. Jablokov, M.S., *Ductile Fracture and Damage Accumulation Behavior of HY-100 Structural Steel;* John-Paul Kucera, M.S., *Processing Strategies and Analysis of Fine-Grain PZT-5H, PZT-5A, and Modified PbTio3 Piezoceramic Systems;* Jun Li, Ph.D., *Metal Surface Effects on Deposit Formation from Thermally Stressed Jet Fuels and Model Compounds;* Melissa Susanne Lisowski, M.S., *Time-Resolved Small- and Wide-Angle X-Ray Scattering of Poly(Ethylene Oxide) and Poly(Ethylene Oxide) Blends;* Michael Patrick Maglaque Mandanas, M.S., *Characterization and Analysis of Segregation and Particle Formation during Spray Drying of Particulate Suspensions;* Marissa Lee Mock, M.S., *Synthesis and Testing of a Macromolecular Antioxidant;* Matthew Mark Seabaugh, Ph.D., *Texture Development in Liquid Phase Sintered Alpha Alumina via Anisotropic Template Growth;* Nandh Thavarungkul, Ph.D., *Modulus and Yield Stress of Drawn LDPE.*

Meteorology – Bradley King Cameron, M.S., *Observations of the Entrainment Zone in a Rapidly Growing Convective Boundary Layer;* Dominic Stephen Preiswerk, M.S., *An Analysis of a Global Oceanic Carbonyl Sulfide Model;* Raymond Arthur Shaw, Ph.D., *Laboratory and Theoretical Studies of Ice Production in Clouds.*

Mineral Economics — Shengzhong Hui, M.S., *An Economic and Econometric Study of Petroleum Markets in the U.S.*

Mineral Processing – Ming Chang, M.S., *Block Copolymers for Control of Highly Loaded Aqueous Dispersions;* Edward C. Dowling, Ph.D., *An Evaluation of Characterization and Modeling Methods for Laboratory and Industrial Scale Froth Flotation;* Senthil Ramaswamy Kumar, M.Eng., *Characterization of Particle Shape;* Chairoj Rattanakawin, M.S., *Aggregate Size Distributions in Flocculation;* Russell Allen Smith, M.S., *Effect of Particle Size on Ultrafine Coal Flotation.*

Mining Engineering—Wilson Miola, Ph.D., *Analysis of Dust Concentration Patterns in High-Production Longwalls.*

Petroleum & Natural Gas Engineering - Meshal Khalaf Algharaib, M.S., *The Efficiency of Horizontal and Vertical Well Patterns in Waterflooding: A Numerical Study;* Yusuf Serdar Dogulu, Ph.D., *Modeling of Well Productivity in Perforated Completions Using Near-Wellbore Grid Generation.*

Polymer Science & Engineering - Kirk Martin Cantor, Ph.D., *An Investigation of the Curing Process for Moisture-Crosslinkable Polyethylene Used in Cable Coating Extrusion.*

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