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GSA TODAY

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INSIDE

Fractal Aspects of Geomorphic and Stratigraphic Processes

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Erosional drainage pattern in the southern Basin and Range region, western United States (courtesy of Arthur Bloom, Cornell University).

ABSTRACT

Fractal behavior implies power-law, scale-invariant statistics; these statistics are applicable to a wide variety of geological problems. Although topography is often complex, statistically, it usually exhibits fractal behavior; drainage networks are a classic example of a fractal tree. High stands and low stands in reservoirs have been demonstrated to obey fractal, power law statistics; there is also evidence that peak river discharges during floods obey fractal statistics. Floods are responsible for the deposition of some sedimentary sequences; sedimentary layering under a variety of circumstances satisfies fractal statistics.

INTRODUCTION

The subjects of hydrology, geomorphology, sedimentology, and stratigraphy are interrelated. Landforms are created by tectonic processes but are destroyed by erosion; sediment erosion and deposition are primarily responsible for the surface morphology of the continents. Erosion is dominated by floods, but it is a subject of controversy whether erosion is dominated by the very largest floods or a characteristic flood, say the 10 year or 100 year flood. Erosional processes are responsible for the development of drainage networks, which in turn dominate the development and evolution of landforms. The deposition of sediments is responsible for the development of stratigraphic sequences. These sequences may contain a wealth of information on paleoweather and climate if they can be interpreted.

It is easy to argue that the coupled processes of rainfall, runoff, erosion, material transport, and deposition are so complex as to defy analysis. Yet it must be recognized that there is considerable order in this complexity; fractal statistics are widely applicable. Self-similar fractals are defined by the relation

$$N = C_1 r^{-D} \text{ or } D = \frac{\log (N_u/N_{n+1})}{\log (r_{n+1}/r_n)} \quad (1)$$

where D is the fractal dimension, N is the number of objects with a linear dimension r, and C is a constant of proportionality. The concept of fractals was introduced by Mandelbrot (1967) in terms of the length of the west coast of Great Britain. His result is given in Figure 1A; the measured length P of the coast line is given as a function of the length r of the measuring rod. Good agreement with the fractal relation

$$P = Nr = C_1 r^{1-D} \quad (2)$$

is found taking $D = 1.25$. Similar results are obtained for the length of contours on topographic maps; three examples are also given in Figure 1 for diverse geologic settings. It is seen that there is little variation in the fractal dimension (1.15–1.25); the fractal dimension of topography is not sensitive to the geologic setting and is not diagnostic of age.

The height of topography along a linear track is equivalent to a time series[1]. It is common practice to expand a time series in a Fourier series over the interval L; the coefficients in the Fourier series A_n correspond to the wave length $\lambda_n = 2\pi/k_n$, with k_n the wave number. The spectral power density of a time series is given by $S_n = A_n^2 L$. A time series is a self-affine fractal if (Turcotte, 1992)

$$S_n = C_2 k^{-\beta} \text{ or } A_n = C_3 \lambda_n^{\beta/2}. \quad (3)$$

The corresponding self-affine fractal dimension is given by $D = 1/2(5 - \beta)$.

Spherical harmonic expansions of the topography on a planet are equivalent to the Fourier expansion of a time series. Spherical harmonic expansions of the global topography of Earth (Rapp, 1989) and Venus are given in Figure 2. In both cases, good agreement with equation 3 is obtained taking $\beta = 2 (D = 1.5)$; this is equivalent to the result $A_n = C_3 \lambda_n$. In the spectral domain, mountains have the same height to width ratios independent of size.

From Figure 2 it is seen that the amplitude of the topography on Venus, A_n, is about a factor of four less than on Earth; but on both planets the topography has the same spectral dependence $\beta = 2$. This is somewhat surprising because erosion is dominant in the evolution of many landforms on Earth; erosion is virtually absent on Venus, so that tectonic processes are dominant. This suggests that the tectonic processes that build topography and the erosional processes that destroy topography both give the same statistical behavior. Once again, the fractal dimension of topography does not appear to be diagnostic. It should also be pointed out that the fractal dimensions of topography associated with self-affine spectral expansions and self-similar coastline lengths are not, in general, equal. However, under a wide variety of conditions, topography does obey fractal statistics to a good approximation.

Drainage networks are classic examples of fractal trees. It is standard practice in geomorphology to use the Strahler (1957) ordering system. When two like-order streams meet, they form a stream with one higher order than the original. Thus, two first-order streams combine to form a second-order stream, two second-order streams combine to form a third-order stream, and so forth. The bifurcation ratio R_b is defined by

$$R_b = \frac{N_n}{N_{n+1}}, \quad (4)$$

where N_n is the number of streams of order n. The length-order ratio R_r is defined by

$$R_r = \frac{r_{n+1}}{r_n}, \quad (5)$$

where r_n is the mean length of streams of order n. From equation 1 the fractal dimension of a drainage network is (La Barbera and Rosso, 1989)

$$D = \frac{\ln R_b}{\ln R_r}. \quad (6)$$

Horton's (1945) laws require that R_b and R_r be nearly constant for a range of stream orders in a drainage basin; thus, drainage networks were recognized as

Fractal *continued on p. 211*

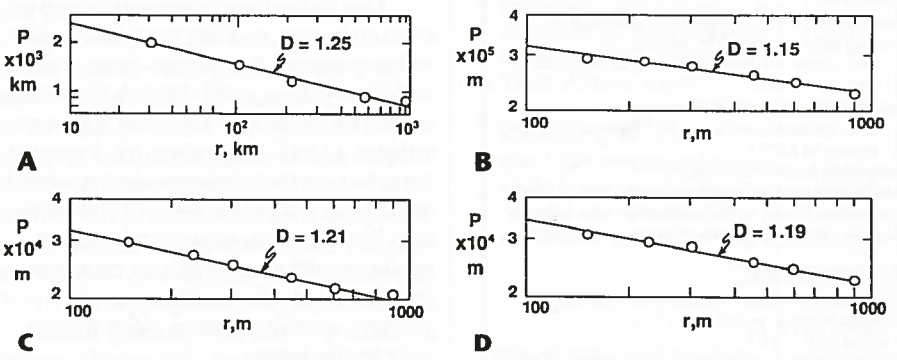

Figure 1. A: Length P of the west coast of Great Britain as a function of the length r of the measuring rod. B–D: Lengths P of specified topographic contours in several mountain belts as a function of the length r of the measuring rod; B: 3000 ft contour of the Cobblestone Mountain quadrangle, Transverse Ranges, California; C: 10,000 ft contour of the Byers Peak quadrangle, Rocky Mountains, Colorado; D: 1000 ft contour of the Silver Bay quadrangle, Adirondack Mountains, New York. Correlations are with the fractal relation shown in equation 2.

[1]*Editor's note:* For those readers who are, as I am, mathematically deprived, a Fourier series can be used to approximate a complex curve by addition of a number of sine and cosine waves of different wavelength (λ_n) and amplitude (A_n).

—*E. M. Moores*

IN THIS ISSUE

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WASHINGTON REPORT

Bruce F. Molnia

Washington Report provides the GSA membership with a window on the activities of the federal agencies, Congress and the legislative process, and international interactions that could impact the geoscience community. In future issues, Washington Report will present summaries of agency and interagency programs, track legislation, and present insights into Washington, D.C., geopolitics as they pertain to the geosciences.

Meet Gordon P. Eaton, New Director of the U.S. Geological Survey—Part 2

This Washington Report presents a continuation of *GSA Today's* discussion with Gordon Eaton, new Director of the U.S. Geological Survey (USGS) about the future of the USGS and the future of the earth sciences.

GSA Today: You have raised the issue of research. In a Gordon Eaton–directed USGS, what do you want the mix to be between applied, needs-driven research and basic research?

Eaton: I don't have any magic number that I think represents balance. I recognize that there has been a constant tension between curiosity-driven science and public service–driven science in the history of the U.S. Geological Survey. Right now, the Survey as a whole is doing about 40% basic research and 60% applied research. Congressman George Brown (D—CA), possibly the greatest friend of science in Congress today, has made some interesting remarks to the National Academy on this tension, which he sees as a "flawed dogma in the scientific community." He went on to say that there is, "a major proportion of basic research that is driven simultaneously by the quest for knowledge and the quest for use."

Clearly, the nation no longer believes on blind faith that society is somehow going to benefit 100% from pure basic research activities. I think a group of very bright people, like USGS people, can package and market relevant earth science with basic research at the core of what it promises to deliver. In the short time I have been back at the Survey, I've seen many examples in which our scientists have found ways to carry out programs that combine basic and applied research in a way that strengthens both approaches.

GSA Today: What about the role for monitoring long-term earth science observational studies? The USGS is one of the few organizations in the world that performs systematic observation on a long-term basis. National Science Foundation (NSF) generally does not provide funding for monitoring.

Eaton: Yes, monitoring is very important. That is a key role for us. Other than some local or regional seismic networks, universities really can't, and aren't interested.

Our mapping program is involved in monitoring in a big way, just as our water program has always been. There will always be a need, I think, for assessments of resources. Whether that constitutes a kind of monitoring, I am not sure, but periodic reassessments would seem to constitute a form of monitoring. But there are other kinds, earthquake monitoring, volcano monitoring. I see our role continuing on, perhaps even becoming more important in the future.

GSA Today: Do you foresee stronger cooperative ties outside of government with the academic institutions, resulting in a mix of their research and USGS monitoring?

Eaton: Yes. In times of constrained personnel ceilings, I think we can and ought to tap the best science we can. As NSF and Office of Naval Research (ONR) funding for academia becomes more difficult to obtain, I think the USGS ought to look to partnerships with the universities. I am thinking about a true partnership in terms of shared resources. Cooperative agreements are a funding vehicle that we could use to foster these partnerships.

GSA Today: The USGS has a long history of international cooperation, involving more than 60 countries. What do you see as the role of international cooperation for the USGS under your directorship?

Eaton: I think the USGS hasn't yet realized the full potential that is out there. We need to be looking at these opportunities vigorously. We have a lot to offer. We're unique in that we can offer expertise in mapping, water, and geology. As you know, we have often had offices, particularly in the area of mineral resources, in places like Jeddah and many South American countries. For one thing, international cooperation allows this nation to maintain an awareness of the resources in other countries. It helps those other countries better understand the resources that exist within their own borders. I really see international cooperation as something significant. I am giving it very serious thought. I am going to form a committee to look at the issue of creating an international office at the Director's level.

GSA Today: The USGS just lost almost 600 employees (about 7%–7.5% of the entire organization) through the April 1994 federal buyout. What do you think the short-term effect of this reduction will be? In the long term, will the functions that those people performed be covered?

Eaton: The answer to the latter part of your question is yes, they will. It is causing us some short-term problems. When you have voluntary departures of that kind, they don't always occur where you would like to find the most relief. The flip side of that is some people left critical positions. Eight senior managers, members of the Senior Executive Service (SES), left our water program. I have made short-term appointments in some of those positions, with the understanding that I am looking at the whole SES issue. I am hoping that there will be another window of opportunity for an orderly buyout plan again in the next fiscal year. But the Department of Interior has not given any indication that they are thinking about another buyout.

GSA Today: A major thrust of President Clinton and Vice-President Gore is Reinventing Government—making government do more at less cost [see November 1993 Washington Report]. How does the USGS fit into the U.S. government of the future?

Eaton: I think it will fit very well. I see us as very relevant to the federal government in the future. But we are going to have to work on this very issue. As you may know, I have been appointing committees to look at issues like standing rules and regulations so we can strip away the troublesome kinds of things that are more barriers than they are supports. It's a matter of getting about our own streamlining and relevancy drills.

GSA Today: The President has abolished the federal Coordinating Com-

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Earthquake Hazards Reduction Fellowship Available

Under a cooperative agreement established with FEMA, the Earthquake Engineering Research Institute is offering the **1995 Professional Fellowship,** to provide an opportunity for a practicing professional to gain greater skills and broader expertise in earthquake hazards reduction, either by enhancing knowledge in the applicant's own field or by broadening his or her knowledge in a related but unfamiliar discipline.

The fellowship provides a stipend of $30,000 beginning in January 1995, to cover tuition, fees, relocation, and living expenses for a six-month period.

Applicants must provide a detailed work plan for a research project that would be carried out in the six-month period. The Fellow will be expected to produce a written report upon completion of the project. All applications must be accompanied by a professional résumé and letter of nomination from the faculty host(s) at the cooperating educational institution(s). Faculty members should also indicate the institution's ability to provide research facilities, including library, work space, telephone, and computer access. Applicants must hold U.S. citizenship or permanent resident status.

Candidates may obtain an application form from the Earthquake Engineering Research Institute, 499 14th Street, Suite 320, Oakland, CA 94612-1902, (510) 451-0905, fax 510-451-5411. An application can be faxed to you; call the EERI AutoInfoRequest Hotline at 1-800-230-4333 and request Document #710.

Deadline for receipt of all application materials at EERI is *September 16, 1994*. Announcement of the award will be made October 17, 1994.

Eaton *continued from p. 202*

mittee on Science, Engineering, and Technology (FCCSET) and replaced it with the National Science and Technology Council (NSTC) [see March 1994 Washington Report]. How will the formation of the NSTC affect federal science and the USGS?

Eaton: I see it affecting federal science in very positive ways. You know the FCCSET approach was to establish four or five major crosscutting science priorities. I had a lot of trouble seeing where earth science fit into these priorities. You could see where global change fit. You might imagine you could see, in part, where advanced materials fit in and even high-performance computing fit in, largely in the area of demonstration. Under the new structure, the Committee on Environment and Natural Resources (CENR) provides a clear home for the earth sciences. CENR defines, through its subcommittee structure, the four themes that I intend to overlay on the USGS: hazards, resources, the environment, and basic information.

We had an opportunity to visit with the Office of Management and Budget (OMB) a couple of weeks ago. We simply took the CENR priorities along as scorchers to show how we would relate. We relate exceedingly well. I was really impressed with how easy it was for us to say, "Yes, we are relevant to this or that priority."

I like this approach, and I think we will be able to play so much more easily in this structure than we could in the old one. In fact, USGS people have been invited to chair some of CENR's subcommittees.

GSA Today: Going back to something very fundamental, geologic mapping was almost the first activity that the USGS performed. Congress passed the Geologic Mapping Act of 1992, calling for closer cooperation with the states, but they didn't appropriate the funds to really make it happen [see December 1992 Washington Report]. What do you think will be the USGS involvement with respect to geologic mapping?

Eaton: You know, authorization bills are essentially free. It is easy to enthuse, and of course, all of us in the earth science community found it easy to support the initiative because we are aware of the fundamental value of geologic mapping. But, quite frankly, as a stand-alone thing, geologic mapping for geologic mapping's sake, or framing geologic mapping as a national need in and of itself, is no longer sufficient as a selling point. It is a technique, an approach, just like airborne magnetics is a technique, or mass spectrometry is a technique. We cannot take issues like that, I see now, to the Congress and expect that they will fall all over themselves with enthusiasm. We need to be much more specific about why we need geologic mapping in a certain specific area. If geologic mapping activities are going to be funded, they are going to have to be sold inside packages that really address national priorities, national concerns, and national needs.

GSA Today: There are 18,000 *GSA Today* readers who will see this interview. What would be the most important single thought that you would want to convey to them?

GSA's E-mail Address Has Changed

GSA has published e-mail addresses for many of its headquarters employees (for example, "jclark@geosociety.com"). Due to a change this is now incorrect. All addresses remain the same except that ".com" has been changed to ".org" (for example, "jclark@geosociety.org").

Eaton: I see the whole of the earth sciences being made up of many components. The USGS and the state geological surveys are one. Certainly the community of academic earth scientists, which is responsible directly for education and for basic research, is another. The major professional societies like the GSA are a third. All are cooperative partners in the maintenance, the advancement, and the selling of our science. In our care, collectively, is the health, nourishment, and future of the science.

I think the academic community, the USGS, and state surveys have to work very closely together. We need to continue to talk together through forums that are provided by the GSA. We need to talk about what we see as our proper roles. Then we need to join hands in partnership. When times get tight, the worst thing to resort to would be competing with one another. I am very mindful of that, having come out of Lamont and into the USGS.

The USGS needs to reach out to the academic community and the academic community needs to reach in to the USGS. I say that even in full knowledge of the fact that we are having trouble sending some of our own people to the field. But we absolutely have to make those adjustments. I think that we both have to engage in our own respective ways in educating the public at all levels, right down through elementary school, about the importance and relevance of earth science.

I see the USGS beginning to move in these directions. I also saw signs in the academic community, which I just left after 13 years. I see a very clear role for the GSA in this as well. All of us need to pay very close attention to the recent NRC study, "Solid Earth Sciences and Society." I think we all need to be mindful of the fact that the game has changed significantly, that the nation is no longer going to bestow unlimited resources on either the academic researchers or those of the USGS, just to pursue curiosity-driven research. We have got to demonstrate our role and our relevance if we are going to continue to get funding.

GSA Today: Thank you very much. We appreciate your insights and are glad that we had the opportunity to talk with you about the USGS and the future directions for earth science in the United States and abroad. ■

Penrose Conference Report

From the Inside and the Outside: Interdisciplinary Perspectives on the History of Earth Sciences

Conveners
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This historically focused Penrose Conference of 1994 was in its own way historic: It was the first Penrose Conference ever to be organized around a theme of historical examination of the earth sciences. The meeting's dynamics tapped into a widespread feeling within the earth sciences community that, at this moment, historical perspective is especially timely for a family of disciplines undergoing critically important changes. It also drew upon a growing awareness that the expanding body of historical research concerning these disciplines has so far failed to define a cohesive and fully interactive cadre of researchers.

In recent years we have witnessed a dramatic increase in historical examination of the earth sciences, both in the level of activity and in the quality of outcome. Scientists and scholars have shown growing interest in historical, philosophical, and sociological study of development of the geosciences and in preservation of archival materials for scholarly analysis. Yet much of this work has occurred in relative isolation, owing partly to the fact that its practitioners work in distinct intellectual communities—in different disciplinary and institutional settings—with rather weakly established patterns of interaction. It has often been observed that members of these distinct communities tend to define their objectives in different ways and frequently go about historical inquiry using different and sometimes incompatible methods.

The Penrose Conference devoted to Interdisciplinary Perspectives on the History of Earth Sciences was held in San Diego, California, March 19–22, 1994, to bring together people concerned with historiographic and methodological issues related to the earth sciences. A basic premise of the conference was that scientists, as "insiders" to the technical activities being addressed historically, tend to have quite different views than do "outsiders," notably historians likely to apply analytic approaches provided by the humanities and social sciences to scientific activities. The conference program reflected the intention of fostering constructive debate and dialogue between members of these groups. The conference's aims included increasing fruitful interaction among scholars writing on the history of the earth sciences and strengthening the visibility and accessibility of historical work within the scientific community.

The conference was attended by 88 participants from six countries (United States, United Kingdom, Australia, France, Italy, and Russia). In keeping with the conference's objectives, members of the group reflected a tremendous variety of experiences, purposes, and attitudes. Among those present, for example, were a number of seasoned authors of historical publications, as well as students and other historical neophytes (both young and old) just beginning to look seriously at historical issues concerning the earth sciences; some geoscientists with extensive practical experience, as well as some humanities scholars with limited acquaintance of the sciences; some advocates of history's basic role as a tool for advancement of goals defined within the sciences, as well as some defenders of history as an autonomous enterprise. There were geoscientists and historians with academic, government, and proprietary affiliations; teachers; laboratory, field, and museum researchers; archivists and librarians; and philosophical, literary, and sociological scholars. Nine among those in attendance were graduate students, some in the earth sciences and others in the history of science. Although many of the participants would properly claim professional identifications both in the sciences and in history, the ratio of those associated most strongly with the former and the latter, respectively, was approximately two to one.

In an intense schedule of presentations, discussion, and debate, the conference saw undisputed success

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in the identification and clarification of significant historiographic problems and issues. Despite, unsurprisingly, much more limited success in resolving these problems and issues, the conference was marked—to everyone's great satisfaction—by genuine warmth and cordiality, reflecting gratifying mutual respect and understanding among participants with differing viewpoints.

There were sessions during four mornings and three afternoons and evenings. The main morning sessions were initiated by prepared presentations (given by Martin Rudwick, Chandra Mukerji, Hatten S. Yoder, Jr., James R. Fleming, Ronald Rainger, and Robert H. Dott, Jr.), followed by provocative commentaries and discussion. These addressed broad and fundamental questions, such as reasons for studying the history of earth sciences, differing visions of how this should be done, comparative strengths and weaknesses of insider and outsider perspectives, and similarities and differences between the historical development of earth sciences and that of other sciences. Afternoon and evening sessions were organized around particular themes and problems (e.g., questions of audience, presentist perspectives and interpretations, oral and contemporary history, biography, archives, and other historical resources, history in teaching the earth sciences, and women in the history of the earth sciences). These sessions were sometimes initiated through brief panel presentations, sometimes by short work-in-progress reports, and occasionally by immediate open discussion. Mott Greene led a special evening session on publication—on reaching and shaping our audiences.

The insider-outsider premise generally worked well as a way to approach many of the conference's concerns. There was widespread agreement, however, on two points: (1) that constructive use of an insider-outsider theme is best pursued in a measured and tolerant spirit, avoiding adversarial confrontation between groups holding different concepts of why and how to study earth sciences history; and (2) that behind the superficial insider-outsider duality there lies a more complex and pluralist reality. As Martin Rudwick observed, virtually all of us are to some degree at once both insiders and outsiders, with different balances of competence and experience in trying to confront both science and history.

In her concluding remarks on behalf of the conveners, Naomi Oreskes drew four central observations out of the conference's proceedings:

1. Historical study of the earth sciences is important for different groups for varied reasons. In particular, it is important for those in the geosciences, both as an intellectual tool in the enlargement of scientific knowledge and as a foundation for framing the significance of earth science for the wider culture. It also is important for historians and others engaged in metascientific studies, where there has long been a lamentable tendency to regard physics (and, more recently, biology) as a sufficient exemplar of what science is and does.
2. The history of the earth sciences is not just geology, much less just the history of stratigraphy and historical geology. Although it is true that "geology" has at times encompassed far more within the earth sciences than sometimes is thought, the diversity and complexity of activities within the earth sciences, both now and in the past, call out for closer examination.
3. Like good science, good history comes in more than one form, but not just any form. Quality counts in history as in the sciences. Historians and scientists, when they are living up to appropriate standards, have in common a highly cultivated respect for evidence and accuracy. Self-aware and critical evaluation of evidence, and of our various research agendas, is essential for good history of earth sciences studies. So is cognizance of the context of scholarly debate about the development of earth sciences.
4. Finally, because of the interaction of disciplines inherent in historical study of earth sciences, a theme resonating throughout the conference was *respect*. Good history exhibits respect for the integrity of the past, which historians strive to understand on its own terms, even when the intention may be (quite legitimately) to utilize the past for present purposes. Good history of the earth sciences shows respect for the technical content and craft of science, past and present. Good history displays respect for the people studied and for their motivations, whether or not these correpond to our own judgments. And good historical study of earth sciences involves mutual respect for other scholars engaged in the process of enlarging our understanding.

Prospects for maintaining the spirit and momentum generated at the conference now ride in part on two sets of plans. One is for establishment of an electronic bulletin board; the other is for meetings every two or three years of an informal, self-sustaining interdisciplinary interest group—the Friends of GeoClio. Those wishing to be informed of future activities should contact Ken Taylor. ■

Penrose Conference Participants

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Joan Warnow-Blewett
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Chester Zenone
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In Memoriam

Harold J. Bissell
Orem, Utah
June 9, 1994

James S. Cullison
Monticello, Florida
May 28, 1994

Ronald K. DeFord
Austin, Texas

Donald Levandowski
West Lafayette, Indiana
April 8, 1994

Marie Morisawa
Binghamton, New York
June 10, 1994

Herbert W. Yoho
Dowling Park, Florida
May 9, 1994

GSAF UPDATE

Robert L. Fuchs

El Pomar Foundation Awards Grant to GSA

El Pomar Foundation of Colorado Springs, Colorado, has awarded the Geological Society of America a grant in the amount of $132,000. The funds match the challenge grant received in March 1994 from Denver's Boettcher Foundation and fulfill the conditions of that challenge (see *GSA Today,* May 1994, p. 131). The total grant from these two leading Colorado foundations is $264,000, which will be used to meet capital equipment needs of Science Awareness through Geoscience Education (SAGE) and the Publications Department. Funds will also be used to purchase components of the expanded GSA network system that is part of the addition to the Boulder headquarters building.

The awards from the El Pomar and Boettcher Foundations allow GSA to proceed with several important equipment purchases in its education, publication, and internal communication functions. The SAGE technology training facility will be a state-of-the-art center for classroom training of K–16 teachers, earth science educators, scientists, and consultants. Equipment for the Publications Department will provide urgently needed upgrades in the pre-press production of the three GSA monthly periodicals, plus *Abstracts with Programs,* memorials, and dozens of ancillary print items. In addition, the equipment and software will enable GSA to eventually handle electronic acceptance of abstract submissions. Finally, the completion of the headquarters addition and ensuing staff relocations have necessitated expansion of the in-house computer network and attendant equipment into that facility.

El Pomar Foundation was founded in 1937 by Spencer Penrose, younger brother of former GSA president and benefactor Richard A. F. Penrose, Jr. Like his older brother, Spencer was a man of vision and great accomplishment, with an equally strong interest in Earth and its resources. The Penrose brothers' fortunes were made in the western United States at the turn of the century, particularly in the gold fields of Colorado and the copper mines of Utah. Spencer worked with long-time associates such as Charles L. Tutt, Charles MacNeill, D. C. Jackling, and brother Richard to develop gold mines in Cripple Creek and the enormous copper mine in Bingham Canyon. His success in mining formed the basis for the many projects that have become some of Colorado's most cherished landmarks—Pikes Peak Highway, Cheyenne Mountain Zoo, and the Will Rogers Shrine of the Sun. In 1918 Spencer built the Broadmoor Hotel, to this day a world-class resort located in Colorado Springs in the foothills of the Rocky Mountains.

Spencer married Julie McMillan of Colorado Springs in 1906 in London, a wedding in which Richard, who was then traveling in Europe and South Africa, played the role of family intermediary and correspondent. When Spencer died in 1936, his widow continued his philanthropic work until her death in 1956. The bulk of her estate was left to El Pomar Foundation. Through its grant program, the Foundation assists worthwhile groups and institutions throughout Colorado, focusing on arts and humanities, civic and community activities, education, health, and human services. El Pomar has made grants amounting to more than $170 million since its inception, and its assets now exceed $300 million. In 1993, grants paid totaled $11.7 million, to 185 recipients.

The grant from El Pomar is part of GSA's Second Century Fund for Earth • Education • Environment. GSA President William R. Dickinson commented, "This award by El Pomar Foundation is a very significant addition to the Society's capital campaign, for which we are most grateful. In addition, with this gift a most important event has occurred that cannot be measured in dollars—the joining once again of two brothers, some 60 years after their deaths and through their successor organizations, in earth-related activities, which will now benefit youth and stimulate interest in earth science."

Gifts for Research Grants—Program or Endowment?

GSA's student research grants program began in 1933 and has continued uninterrupted until this day. Over this 62-year period 5524 graduate students have received a total of $5.1 million to support their projects. In most cases, this money has been the first outside funding for a new scientist, a tangible confirmation by fellow scientists of the student's ability and potential, a vote of career confidence, so to speak. This program has been highly popular with GSA members and outside organizations who are contributors to the Society.

Donors to student research grants can be divided into program contributors and endowment contributors. That is, some wish their contributions to be spent immediately for grants, while others wish to add to the Foundation's endowment, from which the income is spent each year. However, without specific instructions it is often difficult for the Foundation staff to ascertain the donor's intention in this regard. In order to clarify this situation, at its May meeting the Foundation's Board of Trustees took action to reaffirm the specific funds that hold these two kinds of gifts.

There are two principal Foundation funds for research grants: GEOSTAR and the Research Grants Fund. These are in addition to a number of named, restricted funds such as the memorial endowment funds. GEOSTAR, Supporting The Advancement of Research, is the Foundation's endowment fund for student research. Only income from this fund is used for grants each year. The Research Grants Fund disburses all annual contributions during the following year's grant award process. Expenditure of GEOSTAR income and Research Grants Fund monies is directed by GSA's Committee on Research Grants.

A donor wishing to support student research grants should designate his or her gift for GEOSTAR if endowment, or the Research Grants Fund if a program gift for current disbursement. Gifts can also be made to named, restricted funds, a list of which can be found with the annual dues statement or obtained by calling the Foundation office.

Have You Written a Will?

Surprisingly, the majority of Americans die without having written a will. Does the absence of a will really make a difference? For most people the answer probably will be yes.

If you do not have a will, the state in which you live will essentially write one for you. Under state laws of descent and distribution, your property will be disposed of according to the mandates of the state. Your personal wishes will not enter into the matter.

The problem can be easily remedied, for most people at very little expense, by having an attorney prepare a will. Individuals may also write their own wills, called holographic wills, legal in nearly all states. A properly drawn will is important for the future of the people you love, and for the charitable causes about which you care and in which you sincerely believe.

If you wish to learn more about wills, or if you wish to revise your existing will (a periodic review is important) we have a booklet that you will find of interest. The title is *Planning Your Bequests,* and we will be happy to send you a copy if you call the Foundation office at (303) 447-2020, or write us (you can use the accompanying coupon). ■

Donors to the Foundation—April and May 1994

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Elmer A. Bettis*
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Bruce L. "Biff" Reed Scholarship
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*Century Plus Roster (gifts of $150 or more).

GSA Foundation
3300 Penrose Place
P.O. Box 9140
Boulder, CO 80301
(303) 447-2020

GEOSTAR
Supporting The Advancement of Research

☐ Enclosed is my contribution in the amount of $_____ for
☐ GEOSTAR ☐ Research Grants Fund

☐ Please add my name to the Century Plus Roster (gifts of $150 or more).

☐ I'm working on my will. Please send me the booklet *Planning Your Bequests.*

PLEASE PRINT

Name _____

Address _____

City/State/ZIP _____

Phone _____

NEW GSA MEMBERS

The following 400 members were elected to membership by Council action during the period from October 1993 through March 1994 (*indicates transfer from Student Associate to Member).

*Christopher Abate
Mohamed G. Abdelsalam
Charles H. Acord
Paul Aharon
*Maureen Alai
*Stephen T. Algar
Boyd Allen III
Bruce E. Allison
Warren D. Allmon
*Peter D. Ambrose
*Arlene V. Anderson
*Matina Angelakos
*Deborah J. Anthony
*Nan C. Arens
Donald F. Argus
Kazunori Arita
Rosemary A. Askin
*Tania S. Bacchus
Jeffrey E. Bahling
*Ronald J. Bakker
*Denis M. Balcer
Jack G. Baldauf
Michael J. Balogh
Vicky Bankey
Ofer Bar-Yosef
*Ginger A. Barth
John H. Barwis
Les P. Beard
Alwynne B. Beaudoin
*Bruce C. Beaudoin
*Sheena K. Beaverson
Kelly A. Beck
Clifton F. Bell
Edward E. Berg
*Kathryn M. Bethune
Christian Betzler
*Kim M. Bishop
Sue A. Blake
*Jennifer G. Blank
Richard P. Boekenkamp
Richard K. Borden
*Francesca M. Borrelli
Teresa S. Bowers
*Nicholas G. Boyd
Douglas D. Boyer
William C. Bragdon
*Richard T. Brandley
Garrison L. Brewer
Kevin E. Brewer
*Pamela Chase Brock
Eric R. Brown
Terry R. Bruns
Bjorn Buchardt
Martin Burkhard
*Edward L. Burrows
*John O. D. Byrd
*Stephen M. Byrnes
Omar N. Cabrera
Rick W. Caranfa
Drew A. Carey
Sandra J. Carlson
*Melanie R. Carpenter
*Larry S. Carter
Kevin F. Cassidy
*Vincent M. Ceci
*Laurinda Chamberlin
Dane R. Chance
Richard J. Cheel
Daniel P. Claycomb
*Drew M. Clemens
*Rebekah K. Condon
Peter A. Conovitz
Salvatore J. Consalvi
Patrick R. Considine
Andrew S. Cooper
Jordi Corominas
Ray M. Coudray
*Clinton A. Cowan
Thomas E. Crew
*Matthew A. Cunningham
*Paul A. Daniels , Jr.
Nancy M. David
*J. Matthew Davis
Peter Davis
Timothy J. Dempster
*Christopher D. Dennen
Robert P. Dickerson
*Ron M. Dixon
Mark P. Dobday
*Cynthia R. Domack
*Joachim O. Dorsch
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Ronald M. Drake III
*George C. Dudkiewicz
James A. Dunaway
*Gail F. Eaton
*Denton S. Ebel
Helmut P. Echtler
*Thomas Ehrendorfer
*Elizabeth A. Eide
*Vernon P. Elarth
Christopher F. Elders
Jonathan P. Erickson-Bass
Michael A. Evanto
Sarah K. Faldetta
C. Mark Fanning
*Kristen Nilsson Farley
*Todd C. Feeley
R. Jean Fend
Clark H. Fenton
Jane G. Ferrigno
*Jeffrey A. Fillipone
Robert C. Finitel
*John L. Finnigsmier
John V. Firth
Rachel Fischer
*Timothy G. Fisher
Timothy J. Flanagan
Akiva Flexer
David S. Foster
*Bruce W. Fouke
John W. Fowler
Howard J. Frank
David A. Franzi
Amos Frumkin
George A. Furst
*Jon O. Garbisch
Peter Garrett
*Kyle R. Gay
*Peter G. George
*Gayle C. Gleason
*John M. Godfrey
*Steve C. Good
*William M. Goodman
Kevin B. Gracey
Kaspar Graf
*Lisa B. Grant
*Stephen W. Grant
Julia K. Grim
*Michael R. Gross
Todd D. Growney
Djorje Grujic
*Tim L. Gubbels
*Kristin L. Haas
Jay S. Hadi
*Teresa K. Hagelberg
*Steffen G. Hagemann
*Christopher P. Hamilton
*Rex A. Hanger
*Kimberly A. Hannula
Dawn M. Hanson
Sandra L. Harris
*Leslie E. Hasbargen
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*James E. Holl
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*Kathryn A. Hoppe
Timothy J. Horscroft
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*Christopher M. Hunsicker
Samuel C. Hurley IV
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*Grace V. Irby
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*Cesar Jacques-Ayala
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Jeanette H. Leete
Patrick LeFort
Marlene N. Leistico
*Felix Lerch
*Margaret A. Lessenger
Yvonne C. Leung
Alan Levander
Julia A. Lewis
Margaret M. Lidback
*Hui-Ling Lin
Menghua Liu
Shumin Liu
Maria M. Lopes
Stephen B. Lucas
*David J. Ludwikoski
Joyce Lundberg
*Jennifer Nicole Lytwyn
Jody V. Maliga
Richard J. Mandle
*Barbara A. Marin
Gary C. Martin
*James C. Matthews
*Ralf O. Maxeiner
*Michael T. May
J. Barry Maynard
*Elizabeth A. McClellan
Brian McClelland
Craig J. A. McEwan
*Cecilia M. G. McHugh
James M. McWhorter
*Grant A. Meyer
Jason M. Mills
*Heather A. Moffat
*Mats O. Molen
Emanuela Molinaroli
Lea B. Monaghan
Charles F. Moore
*Toby B. Moore
Gabriela Mora-Alvarez
Raymond R. Moreno
*Julia K. Morgan
*Richard J. Mould
*Thomas G. Muhich
Benita L. Murchey
Kevin N. Murdock
*Mark W. Murosky
John L. Nabelek
*Patricia M. Natali
Matthew E. Neutra
*Douglas S. Neves
Ewa M. Newman
Geoff T. Nichols
*Alice Nightengale
*Jon W. North
Richard J. O'Connell
*Christie M. O'Day
Margaret M. O'Neill
*Paul B. O'Sullivan
Nicholas H. S. Oliver
William J. Opfel
*Joseph J. Ozog , Jr.
Richard J. Paciorka
Kye-Hun Park
*Sallyann Paschall
Edmund E. Peck
Eric M. Peper
Dolores Pereira
Mark A. Person
*Silvio Pezzopane
*Michael A. Piepenburg
*William N. Pizzolato
Chris Pollowi
Lawrence J. Poppe
*James J. Pospichal
Karyn E. Powers
Russell S. Powers
*Stephen A. Prevec

NEW GSA FELLOWS

The following 21 members were advanced to Fellowship in May 1994.

Mary P. Anderson
James L. Bischoff
Arthur H. Brownlow
George E. Brogan
Bruce W. Chappell
Harry E. Cook
Shirley P. Dutton
Marilyn A. Grout
Karl S. Kellogg
John W. Lindemann
David W. Love
Winthrop D. Means
Kent C. Nielsen
Frederick L. Paillet
Darryll T. Pederson
Karen L. Prestegaard
Richard L. Reynolds
John F. Shroder, Jr.
John H. Spang
Richard W. Spengler
Jan Tullis

NEW GSA STUDENT ASSOCIATES

The following 588 Student Associates became affiliated with the Society during the period from October 1993 to March 1994.

Andrew B. Aceves
Stephen D. Adams
Daniel A. Akers
Penny L. Alano
Amy D. Alberts
Joseph T. Alex
M. Anantharamakrishnan
Roberto Anaya
Douglas A. Anderson
Erica L. Anderson
Robert C. Anderson
Christopher E. Angel
Michael Arminio , Jr.
Hassan A. Awlia
Monica A. Bader
*Rahul Bahadur
Marshall W. Balick
Eric J. Bard
Erin E. Barger
Sharon L. Barker
Kim E. Barlet
R. Keith Barnhill
Christine M. Barretta
Douglas Barrie
Ethan F. Baxter
Nick M. Beeler
Deborah L. Beier
Mary S. Bell
Ellin Beltz
Lisa M. Benner
Laurie D. Benton
Bryan J. Bergmann
Alexa Bernotavica
Sandra Bezenek
Michael Bierbaumer
Jean S. Birks
Nevine D. Boghossian
Aaron L. Bogucki
James S. Bone
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Bonnie K. Bradshaw
Rebecca M. Bradshaw
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Adam B. Bridges
William D. Briggs
Alice G. Brown
Carlton A. Brown
Christopher B. Brown
Erin J. Bryant
Arndt L. Buhlmann
Julie M. Bunn
Sandeep Burman
Michael F. Burns
Jeffrey D. Burt
Cynthia A. Burtnett
Laura J. Cadmus
Jordi Cama-Robert
Teree C. Campbell
Brian S. Carl
Ana Maria S. Carmo
Larry K. Carr , Jr.
Oscar E. Castaneda
Elizabeth D. Castenson
Alessandra M. Cazzaniga
Baolong Chai
Jitesh Chanchani
Ying Chang
Lars C. Cherichetti
Joshua B. Chessman
Jonathan K. Child
Todd K. Choban
Catherine A. Christoffel
Victoria B. Church
Lisa L. Churchill
Heather L. Clark
Scott K. Clark
Margo Clerkin
Susan A. Cochran
Elizabeth M. Cockey
Lawanda N. Coffee
Tobi H. Cohen
Mark R. Colberg
Dwight F. Coleman
Paul C. Coleman
Patrick M. Colgan
William H. Collins III
Fabrizio Colombo
Ronald G. Colyer
Jeffrey W. Cook
Michelle L. Coombs
Florence E. Cooper
Frances G. Cooper
Laura L. Cossey
Mary A. Costello-Walker
Amy E. Craven
Fray A. Crease
Carol LaVopa Creasey
Scott L. Cross
Matthew H. Dacey
Ted Daeschler
Julia F. Daly
Phillip W. Darby
Calli BJ Daume
Bruce J. Davidson
Kyle A. Davies
Jim R. Davis
Geoff E. Day
Charles H. Dean
Alexander L. Densmore
Justin D. Derrick
Kathryn M. Desmarais
Widya Dharmasamadhi
Linda J. Diks
Eric D. Dillenbeck
Yi Ding
Eleanor T. Dixon
J. Djuhaeni
Alton C. Dooley , Jr.
David M. Doolin
Richard C. Doucette
Jill Douglass
Bruce C. Dougan
Carl N. Drummond
Mark P. Dubois
Leslie M. Dudley
Karlyn H. Duncan
Carl W. Ebeling
Jaelyn J. Eberle
Rebecca M. Edwards
Sandrine A. Elinski
Henry K. Elliott , Jr.
Stephen L. Elliott
William S. Elliott , Jr.
Brenda J. Embden
John J. England
Cynthia M. Erickson
Donald C. Ernst
Sheryl D. Ervin
Peter D. Falk
Ximo Fan
Mostafa Fayek
Todd J. Feenstra
Robert J. Ferguson
Eric J. Fermann
Vicki L. Ferrini
Daniel L. Feuerbach
Grace A. Fitzpatrick
Kevin M. Flaherty
H. L. Fleischhauer
Natalie P. Flynn
Susan L. Folkert
David G. Francis
Michael M. Frank
Andrew C. Fulton
Richard L. Funk
Patrick M. Gallagher
Kevin L. Gambrell
James A. Garabedian
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Jonathan M. Glen
Dagmar N. Gnieser
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Genevieve F. Healy
Mary K. Helbing
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Marc S. Hendrix
David M. Hernandez
Martha C. Herzog
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M. L. Hirsh
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Elizabeth A. Holland
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Edward R. Hornibrook
Doreen A. Hoskins
Sara C. Hotchkiss
Patrick R. Houle
Saijin Huang
Richard C. Hummel III
David H. Huntley
Syed R. Husain
Alexander Iriondo
Matthew G. Jager
Jacek Jaminski
Emannelle J. Javaux
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Thomas D. Johnson
Trina K. Johnson
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Russell J. Kanith
David A. Kanzer
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Abdullah Karaman
Daniel B. Karner
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Simon A. Kattenhorn
Susan M. Keay
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SAGE REMARKS

Second Annual Meeting of the Coalition for Earth Science Education—Supporting Systemic Reform in Science Education

Laure Wallace, USGS, Reston, Virginia

It is imperative that science organizations and societies continually reassess their outreach programs to the educational community by engaging teachers in the process of defining needs through development to implementation.

Scientists and teachers from a host of earth science agencies, societies, and organizations met at the second annual meeting of the Coalition for Earth Science Education at the U.S. Geological Survey in Reston, Virginia. A panel discussion with Patricia Ann Goodnight, an award-winning elementary science teacher from Washington, D.C., Sarah Clemmitt from Montgomery Blair High School in Maryland, and Jeff Bryant, an education specialist from the Monterey Bay Aquarium was one of the most informative and lively sessions of the meeting.

The following are some of the thoughtful ideas and advice that the panel presented for merging the professional skills of scientists and teachers for the betterment of science:

- Local and regional input is critical. Partner with a teacher and learn techniques that will help you in the classroom. Know your school. Is it rural, urban, suburban? What are the ethnic and cultural diversity issues? If you know these issues, you will have the greatest impact.
- If you visit a classroom or partner with a teacher, bring posters and hands-on materials. "Teachers are great beggars and bag people."
- Have teachers work a day with you to learn and grow professionally.
- The reform efforts like AAAS Project 2061, NSTA's Scope, Sequence, and Coordination, and the National Science Standards translate to hands-on, integrated science and cooperative learning to the classroom teacher. Materials that are developed need to reflect these initiatives.
- Understand the curriculum objectives so that you can be most effective. If you are developing curriculum materials, develop the materials to meet regional needs and train teachers in their use.
- Earth science is still considered a "dummy science," the science for those kids who can't succeed in the "hard" sciences, but we cannot neglect the fact that we are still reaching kids who need to be scientifically literate. We need to keep these children in the system as we try to move our science into parity with chemistry, physics, and biology. The good news is that the system is changing. The new National Science Standards are a big leap toward elevating the earth sciences.

One final piece of information was that "little people don't bite—usually." So, meet a teacher and find out what you can do in your local community. Call Ed Geary, GSA's Coordinator for Educational Programs, at (303) 447-2020 and start formal partnerships. Jeff Bryant's comment,taken from one of his favorite books,is germane: "Learn to talk so they will listen. Learn to listen so they will talk." It is in this exchange that we will find the outreach path that will support systemic change for a science-literate society.

*Aida Bahtijarevic Pruitt
*Lynn L. Pryer
*Jeffrey P. Raffensperger
Jerry E. Rahn
*Brian C. Reed
Thomas E. Reilly
Victoria H. Remenda
James M. Renner
Kinga M. Revcsz
*David James Reynolds
Jimmy M. Reynolds
*Ian J. Richards
*Robert C. Roback
*Steven R. Robinson
Perry O. Roehl
Philip T. Rogan
Robert D. Rogers
*Edwin A. Romanowicz
David M. Rubin
William Ruddiman III
Scott Ryan
William E. Sanford
Francis J. Sansone
Alok Sarkar
Janet E. Sawyer
John W. Schanck
Timothy D. Scheibe
Wendy A. Schell
Juergen Schieber
Stanley Schleifer
Stephen J. Schneider
Thimo Schultheiss
Dillon K. Scott
Domenic A. Screnci
*Michele A. Seidl
Guatam Sen
J. John Sepkoski , Jr.
*Amanda Sigillito
*Holly P. Silva
Frederick E. Simms
F. William Simonds
Jill K. Singer
Anthony J. Skeryanc
*John R. Smerekanicz
*Carl J. Smith
David L. Smith
Douglas K. Solomon
Leslie J. Sonder
*Leslie J. Sontag
Arthur E. Soregaroli
Rasoul B. Sorkhabi
*Christopher C. Sorlien
Satish K. Srivastava
*Sandra J. Steacy
*Charles L. Stebbins , Jr.
William J. Stephenson
*Larry D. Stetler
*Dok T. Stevens
Mark T. Stewart
Frank M. Stieger
Janet R. Stone
*Gary D. Storrick
*Catherine L. Summa
*James D. Suydam
Peter K. Swart
*Melissa A. Swartz
*Andrea K. Sykora
*Regina N. Tempel
Kenneth J. Terrell
*Alan D. Thompson
*Amy G. Thompson
Jann Thompson
*Stuart N. Thomson
Jeffrey J. Thuma
Torbjorn E. Tornqvist
Anne M. Trehu
Bruce D. Trudgill
Jill L. Turner
*Jon S. Vail
Appathurai Vairavamurthy
*Margaret C. Van Buskirk
*Gregory S. Vandeberg
Robert D. VanGundy
*David Verdonck
*Stephen J. Vincent
*Diederik Visser
*Georgia Vondra-Amos
James W. Warner
John K. Warren
*Michael T. Whalen
Matthew J. White
Robert W. Wichman
John B. Williams
Van S. Williams
Jeffrey T. Wilson
Donald S. Windeler , Jr.
Michael R. Wing
William J. Winters
Andrew D. Wise
David C. Wisniewski
Marcia G. Wolosz
Mark E. Wood
Jeffrey C. Wright
Jiannan Xiang
Takeshi Yamagata
Tsan-Yao F. Yang
Valentina Yanko
Jeanne B. Yeshilian
Mostafa M. Zayed
Yemane B. Zecharias
*William G. Zempolich
*Paul L. Zweng ■

Melissa A. Lamb
Jenny L. Lamont
Jonathan E. Landau
Craig B. Lane
Jeffrey M. Langevin
Robert M. Langridge
Douglas J. Leaffer
Willy LeBihan
Kyung-Ho Lee
Joseph F. Leising
Lisa A. Lemaster
Robert E. Lennox II
Lynn A. Leonard
Elisabeth Levac
Alan Levitus
David R. Lewis
David S. Lewis
Jianren Li
Lan Li
Liangquan Li
Ning Li
Zhaohui Li
Frank G. Lieth
Lee J. Lindman
Mark F. Linker
Mike K. Liquori
David C. Little
Edward C. Little
Chongxuan Liu
Sharon M. Locke
Caroline LoVetere
Yi Lu
Michael J. Lutz
David R. MacDonald
Steve E. Macias
Joseph F. Maciorowski
Jenna-Marie Maconochie
Mary Ann Madej
Margaret M. Maher
Matthias J. Malin
Nathalie Marchildon
Kimberly A. Marsella
Christopher B. Martin
James M. Martin-Hayden
Candace S. Martinez
Linda J. Martinez
Sumaryanto Y. Martosudarmo
Jeffrey G. Masek
Giuseppina Mattietti-Kysar
Larissa L. Maughan
Tracy K. Mayo
Ruben A. Mazariegos
Walter B. McClendon
Gordon G. McCrimmon
Susan K. McDonald
Timothy W. McDonald
Barbara A. McGavern
Cathleen E. McGinnis
Patrick J. McGovern , Jr.
Jay A. McIntyre
Vicki S. McKenna
Heather E. McLean
Shirley J. McLuaig
Jody A. McMullan
Ryan P. McNulty
Melanie L. McQuinn
David F. McReynolds
Ted S. Melis
Annie M. Mellen
Laurie S. Menefee
Ari Menitove
Douglas S. Miller
Gretchen L. Miller
Jeffrey P. Miller
David B. Mitcheltree
Timothy G. Monaghan
Connie L. Mongold
John J. Moore
Jean E. Moran
Leslie C. Morgret
Jennifer D. Morris
Lisa S. Morrow
Lee H. Morse
David E. Mostoller
Michael D. Myers
Stephen C. Myers
Anthony K. Nance
Kenneth P. Narkiewicz
Jon L. Nauert
Jean Christophe Navarre
Sarah H. Nesbitt
Hans C. Neve
Sharif Nezam-Mafi
Laura E. Norton
Wendy E. Nystrom
John P. O'Donnell
Kevin M. O'Grady
Emily M. Oatney
Michael T. Ocsody
Olatunde S. Oguntola
Christine M. Orgren
Carol J. Ormand
Ewa A. Ossowska
Gary R. Overton
Daphne L. Owens
Lisa D. Oxboel
Ivan Padilla
Beth L. Parker
Dean B. Parks
Kristin N. Pastor
Jens T. Paterson
Lina C. Patino
William P. Patterson
Robert J. Paulson
Norma J. Pearson
Anne B. Peery
Tatiana V. Petalas
Shane M. Peuchaty
Randy S. Phillips
Michelle A. Pike
Scott R. Pim
Benjamin P. Plummer
Franck Poitrasson
Garrett A. Politis
Andre Potochnik
Carolus Prasetyadi
Jonathan D. Price
Kimberly A. Price
Alan G. Punshon
Ana Putar-Roberts
Wendolyn C. Quigley
Todd W. Quillen
Maria I. Ramirez
Kesler A. Randall
Ji-Long Rao
Kelly B. Rash
Kent Ratajeski
Lisa C. Ray
Timothy W. Reardon
Brent H. Reck
Edward G. Reinhardt
Phillip G. Resor
Jonathan J. Rich
Mark A. Riihiaho
Bianca Rimoldi
Christopher A. Risden
Paula E. Ritter
Anthony M. Rizzuti
Angela L. Roach
Jeffrey L. Ronck
Donald G. Rood
Kurt J. Rosenberger
Leanne M. Roulier
Harold D. Rowe
Mousumi Roy
Garry L. Running IV
L. Christine Russell
Jacob Russin
Catherine M. Saavedra
Sherry C. Sabo
Asa Sadi
Peter B. Sak
Christopher A. Salvador
Carlos Sancho
Amy K. Sapp
A. Brenn Sarata
Rebecca R. Sauer
Ken D. I. Saunders
Thomas P. Schar
William M. Schieb
Allison B. Schill
Eric W. Schinsing
Mark D. Schmitz
Frank M. Schneider
David A. Schwandt
Reed A. Schwimmer
James D. Scott
George M. Sechen , Jr.
Julie M. Sexton
Michael J. Seybold
Donna M. Sharp
Katherine F. Shaw
Elizabeth P. Shawkey
Aaron M. Sheaffer
Anne G. Sherman
Jennifer N. Sherman
Colleen T. Sherry
Brett A. Shoaff
Bryan N. Shuman
Luz L. Sierra
Claire M. Sigler
Roger G. Sigler
Adam C. Simon
William F. Simons
Adele V. Simpson
Mary J. Sincock
Donald L. Siron
John G. Siskowic
Rajan Sivaramakrishnan
Evelynn C. Slaughter
Valerie F. Sloan
Amy K. Smith
Andrew G. Smith
Brett A. Smith
Francesca A. Smith
Rebecca T. Smith
Terri C. Smith
Mara M. So
Josef A. Sobieraj
Josef M. Soler
Bille Jo Sorenson
Giacomo Spadini
Piyush Srivastav
Nathan J. Stamm
David N. Steer
Heston C. Stein
Neil D. Storey
William H. Straight
James R. Struthers
Zdena Sucha
Esther M. Sullivan
Kimberly D. Sullivent
Michael A. Summers
Yan Sun
Jamie C. Surette
Kathryn H. Swaggart
Natalie L. Sweet
Lara M. Swenson
Daniel P. Switek
Michael P. Sykes
Elizabeth M. Symchych
Toshihiro Tabata
Emi Tamada
James Z. Taylor
Robert G. Taylor
Chellie S. Teal
Eric A. Tenthorey
Frank J. Tepley III
David A. Terry
Donald M. Thieme
Brian J. Thompson
Caleb H. Thompson
Cheryl M. Thompson
Randall L. Thompson
Stacy L. Thornley
Hilke Timmermann
MaryEllen Tuccillo
Michael J. Turner
Russell D. Underhill
Mario H. Valderrama
Paula D. Valencik
Roderick W. Vasek
Laura M. Vaugeois
Robin L. VerSchneider
Kristi L. Vockler
Delilah E. Vreeland
Chris R. Vyhnal
David E. Walker
Jeffrey A. Walkley
Elizabeth H. Wallman
Alex R. Walter
Hui Wang
Charles W. Ward
Bradley J. Weaver
Bambi Jo Webb
Craig A. Webb
Helen F. Webb
Wei Wei
Bruce L. Weiner
Eric Wemmelmann
John M. Whalen
Daniel P. White
Caroline S. Whitehill
Thomas A. Wickham
Peter D. Wilf
Kurt M. Wilkie
Christopher P. Williams
Gwyneth A. Williams
Cindy G. Willman
Gary S. Wilson
Robert M. Wilson
Kenneth W. Wisian
Barbara A. Wolf
Cecily J. Wolfe
Anne M. Woods
Karen E. Wright
Changde Wu
Guoping Wu
Vanessa L. Wyser-Pratte
R. Aileen Yingst
Nejat Yolasan
Suk Hoon Yoon
Christopher I. Young
Melinda A. Youngblood
George H. Yu
Elizabeth S. Yuan
Janet W. Yun
Samuel A. Zebelman
Terri D. Zeman
Hubao Zhang
Jijun Zhang ■

MEETINGS

1994 Meetings

August

New Perspectives in the Appalachian-Caledonian Orogen: A Symposium in Honour of Hank Williams, August 12–13, 1994, (field trip August 14–19), Corner Brook, Newfoundland, Canada. Information: J. Hibbard, MEAS, Box 8208, NCSU, Raleigh, NC 27695, (919) 515-7242, fax 919-515-7802, E-mail: hibbard@meavax.nrrc.ncsu.edu; or C. van Staal, Geological Survey of Canada, 601 Booth St., Ottawa, Ontario K1A 0E8, Canada, (613) 995-4333, fax 613-995-7997, E-mail: vanstaal@cc2sutp.emr.ca.

Clay Minerals Society 31st Annual Meeting, August 13–18, 1994, Saskatoon, Saskatchewan, Canada. Information: Ahmet R. Mermut, Dept. of Soil Science, Saskatchewan Institute of Pedology, University of Saskatchewan, Saskatoon S7N 0W0, Canada, (306) 966-6839, fax 306-966-6881, E-mail: mermut@sask.usask.ca.

West Australian Basins Symposium, August 14–17, 1994, Perth, Australia. Information: Petroleum Exploration Society Australia, Attn.: J. B. O'Reilly/N. K. Guppy, P.O. Box 1102, West Perth, W.A. 6872, Australia, phone 61-9-481-6666, fax 61-9-481-1952.

The South Atlantic: Present and Past Circulation, August 15–18, 1994, Bremen, Germany. Information: South Atlantic Symposium, Barbara Donner, Fachbereich Geowissenschaften der Universität, Postfach 33 04 40, D-28334 Bremen, Germany.

45th Highway Geology Symposium, August 17–19, 1994, Portland, Oregon. Information: Scott Burns, Dept. of Geology, Portland State University, Portland, OR 97207-0751, (503) 725-3389, fax 503-725-3025.

14th International Sedimentological Congress, Equatorial Gateway in Atlantic Symposium, August 21–26, 1994, Recife, Brazil. Information: Luba Jansa, Bedford Institute of Oceanography, Dartmouth, N.S., Canada B2Y 4A2, (902) 426-2734, fax 902-426-4465, E-mail: jansa@agcrr.bio.ns.ca.

International Geographical Union Regional Conference, Environment and Quality of Life in Central Europe: Problems of Transition, August 22–26, 1994, Prague, Czech Republic. Information: Conference Secretariat, IGU RC 1994, Albertov 6, 128 43 Praha 2, Czech Republic, phone 42-2-24912060, or 42-2-296025, fax 42-2-24915817 or 42-2-296025, E-mail: kucera@prfdec.natur.cuni.cz

International Symposium on Paleoenvironmental History of East and South Asia and Cretaceous Correlation (IGCP 350), August 24–29, 1994, Taegu, Korea. Information: Ki-Hong Chang, Dept. of Geology, Kyungpook National University, Taegu, Korea 702-701, phone 82-53-950-5355, fax 82-53-957-0431, E-mail: khchang@bh.kyungpook.ac.kr.

Mapping & Remote Sensing Tools for the 21st Century, August 26–29, 1994, Washington, D.C. Information: ASPRS, Dept. DP, 5410 Grosvenor Lane, Suite 210, Bethesda, MD 20814-2160, (301) 493-0290, fax 301-493-0208, E-mail: e7g4hem@toe.townson.edu

■ **Environmental Issues and Waste Management in Energy and Mineral Production Third International Conference,** August 29–September 1, 1994, Perth, Western Australia. Information: Co-Ordinated Functions Pty Ltd., P.O. Box 1305, West Perth, WA 6872, Australia, phone 61-9-324-2555, fax 61-9-324-2666.

Proterozoic Crustal and Metallogenic Evolution, August 29–September 1, 1994, Windhoek, Namibia. Information: G.I.C. Schneider, Geological Society of Namibia, P.O. Box 699, Windhoek, Namibia, phone 264-61-37240, fax 264-61-228324.

V.M. Goldschmidt Conference, August 29–September 2, 1994, Edinburgh, Scotland. Information: B. Harte or P. Symms, V.M. Goldschmidt Conference 1994, Dept. of Geology and Geophysics, University of Edinburgh, Grant Institute, West Mains Road, Edinburgh EH9 3JW, Scotland, UK.

September

Cyclicity in Global Geology, Australian Geological Convention Symposium, September, 1994, Perth, Australia. Information: Bryan Krapez or C. McA. Powell, Dept. of Geology, University of Western Australia, Nedlands, 6009, Australia.

Arctic Ocean Grand Challenge, Scientific Rationale–Strategy–Science Plan, Helsinki, Finland, September 2–7, 1994. Deadline for applications: May 6, 1994. Information: Josip Hendekovic, European Science Foundation, 1 quai Lezay-Marnésia, 67080 Strasbourg Cedex, France, phone 33-88-76-71-35, fax 33-88-36-69-87.

Prospecting in Areas of Glaciated Terrain—Tenth Conference, September 5–7, 1994, St. Petersburg, Russia. Information: The Conference Office, The Institution of Mining and Metallurgy, 44 Portland Place, London W1N 4BR, England, phone 44-71-580-3802, fax 44-71-436-5388.

Biotic Recoveries from Mass Extinctions, IGCP Project 335, September 5–8, 1994, Plymouth, United Kingdom. Information: Malcom B. Hart, Dept. of Geological Sciences, University of Plymouth, Drake Circus, Plymouth, Devon P1A 8AA, UK, fax 44-745-233-117; or Douglas H. Erwin, Dept. of Paleobiology, NHB-121, Smithsonian Institution, Washington, DC 20560, (202) 357-2053.

International Conference on Arctic Margins, (ICAM '94), September 5–9, 1994, Magadan, Russia. Information: Kirill V. Simakov, North East Science Center, Russian Academy of Sciences, 16 Portovaya St., Magadan, Russia 685000, (907) 474-7219 (USA) or 7-41-3-223-0953 (Russia); or Dennis K. Thurston, Minerals Management Service, 949 E. 36th Ave., Anchorage, AK 99508-4302, (907) 271-6545, fax 907-271-6565.

Alluvial Basins: Past and Present Environments, September 10–15, 1994. Lunteren, The Netherlands. Information: Josip Hendekovic, European Science Foundation, 1 quai Lezay Marnésia, 67080 Strasbourg Cedex, France, phone 33-88-76-71-35, fax 33-88-36-69-87.

First International Airborne Remote Sensing Conference and Exhibition: Applications, Technology, and Science, September 11–15, 1994, Strasbourg, France. Information: Robert Rogers, ERIM, Box 13001, Ann Arbor, MI 48113-4001, (313) 994-1200, ext. 3234; fax 313-994-5123.

Illinois Basin Energy and Mineral Resources Workshop, September 12–13, 1994, Evansville, Indiana. Information: Theola Evans, Kentucky Geological Survey, 228 MMRB, University of Kentucky, Lexington, KY 40506, (606) 257-5500, E-mail: theola@kgs.uky.edu.

Salt Tectonics, September 14–15, 1994, London, England. Information: Ian Alsop, Derek Blundell, and Ian Davison, Dept. of Geology, Royal Holloway, University of London, Egham, Surrey, UK, phone 44-784-443615, fax 44-784-471780.

Underground Technology Research Council, September 16–18, 1994, Chicago, Illinois. Information: John MacDonald, Meeting Chairman, Guy F. Atkinson Construction Company, P.O. Box 428, Enumclaw, WA 98022, (206) 825-1410, fax 206-825-2514; or Frank Kendorski, UTRC Chairman, Morgan Mining & Environmental Consultants, Ltd., 4921 Chase Avenue, Downers Grove, IL 60515, (708) 305-7900, fax 708-305-9841.

Fifth International Mine Water Congress, September 18–23, 1994, Nottingham, UK. Information: Conference Secretary, IMWA Conference, c/o Department of Mineral Resouces Engineering, University of Nottingham, University Park, Nottingham NG7 2RD, UK.

■ **Global Gas Resources Workshop,** September 19–21, 1994, Vail, Colorado. Information: Carol Ruthven, Bureau of Economic Geology, University of Texas, University Station, Box X, Austin, TX 78713-7508, (512) 471-1534; fax 512-471-0140, E-mail: ruthvenc@begv.beg.utexas.edu.

Geomorphology and Natural Hazards (25th Annual Binghamton Geomorphology Symposium), September 24–25, 1994, Binghamton, New York. Information: Marie Morisawa, Dept. of Geol. Sciences and Environmental Studies, State University of New York, Binghamton, NY 13902-6000, (607) 777-2837, fax 607-777-2288, E-mail: marieem@bingvmb.cc.binghamton.edu.

Society for Organic Petrology 11th Annual Meeting, September 25–30, 1994, Jackson, Wyoming. Information: Ron Stanton, U.S. Geological Survey, 956 National Center, Reston, VA 22092, (703) 648-6462, fax 703-648-6419, E-mail: rstanton@ncrds.usgs.er.gov.

Geochemical Event Markers in the Phanerozoic, final meeting of IGCP Project 293, September 26–28, 1994, Erlangen, Germany. Information: Michael M. Joachimski, Institute of Geology and Mineralogy, University of Erlangen/Nürnberg, Schlossgarten 5, 91054 Erlangen, Germany, 49-9131-852615, fax 49-9131-859295; or Helmut H. J. Geldsetzer, Geological Survey of Canada, 3303-33rd St., N.W., Calgary, Alberta T2L 2A7, Canada, (403) 292-7155, fax 403-292-5377.

Littoral 94, European Coastal Zone Association for Science and Technology Second International Symposium, September 26–29, 1994, Lisbon, Portugal. Information: Associação EUROCOAST-Portugal, a/c Instituto de Hidráuclica e Recursos Hídricos, Faculdade de Engenharia-Universidade do Porto, Rua dos Bragas, 4099 Porto Codex Portugal, fax 351-2-310870, 351-2-318787, 351-2-319280.

12th Australian Geological Convention, September 26–30, 1994, Perth, Australia. Information: Secretary, 12AGC, P.O. Box 119, Cannington, WA 6107, Australia, 61-9-351-7968, fax 61-9-351-3153.

Eco Rio '94, International Symposium on Resource and Environmental Monitoring, September 26–30, 1994, Rio de Janeiro. Information: National Institute of Space Research—INPE c/o Mônica Oliveira, CRI, P.O. Box 515, Av. dos Astronautas, 1758-CEP 12227-010, San José dos Campos, SP-Brazil, phone 55-123-22-9816 or 41-8977, ext. 250, fax 55-123-21-8543 or 22-9325.

■ **Pennsylvania Geologists 59th Annual Field Conference: Some aspects of Piedmont Geology in Lancaster and Chester Counties, Pennsylvania,** September 30–October 1, 1994, Lancaster, Pennsylvania. Information: Field Conference of PA Geologists, P.O. Box 5871, Harrisburg, PA 17110-0871, (717) 787-2379.

October

Association of Engineering Geologists Annual Meeting, October 2–7, 1994, Williamsburg, Virginia. Information: AEG, 323 Boston Post Rd., Suite 2D,

Sudbury, MA 01776, (508) 443-4369 or (508) 443-3639.

Federation of Analytical Chemistry and Spectroscopy Societies Annual Conference, October 2–7, 1994, St. Louis, Missouri. Information: FACSS, 198 Thomas Johnson Dr., Suite S-2, Frederick, MD 21702-4317, (301) 846-4797.

International Association for Mathematical Geology Annual Meeting, October 3–5, 1994, Mont Tremblant, Quebec, Canada. Information: C.-J. Chung, Geological Survey of Canada, 601 Booth St., Ottawa, Ontario K1A 0E8, Canada, (613) 996-3413, fax 613-996-3726, E-mail: chung@gsc.emr.ca.

German Geological Society (DGG) Annual Meeting, October 4–7, 1994, Heidelberg, Germany. Information: Th. Bechstädt and R. O. Greiling, Geologische-Paläontologisches Institut, Ruprecht-Karls-Universität, Im Neuenheimer Feld 234, D-6900 Heidelberg, Germany.

Symposium on Porphyry Copper Deposits from Alaska to Chile, October 5–7, 1994, Tucson, Arizona. Information: Jim Laukes, University of Arizona Extended University, 1955 East Sixth Street, Tucson, AZ 85719-5224, 1-800-955-UofA, fax 602-621-3269, E-mail (Internet): jlaukes.ccit.arizona.edu.

Moving Industrial Minerals into the 21st Century, October 5–7, 1994, Nashville, Tennessee. Information: Meetings Dept., SME, P.O. Box 625002, Littleton, CO 80162-5002, (303) 973-9550, fax 303-979-3461.

9th National Conference on Hydrogeology and Engineering Geology of Karst Terranes, October 16–18, 1994, Nashville, Tennessee. Information: James F. Quinlan, Box 110539, Nashville, TN 37222, (615) 833-4324; or Geary M. Schindel, (615) 255-2288.

Symposium on the Petroleum Geology and Hydrocarbon Potential of the Black Sea Area, October 16–18, 1994, Varna, Bulgaria. Information: Liz Lador, Petroconsultants S.A., Information Research Division, P.O. Box 152, 24 Chemin de la Mairie, 1258 Perly, Geneva, Switzerland, phone 41-22-721-1717, telex 413-541-PETR CH, fax 41-22-721-1747.

Applications of Sedimentary Geology and Paleontology into the 21st Century, October 16–20, 1994, Snowbird, Utah. Information: Myra Rogers, SEPM, P.O. Box 4756, Tulsa, OK 74159-0756, (800) 865-9865, fax 918-743-2498, E-mail: myralee@ aip.edu.

Ninth Annual Conference on Contaminated Soils, October 17–20, 1994, Amherst, Massachusetts. Information: Paul Kostecki, Environmental Health and Sciences, N344 Morrill, University of Massachusetts, Amherst, MA 01003, (413) 545-2934, fax 413-545-4692.

LIRA Workshop on the Ross Orogen: Crustal Structure and Tectonic Significance, October 21–23, 1994, Dallas, Texas. Information: John W. Goodge, Dept. of Geological Sciences, Southern Methodist University, Dallas, TX 75275, (214) 768-4140, E-mail: jgoodge@sun.cis.smu.edu.

■ **GSA Annual Meeting,** October 24–27, 1994, Seattle, Washington. Information: GSA Meetings Department, P.O. Box 9140, Boulder, CO 80301, (303) 447-2020, ext. 113, E-mail: mball@geosociety. org (recently changed from .com).

November

Carolina Geological Society Annual Meeting and Field Trip, November 4–6, 1994, Raleigh, North Carolina. Information: Skip Stoddard, Dept. of MEAS, Box 8208, North Carolina State University, Raleigh, NC 27695-8208, (919) 515-7939, fax 919-515-7802, E-mail: stoddard@meavax.nrrc.ncsu.edu.

Glacial-Interglacial Sealevel Changes in Four Dimensions, November 5–10, 1994, St. Martin, Germany. Information: Josip Hendekovic, European Science Foundation, 1quai Lezay-Marnésia, 67080 Strasbourg Cedex, France, phone 33-88-76-71-35, fax 33-88-36-69-87.

International Symposium on the Cenozoic Tectonics and Volcanism of Mexico, November 7–11, 1994, Puerto Vallarta, Jalisco, Mexico. Information: Hugo Delgado Granados, Inst. de Geofísica, UNAM, Circuito Exterior, C.U., Coyoacán 04510, México D.F., phone (525) 622-4145, 622-4119, 622-4124, fax 525-550-2486, Internet: hugo@tonatiuh.igcofcu.unam.mx; or Gerardo Aguirre Díaz, Estación Regional del Centro, Inst. de Geología, UNAM, Apdo. Postal 376, Guanajuato, Gto, 36000, México, phone and fax 524-732-3038.

Geology and Resources of the Eastern Frontal Belt, Ouachita Mountains, Oklahoma, November 15–17, 1994, Poteau, Oklahoma. Information: Neil H. Suneson, Oklahoma Geological Survey, Sarkeys Energy Center, Room N-131, 100 East Boyd St., Norman, OK 73019-0628, (405) 325-3031.

International Geological Correlation Program Project 351, Early Paleozoic Evolution in Northwest Gondwana, November 29–December 7, 1994, Rabat, Morocco. Information: Naima Hamoumi, Dépt. de Géologie, Faculté des Sciences de Rabat, B.P. 1226 RP Rabat, Morocco, phone 212-7-7719-57, fax 212-7-77-42-61, telex 36607 M.

■ **Northwest Mining Association 100th Annual Convention,** November 30–December 2, 1994, Spokane, Washington. Information: Northwest Mining Association, 10 N. Post, Ste. 414, Spokane, WA, 99201-0772, (509) 624-1158, fax 509-623-1241.

December

25th Annual Underwater Mining Institute, December 1–4, 1994, Monterey, California. Information: Karynne Chong Morgan, Underwater Mining Institute, 811 Olomehani St., Honolulu, HI 96813-5513, (808) 522-5611, fax 808-522-5618, Internet: 70673.534@compuserve.com, Compuserve 70673,534.

Tectonic Evolution of Southeast Asia, December 7–8, 1994, London, UK. Information: Robert Hall, Geological Sciences, University College, Gower St., London WC1E 6BT, UK, phone 44-784-443592, fax 44-71-387-1612, E-mail (Internet): robert.hall@ucl.ac.uk.

Symposium on Inverse Problems: Geophysical Applications, December 12–14, 1994, Yosemite Fish Camp, California. Information: SIAM Conference Coordinator, 3600 University City Science Center, Philadelphia, PA 19104-2688, (215) 382-9800, fax 215-386-7999, E-mail: meetings@siam.org.

1995 Meetings

February

■ **Mathematical and Computational Issues in the Geosciences, Third SIAM Conference,** February 8–11, San Antonio, Texas. Information: SIAM Conference Coordinator, 3600 University City Science Center, Philadelphia, PA 19104-2688, (215) 382-9800, fax 215-386-7999, E-mail: meetings @siam.org. *(Abstract deadline August 8, 1994.)*

U.S. Geological Survey McKelvey Forum on Energy and the Environment: Application of Geosciences to Decision Making, February 13–16, 1995, Washington, D.C. Information: Dudley D. Rice, U.S. Geological Survey, P.O. Box 25046, MS 971, Denver, CO 80225, (303) 236-5711, fax 303-236-8822, E-mail: rice@bpgsvr.cr.usgs.gov.

March

American Association of Petroleum Geologists and Society for Sedimentary Geology (SEPM) Annual Convention, March 5–8, 1995, Houston, Texas. Information: Michelle Mayfield, AAPG Annual Meetings Manager, P.O. Box 979, 1444 S. Boulder Ave., Tulsa, OK 74101-0979, (918) 584-2555, fax 918-584-2274.

GSA Northeastern Section Annual Meeting, March 20–22, 1995, Hartford, Connecticut. Information: Norman H. Gray, Dept. of Geology and Geophysics, University of Connecticut, 354 Mansfield Road, Storrs, CT 06269-2045, (203) 486-4434.

Oklahoma Geological Survey Workshop on the Ames Structure and Similar Features, March 28–29, 1995, Norman, Oklahoma. Information: Kenneth S. Johnson and Jock A. Campbell, Oklahoma Geological Survey, University of Oklahoma, 100 East Boyd, Rm. N-131, Norman, OK 73019, (405) 325-3031, fax 405-325-7069.

April

■ **Sinkholes and the Engineering and Environmental Impacts of Karst Fifth Multidisciplinary Conference,** April 2–5, 1995, Gatlinburg, Tennessee. Information: B. F. Beck, P. E. LaMoreaux & Associates, Inc., Box 4412, Oak Ridge, TN 37831, (615) 483-7483. *(Abstract deadline: September 2, 1994.)*

Geological Society of South Africa Centennial Geocongress, April 3–7, 1995, Johannesburg, South Africa. Information: Congress Secretariat, Centennial Geocongress, P.O. Box 36815, Menlo Park, 0102, South Africa, phone and fax 27-12-47-3398.

■ **10th Himalaya-Karakoram-Tibet Workshop,** April 4–8, 1995. Information: David A. Spencer, Geologisches Institut, ETH-Zentrum, CH-8092 Zürich, Switzerland, phone 41-1-632-3698, E-mail: daspencer@erdw.ethz.ch.

GSA Southeastern Section Annual Meeting, April 6–7, 1995, Knoxville, Tennessee. Information: Harry Y. McSween, Dept. of Geological Sciences, University of Tennessee, 306 G&G Building, Knoxville, TN 37996-1410, (615) 974-5498.

Geological Society of Nevada Symposium III: Geology and Ore Deposits of the American Cordillera, April 10–13, 1995, Reno, Nevada. Information: Bob Hatch, Chairperson, Geological Society of Nevada, P.O. Box 12021, Reno, NV 89510, (702) 323-4569, fax 702-323-3599.

■ **Mechanics of Jointed and Faulted Rock, Second International Conference,** April 10–14, 1995, Vienna, Austria. Information: H. P. Rossmanith, Institute of Mechanics, Technical University Vienna, Wiedner Hauptstrasse 8-10/325 A-1040 Vienna, Austria, phone 43-1-58-801-5514, fax 43-1-587-58-63, E-mail: rossmanith@emch80.una.ac.at.

■ **Eighth Annual Symposium on the Application of Geophysics to Engineering and Environmental Problems,** April 23–27, 1995, Orlando, Florida. Information: EEGS, Mark Cramer, P.O. Box 4475, Englewood, CO 80155, (303) 771-6101. *(Abstract deadline: October 1, 1994.)*

Third International Symposium on In Situ and On-Site Bioreclamation, April 24–27, 1995, San Diego, California. Information: Betty Weaver, Symposium Coordinator, The Conference Group, 1989 West Fifth Ave., Suite 5, Columbus, OH 43212-1912, toll-free (U.S. and Canada) 800-783-6338, or (614) 424-5461, fax 614-488-5747.

GSA South Central/North Central Sections Joint Annual Meeting, April 27–28, 1995, Lincoln, Nebraska. Information: Robert F. Diffendal, Conservation and Survey Division, 133 Nebraska

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Meetings *continued from p. 209*

Hall, University of Nebraska, 901 N. 17th Street, Lincoln, NE 68588-0517, (402) 472-7546; Page C. Twiss, Dept. of Geology, Kansas State University, Thompson Hall, Manhattan, KS 66506, (913) 532-6724.

May

Water Pollution Modelling, Measuring and Prediction Third International Conference, May 1–3, 1995, Porto Carras, Greece. Information: Liz Johnstone, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Southampton SO40 7AA, UK, phone 44-703-293-223, fax 44-703-29-2853, E-mail: CMI@uk.ac.rl.ib.

Geotechnica 95, Geosciences and Geotechnology Amid Ecological and Economic Considerations, May 2–5, 1995, Cologne, Germany. Information: Alfred Wegener Stiftung, Wissenschaftszentrum, Ahrstrasse 45, 53175 Bonn, Germany.

Water Resources at Risk, May 14–18, 1995, Denver, Colorado. Information: Helen Klose, American Institute of Hydrology, 3416 University Ave., S.E., Minneapolis, MN 55414, (612) 379-1030.

17th International Geochemical Exploration Symposium, Exploring the Tropics, May 15–19, 1995, Townsville, Queensland, Australia. Information: Russell Myers, 171GES, National Key Centre in Economic Geology, James Cook University, Townsville, Q4814, Australia, phone 61-77-814486, fax 61-77-815522.

Geological Association of Canada–Mineralogical Association of Canada Joint Annual Meeting, May 17–19, 1995, Victoria, British Columbia, Canada. Information: Chris Barnes, General Chair, SEOS, University of Victoria, P.O. Box 1700, Victoria, B.C. V8W 2Y2, Canada, fax 604-721-6200.

GSA Rocky Mountain Section Annual Meeting, May 18–19, 1995, Bozeman, Montana. Information: Stephan G. Custer, Dept. of Earth Sciences, Montana State University, Bozeman, MT 59717-0348, (406) 994-6906.

1995 World Geothermal Congress, May 18–31, Florence, Italy. Information: George Frye, Executive Director, International Geothermal Association, LBL 50C, Rms. 106–108, One Cyclotron Road, Berkeley, CA 94720, (510) 486-4584, fax 510-486-4889.

Fifth Annual Goldschmidt Conference, May 24–26, 1995, University Park, Pennsylvania. Information: Suzanne St. Pierre, (814) 865-7557, fax 814-865-3749.

GSA Cordilleran Section Annual Meeting, May 24–26, 1995, Fairbanks, Alaska. Information: David B. Stone, Dept. of Geology and Geophysics, University of Alaska, Fairbanks, AK 99775-0760, (907) 474-7565.

Walter A. Bell Symposium on Paleobotany and Coal Science, May 28–June 1, 1995, Sydney, Nova Scotia. Information: Erwin L. Zodrow, University College of Cape Breton, P.O. Box 5300, Sydney, Nova Scotia, B1P 6L2, Canada, fax 902-562-0119, or Paul C. Lyons, U.S. Geological Survey, MS 956, Reston, VA 22092, fax 703-648-4227.

June

SEG International Field Conference on Carbonate-hosted Lead-Zinc Deposits, June 3–6, 1995, St. Louis, Missouri. Information: Martin Goldhaber, U.S. Geological Survey, P.O. Box 25046, MS 973, Federal Center, Denver, CO 80225-0046, fax 303-236-3200, E-mail: mgold@helios.cr.usgs.gov.

■ **35th U.S. Symposium on Rock Mechanics,** June 4–7, 1995, Lake Tahoe, California–Nevada. Information: Jaak Daemen, Mining Engineering, MS 173, University of Nevada, Reno, NV 89557-0139, (702) 784-4309, fax 702-784-1766; or Richard Schultz, Geological Engineering, MS 173, University of Nevada, Reno, NV 89557-0139, (702) 784-4318, fax 702-784-1766.

■ **Clay Minerals Society 32nd Annual Meeting,** June 4–8, 1995, Baltimore, Maryland. Information: Patricia Jo Eberl, Clay Minerals Society, P.O. Box 4416, Boulder, CO 80306, (303) 444-6405, fax 303-444-2260. *(Abstract deadline: August 26, 1994.)*

Seventh International Symposium on the Ordovician System, June 12–16, 1995, Las Vegas, Nevada. Information: Margaret N. Rees, 7th ISOS, Dept. of Geoscience, University of Nevada, Las Vegas, NV 89154-4010, (702) 739-3890, fax 702-597-4064, E-mail: rees@nevada.edu.

■ **European Coal Conference,** June 26–July 1, 1995, Prague, Czech Republic. Information: European Coal Conference '95, Faculty of Science, Charles University, Albertov 6, 128 43 Prague 2, Czech Republic, phone 42-2-24915472, fax 42-2-296084. *(Abstract deadline: February 28, 1995.)*

July

Eleventh Symposium on Coastal Sedimentology, July 3–9, 1995, Niteroi, Brazil. Information: Cleverson Guizan Silva, Dept. de Geologia/LAGEMAR, Universidade Federal Fluminense, Av. Bento de Maria da Costa 115-a, Charitas, Niteroi, R.J. 24.370-190, Brazil, fax 55-21-711-9917.

Seventh International Williston Basin Symposium, July 23–25, 1995, Billings, Montana. Information: W. Kipp Carroll, General Chairman, (406) 245-2367.

August

3rd International Field Conference and Symposium on Intraplate Magmatism (IGCP 336): Petrology and Metallogeny of Volcanic and Intrusive Rocks of the Midcontinent Rift System, August 22–September 1, 1995, Duluth, Minnesota. Information: Penny Morton, Dept. of Geology, University of Minnesota, Duluth, MN 55812, (218) 726-7962, fax 218-726-8275; E-mail: pmorton@ua.d.umn.edu.

Orogenic Lherzolites and Mantle Processes 2nd International Workshop, August 24–September 5, 1995, Granada, Spain. Information: H. G. Barsczus, Géofluides GBE/ISTEEM-C.P. 057, Université de Montpellier 2, 34095 Montpellier Cedex 5, France, phone 33-6714-3933, fax 33-6714-4774, E-mail: barsczus@dstu.univ-montp2.fr.

Mineral Deposits: From their Genesis to Their Environmental Impacts, 3rd Biennial SGA Meeting, August 28–31, 1995, Prague, Czech Republic. Information: Jan Pasava, Czech Geological Survey, Klarov 131/3, 118 20 Praha 1, Czech Republic, phone 42-2-537011, fax 42-2-7980965.

Tectonics and Metallogeny of Early/Mid Precambrian Orogenic Belts, August 28–September 1, 1995, Montreal, Canada. Information: J. A. Percival, Geological Survey of Canada, 601 Booth St., Ottawa, Ontario K1A 0E8, Canada, (613) 995-4723, fax 613-995-9273, E-mail: jpercival@601C.gsc.emr.ca, or J. N. Ludden, Dept. de Géologie, Université de Montréal, CP 6128, Succ. A, Montréal, Québec H3C 3J7, Canada, (514) 343-7389, fax 514-343-5782, E-mail: luddenj@ere.umontreal.ca.

Third Hutton Symposium: The Origin of Granites, August 28–September 2, 1995, College Park, Maryland. Information: Michael Brown, Dept. of Geology, University of Maryland, College Park, MD 20742, (301) 405-4082, fax 301-314-9661.

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Fractal *continued from p. 201*

being fractal 20 years before the concept of fractals was defined.

Important aspects of surface morphology obey fractal statistics; but the nagging question is, Why? Are the processes that create landforms scale invariant and the only scale-invariant statistics fractal? Or are the underlying processes in a class that generates fractal statistics?

FLOOD STATISTICS

An important question in geomorphology concerns which floods dominate erosion. Is erosion dominated by the 10-year, the 100-year, or the very largest floods? The answer to this question depends upon whether extreme flood probabilities have a logarithmic or power-law dependence on time. The peak river discharge $\dot{V}$ during a flood is a measure of its intensity. If floods have a logarithmic dependence on time, the peak discharge $\dot{V}$ during the most severe flood in a time interval T depends on T according to

$$\dot{V} = C_4 \log T + C_5. \quad (7)$$

If floods have a power-law (fractal) dependence on the interval, then we have

$$\dot{V} = C_6 T^H. \quad (8)$$

With the logarithmic dependence, extreme floods are much less likely to occur than with the power-law dependence. Thus, the more frequent, intermediate-size floods will carry the bulk of the eroded sediments rather than the rare extremely large flood. With a power-law dependence, the very largest floods are generally responsible for the bulk of sediment transport. Flood-frequency statistics also have a variety of other implications; land-use regulations and flood control projects are based on extrapolations for future floods.

Records of the peak flood discharges are generally available for a relatively short period of time; typically 50 to 100 years in the United States. The objective of flood-frequency analysis is to extrapolate the historical record to longer periods of time. A wide variety of statistical distributions have been utilized for this purpose; Turcotte and Greene (1993) have suggested the applicability of the fractal relation in equation 8. The fractal distribution can also be expressed in terms of the ratio F of the peak discharge over a 10-year interval to the peak discharge over a one-year interval. With self-similarity, the parameter F is then also the ratio of the 100-year peak discharge to the 10-year peak discharge and the 1000-year peak discharge to the 100-year peak discharge. The parameters H and F can be related by

$$F = 10^H. \quad (9)$$

We refer to the parameter F as the flood intensity factor.

As two specific examples we consider station 1-1805 on the Middle Branch of the Westfield River in Goss Heights, Massachusetts, for the period 1911–1960 and station 11-0980 in the Arroyo Seco near Pasadena, California, for the period 1914–1965. These stations were chosen because they were two of the ten stations used as benchmarks by Benson (1968), who applied a variety of geostatistical distributions to flood-frequency forecasting. Floods are considered independent only if the peak flows are separated by more than one month. For a 50-year record, the 50 largest values of $\dot{V}_m$ are ordered, the largest $\dot{V}_m$ is assigned a period $T = 50$ yr, the second largest flood a period $T = 50/2 = 25$ yr, the third largest flood a period $T = 50/3 = 16.7$ yr, and so forth. The results for the two stations are given in Figure 3.

For station 1-1805 the fractal fit (F) gives $H = 0.51$ and $F = 3.3$. For station 11-0980 the fractal fit gives $H = 0.87$ and $F = 7.4$. Also included in Figure 3 are the six statistical correlations given by Benson (1968): the two-parameter gamma (Ga), Gumbel (Gu), log Gumbel (LGu), log normal (LN), Hazen (H), and log Pearson type III (LP). For large floods the fractal predictions (F) correlate best with the log Gumbel (LGu), while the other statistical techniques predict longer recurrence time for very serious floods. The fractal and log Gumbel are essentially power-law correlations, whereas the others are essentially logarithmic. The log Pearson type III (LP) is the federally approved distribution for evaluating the flood hazard in the United States. For station 1-1805 the 100 year flood predicted by the fractal correlation is a factor of 1.6 greater than the 100 year flood predicted by the log Pearson type III correlation. For station 11-0980 the 100 year flood predicted by the fractal correlation is a factor of 2.3 greater than the 100 year flood predicted by the log Pearson type III correlation. If, in fact, fractal statistics are applicable, then the use of log Pearson type III statistics consistently underestimates the severity of the 100, 150, and 200 year floods.

The values of H and the flood intensity factor F for the ten benchmark stations considered by Benson (1968) are given in Table 1. These results show that there are clear regional trends in the values of F. The values in the southwest are systematically high; this can be attributed to the arid conditions and the rare tropical storm that causes severe flooding. The values in the Pacific northwest are low; this can be attributed to the maritime climate. Because F is equivalent to a fractal dimension, $D = 2 - \log F$, this may be a case in which the fractal dimension of floods is diagnostic of climate.

The flow in a river is equivalent to a time series. The sum or integral of the flow in a river gives the volume of water stored in a reservoir. Harold Hurst spent his life studying reservoir storage on the Nile and concluded that extreme high stands and low stands in reservoirs obey power-law (fractal) statistics (Hurst et al., 1965). The relations between Hurst's work and self-affine fractals have been considered in detail by Mandelbrot and Wallis (1969a, 1969b).

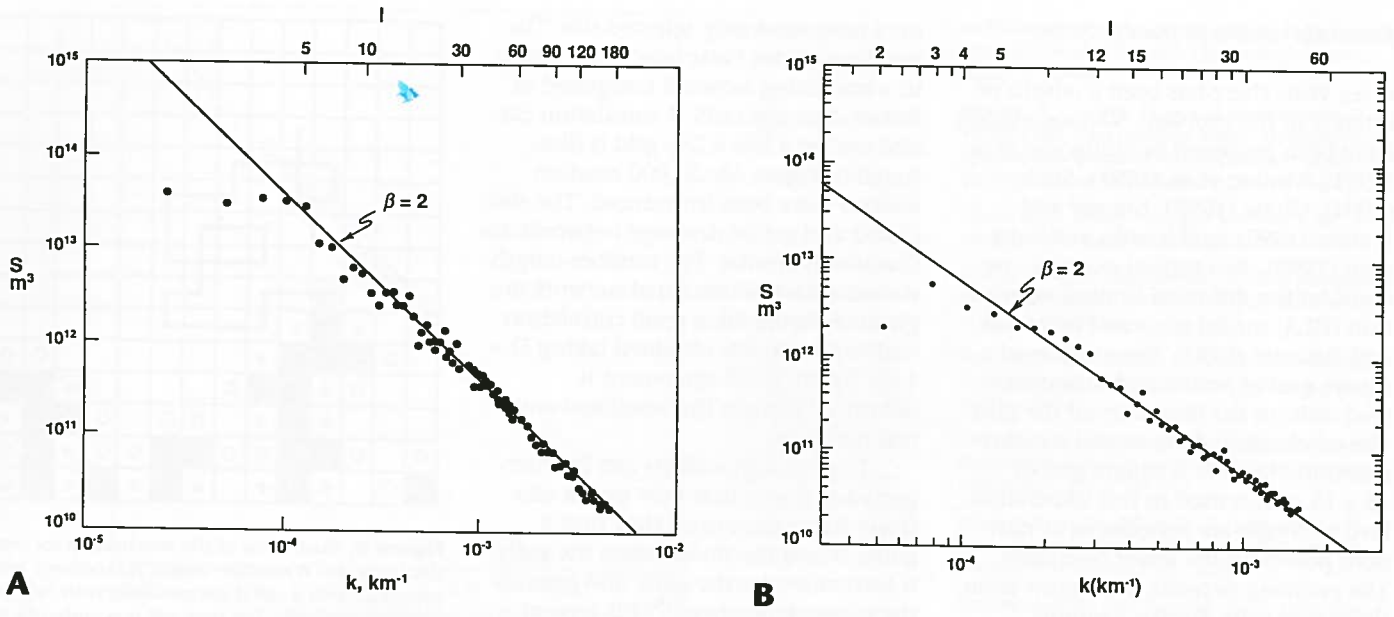


Figure 2. Power spectral density, S, as a function of wave number, k, for spherical harmonic expansions of topography (degree l) for Earth (A) and Venus (B). Correlations are with equation 3, taking $\beta = 2$.

DRAINAGE NETWORKS

Floods cause erosion, and this erosion eventually forms drainage networks. An example of a drainage network is given in Figure 4A; this is the drainage network in the Volfe and Bell Canyons, San Gabriel Mountains, near Glendora, California, obtained by field mapping (Maxwell, 1960). On average, one lower order of streams was found than on standard topographic maps; thus, the lowest order streams are assigned order 0. The number-length statistics for this network are given in Figure 5A; a good correlation with equation 6 was obtained taking $D = 1.81$. Leopold et al. (1964) have obtained similar results for the entire United States; a good correlation with equation 6 was also found with $D = 1.83$. Drainage networks are in general fractal, with little variation in the fractal dimension. Again, the fractal dimension of the drainage network is not diagnostic of its geologic setting.

Various statistical models were proposed in the 1960s in order to simulate drainage networks; this work was reviewed by Smart (1972). In the past

Fractal *continued on p. 212*

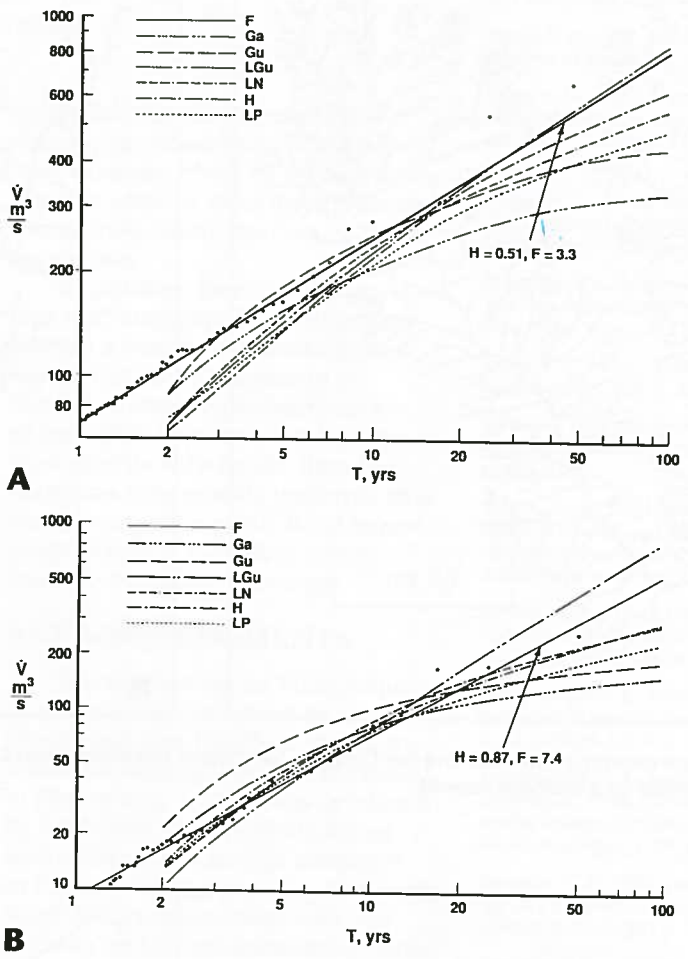


Figure 3. Peak discharge $\dot{V}$ during a flood associated with the period T. The dots are the sequence of observed floods. A: Middle Branch of the Westfield River at station 1-1805 in Goss Heights, Massachusetts. B: Arroyo Seco at station 11-0980 near Pasadena, California. Correlation lines are fractal (F), two parameter gamma (Ga), Gumbel (Gu), log Gumbel (LGu), log normal (LN), Hazen (H), and log Pearson type III (LP). The fractal correlations are with equation 8.

TABLE 1. VALUES OF H AND THE FLOOD INTENSITY FACTOR F FOR TEN BENCHMARK STATIONS

Station	Site	H	F
1-1805	Westfield River, Goss Heights, Mass.	0.513	3.31
2-2185	Oconee River, Greenboro, Ga.	0.540	3.47
5-3310	Mississippi River, St. Paul, Minn.	0.470	2.95
6-3440	Little Missouri River, Alzado, Wyo.	0.520	3.31
6-8005	Elkhorn River, Waterloo, Neb.	0.540	3.47
7-2165	Mora River, Golondinas, N. Mex.	0.630	4.27
8-1500	Llano River, Junction, Tex.	0.719	5.24
10-3275	Humboldt River, Comus, Nev.	0.616	4.13
11-0980	Arroyo Seco, Pasadena, Calif.	0.875	7.4
12-1570	Wenatchee River, Plain, Wash.	0.310	2.04

Note: Stations in Benson (1968) study.

Fractals *continued from p. 211*

three years there has been a rebirth of interest in the problem. Various models have been proposed by Willgoose et al. (1991), Meakin et al. (1991), Stark (1991), Chase (1992), Kramer and Marder (1992), and Inaoka and Takayasu (1993). As a typical example, we consider the diffusion-limited aggregation (DLA) model proposed by Masek and Turcotte (1993). We considered a square grid of points and introduced seed cells on the boundary of the grid. The mechanics of the model are illustrated in Figure 6. A square grid of 15 x 15 cells is used in this illustration. Five seed cells are introduced at random points on the lower boundary. The evolving network must grow from these seed cells. For the example shown, 16 cells have been accreted to the seed cells. Cells are allowed to accrete if one (and only one) of the four nearest neighbor cells is part of the preexisting network. Prohibited sites that already have two occupied neighboring sites are identified by stars. Sites available for accretion to the network are indicated by open circles. A random walker is introduced at a random cell on the grid, and the hypothetical path is traced by the solid line. After 28 random walks it accretes to the network at the shaded cell. A random walker proceeds until the walker either (1) accretes to the network, (2) exits the grid, or (3) lands on a prohibited cell. In each case the walk is terminated, and a new walker is introduced on a new, randomly selected site. The iteration of this basic procedure results in a branching network composed of linked drainage cells. A simulation carried out on a 256 x 256 grid is illustrated in Figure 4B; 20,000 random walkers have been introduced. The simulated and actual drainage networks are reasonably similar. The number-length statistics for the simulated network are given in Figure 5B; a good correlation with equation 6 is obtained taking D = 1.85. Again, good agreement is obtained between the simulated and real networks.

The random walkers can be interpreted as floods that flow over a relatively flat surface until they find a gully. When the flood enters the gully, it further erodes the gully and extends the network headward. This type of headward gully evolution has often been proposed for actual drainage networks (Schumm et al., 1987). The DLA model can also be used to generate synthetic topography. A power-law relation is assumed between stream order and gradient; the resulting topography is given in Figure 7.

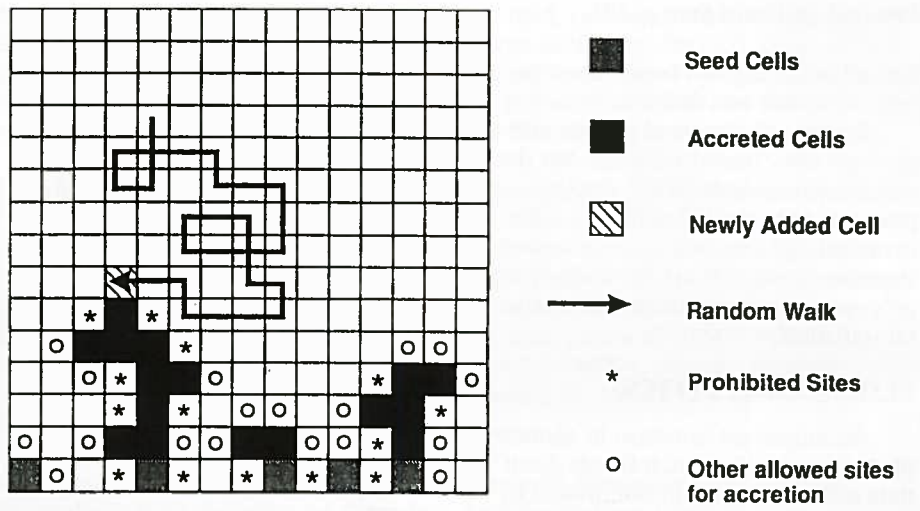


Figure 6. Illustration of the mechanism for network growth in the diffusion-limited aggregation (DLA) model. A random walker is randomly introduced to an unoccupied cell. The random walk proceeds until a cell is encountered with one (and only one) of the four nearest neighbors occupied (striped cell). The new cell is accreted to the drainage network; other allowed and prohibited sites are shown.

STATISTICS OF SEDIMENTARY LAYERS

Eroded sediments are eventually deposited as part of a layered sedimentary sequence. Each layer represents a distinct sedimentation event with an upward gradation from coarse-grained sediments to fine-grained sediments; individual layers are generally separated by well-defined bedding planes. Sediment deposition is a very complex series of processes. In some settings sediments are deposited directly by floods, as in deep lakes. In these cases it may be possible to infer flood-frequency statistics and paleoclimate from sedimentary layering statistics. Sediments deposited in shallow water can be transported and redeposited by storms. Despite the complexities, sediment layering under a variety of circumstances exhibits fractal statistics.

Two recent studies of the thickness statistics of turbidite deposits show fractal statistics. Rothman et al. (1994) carried out direct measurements on an outcrop of the Kingston Peak Formation near the southern end of Death Valley, California. Their results are given in Figure 8A; an excellent correlation with equation 1 is obtained taking D = 1.39. Hiscott et al. (1992) have studied a volcaniclastic turbidity-current deposit in the Izu-Bonin fore-arc basin offshore of Japan. Layer thicknesses were obtained from formation-microscanner images in the middle upper Oligocene part of the section. Results for two DSDP holes located 75 km apart are given in Figure 8B; a good correlation with equation 1 is obtained taking D = 1.12.

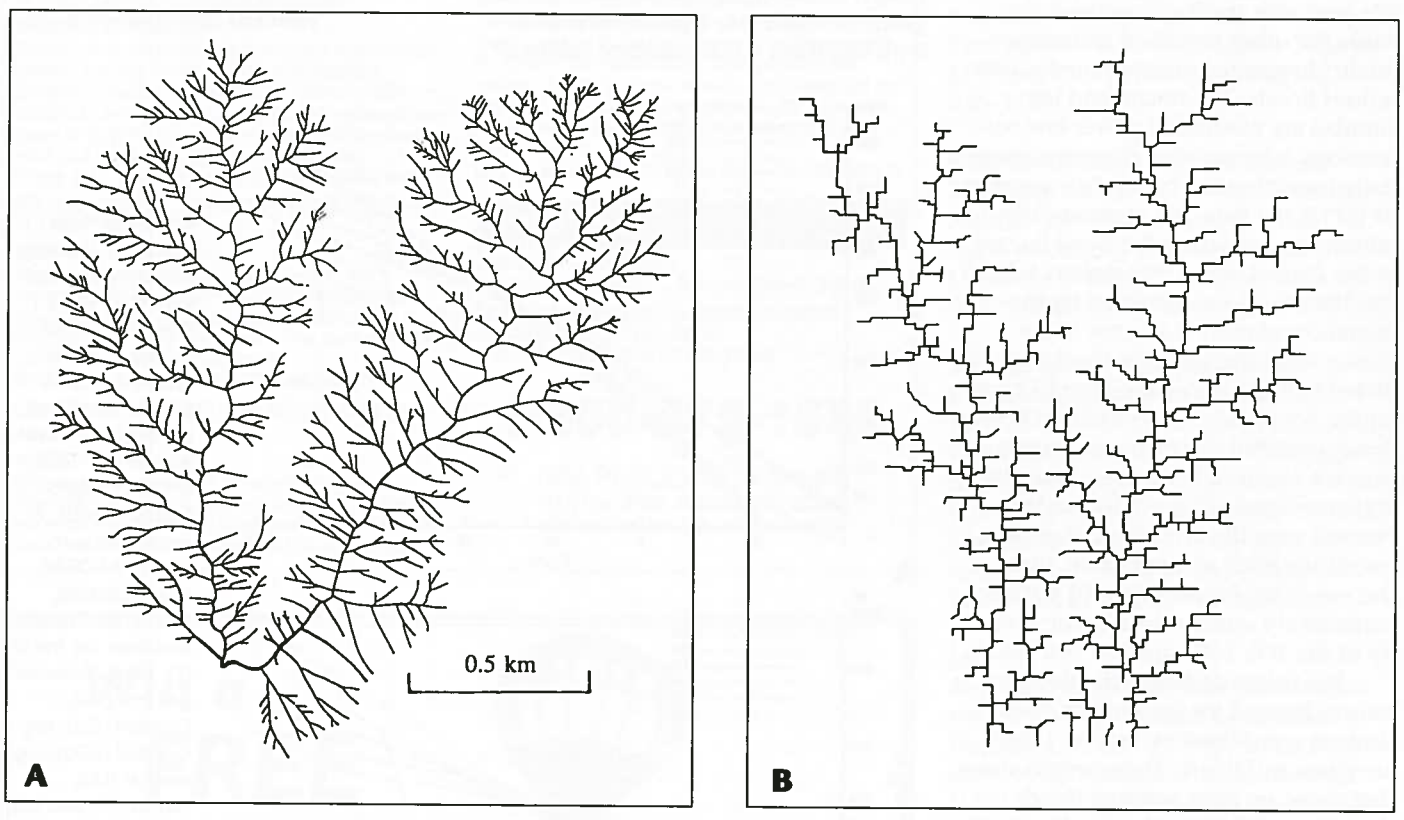


Figure 4. A: The drainage network in the Volfe and Bell Canyons, San Gabriel Mountains, near Glendora, California, obtained from field mapping. B: Illustration of a DLA model for a drainage network.

Turbidite deposits are associated with slumps off the continental margin. Although it is doubtful that the turbidite layer thicknesses scale directly with the sizes of slumps, it is likely that the fractal distribution of layer thicknesses implies a fractal size distribution of slumps. It is interesting to note that Bak et al. (1988) introduced the concept of self-organized criticality in terms of the size distribution of sand slides off sand piles. A conclusion of their studies was that the size distribution of sand slides should be fractal. Over the past several years, several laboratory studies have been carried out to determine the circumstances under which sand slides exhibit fractal statistics; this work was reviewed by Nagel (1992). The fractal statistics of turbidite layering is evidence that the associated slumping may be an example of self-organized criticality.

Fractal correlations of sedimentary sequences are not restricted to turbidite deposits. Stolum (1991) obtained fractal statistics for the Middle Jurassic Tiljo Formation in the North Sea Halten Bank basin; these sediments were deposited in a marine shelf environment. Stolum found values of D = 0.71, 0.80. Malamud and Turcotte (1992) obtained fractal statistics for sandy-bed thicknesses in the shallow marine environment of the Late Devonian Ithaca Formation, New York, with D = 1.41.

The fractal behavior of stratigraphic sequences has also been demonstrated using spectral techniques. Hewett (1986) gave results for a density-porosity log in a well through a late Miocene–early Pleistocene sandstone formation deposited in a deep submarine fan. He showed that the spectrum of the well log correlated with equation 3, taking β = 0.71. Similar results have been reported by Todoeschuck and Jensen (1988) and by Todoeschuck et al. (1990).

Hewett (1986) also developed a fractal-based interpolation technique for determining the porosity distribution in reservoirs. The three-dimen-

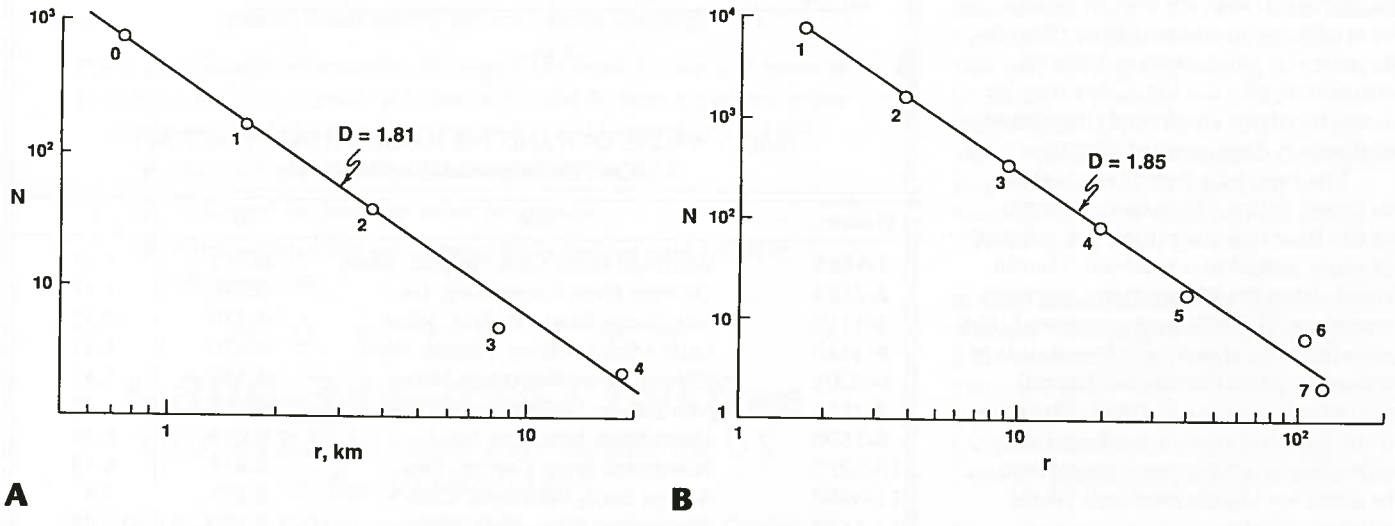


Figure 5. Dependence of the number of streams of various orders on their mean length for (A) the example illustrated in Figure 4A and (B) the model illustrated in Figure 4B. Each circle corresponds to the stream order indicated and the correlations are with equation 6.

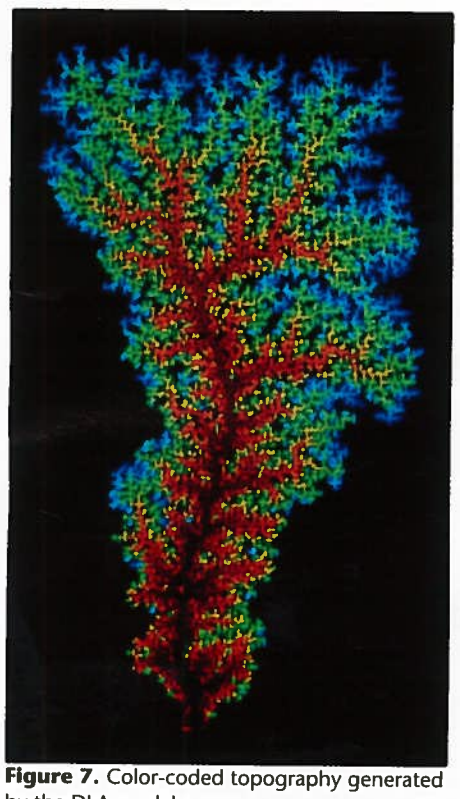
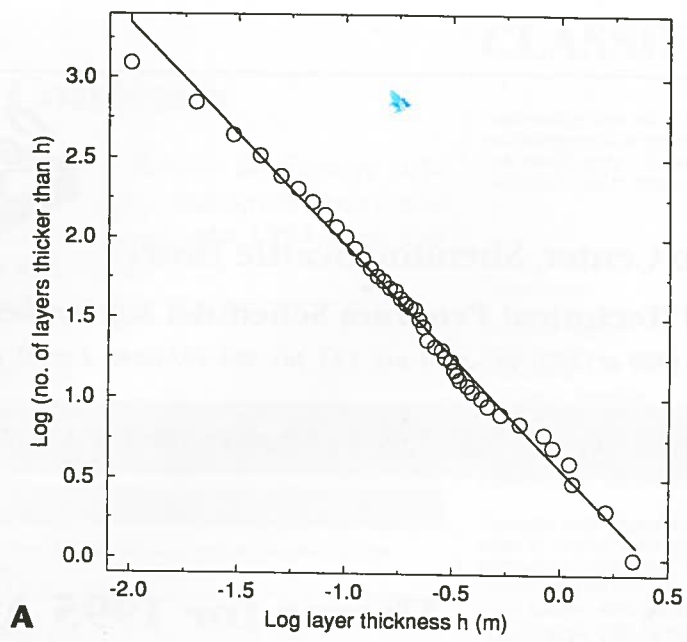


Figure 7. Color-coded topography generated by the DLA model.



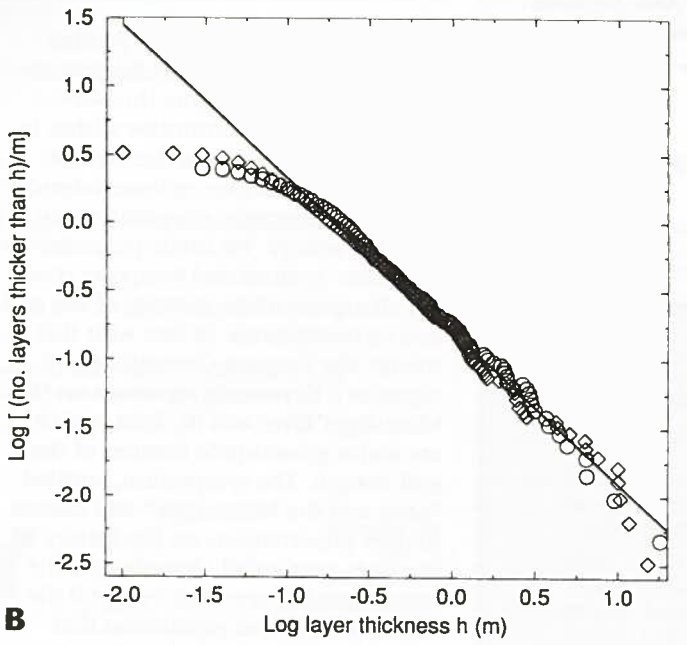


Figure 8. Frequency-thickness statistics for turbidite sequences of sedimentary layers. A: Kingston Peak Formation near the southern end of Death Valley, California. The total number of layers thicker than *h* is given as a function of *h*. B: Izu–Bonin fore-arc basin offshore of Japan. The circles are from Deep Sea Drilling Project (DSDP) hole 792 and the diamonds from DSDP hole 793. The number of layers per meter thicker than *h* is given as a function of *h*. Correlations with equation 1 yield D = 1.39 in A and D = 1.12 in B.

sional porosity of the reservoir was determined from a three-dimensional Fourier expansion. The coefficients in the vertical expansion were obtained from well logs. The coefficients in the horizontal expansions were scaled as the typical noise spectra of topography. The phases in the expansions were determined from well data. A synthetic example is given in Figure 9. This was obtained on a 256 x 256 grid, and the magnitude of the synthetic porosity in this cross section is arbitrary. The coefficients in the vertical Fourier expansion satisfied the fractal relation 3 with $\beta_y = 1.2$, and the coefficients in the horizontal Fourier expansions satisfied relation 3 with $\beta_x = 2.2$; the ratio of the vertical to horizontal coefficients was taken to be 5. With the ratios of the amplitudes of all coefficients determined by the fractal scaling, only the phases remain to be determined by the available data. Well-log data have been used, and the resulting fractal interpolations have been shown to be quite accurate in oil-field secondary recovery tests (Hewett, 1986).

DISCUSSION

Fundamental geomorphic and stratigraphic processes are relatively poorly understood. Some might say that the underlying processes of flooding, erosion, sediment transport, and stratigraphy are so complex as to defy successful modeling. Yet it is recognized that these processes satisfy fractal statistics under a wide variety of circumstances. There is a strong suggestion that modern approaches in statistical physics may be applicable to this class of problems. Examples include diffusion-limited aggregation and self-organized criticality; these approaches yield fractal statistics. In the past, these problems were commonly addressed by geostatistical empiricism. Flood-frequency analysis is an example. It will be exciting to see whether some or all of these processes can be modeled by the new approaches.

In addition, there is the suggestion that stratigraphic layering may contain a wealth of unused information. If the fractal dimension of floods is climate dependent and if stratigraphic sequences can be correlated directly with floods, then the sequences may provide improved data for the evaluation of the flood hazard today as well as providing a new database for paleoclimatology.

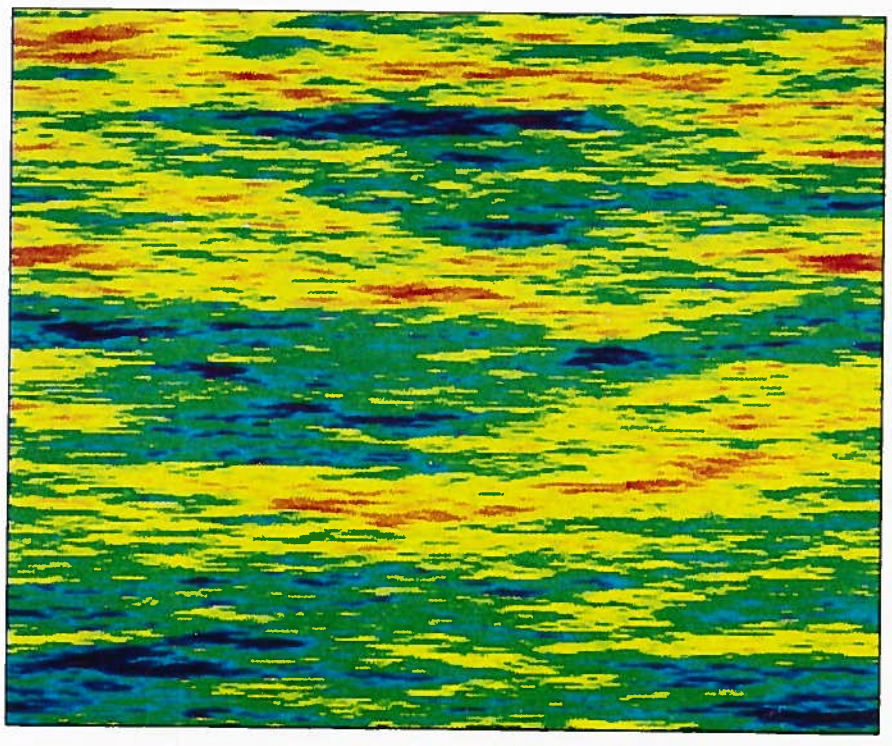


Figure 9. Cross section of a synthetic sedimentary sequence showing color-coded porosity. This is a self-affine fractal; it can be applied at any scale, but the vertical scaling is different from the horizontal scaling.

ACKNOWLEDGMENTS

The work on fractal flood frequency analysis was carried out by Lesley Greene and Kirk Haselton. The DLA model for drainage network illustrated in Figures 4, 5, 6, and 7 was developed by Jeff Masek. The synthetic fractal sedimentary cross section illustrated in Figure 9 was generated by Jie Huang. Bruce Malamud obtained thickness statistics on layered sedimentary cores.

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Theme for 1995 Annual Meeting in New Orleans

The theme for the 1995 Annual Meeting in New Orleans is *Bridging the Gulf*. Through this theme the New Orleans Program Committee wishes to draw major attention to the Gulf of Mexico—its structure, sedimentation, sediment diagenesis, economics, and geologic history. We invite proposals for theme sessions and symposia covering all aspects of the geology of the gulf and its borderlands. In line with this theme, the Program Committee will organize a Keynote Symposium on the Mississippi River and its delta, which are major geomorphic features of the gulf margin. The symposium, entitled "Man and the Mississippi," will feature invited presentations on the history of the river, particularly focusing on the interaction between the river and the dependent human population that lives along its banks and on its delta plain. Major issues to be addressed in the symposium will be channel control, delta-plain subsidence, river-mouth processes, wetland loss, slope instability of the delta front, water quality, and wildlife and fisheries habitat maintenance. We hope to bring together a mix of geologists, engineers, environmentalists, and politicians, each of whom will bring a different perspective to issues centering on the Mississippi. In this sense the theme has a double meaning, for "gulf" also can refer to the communication gap that exists among the different groups that track the problems of the river, or for that matter, the problems of the Gulf of Mexico borderlands in general. The Local Program Committee would be gratified if the New Orleans meeting could in some small way lessen that "gulf." We also invite theme sessions and volunteered papers on upper reaches of the Mississippi, for instance the effect of the great flood of 1993. Beyond theme-related sessions, we are interested in presenting a well-rounded program that reflects the broad spectrum of current research and technology in the geosciences. We invite our colleagues to help us realize this goal. Plan now to join us on the edge of the gulf in 1995. ■

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Selection will be highly competitive. Direct applications will not be accepted. Letters of Nomination should be sent no later than September 1, 1994 to: Selection Committee, W. W. Rubey Faculty Fellow, Department of Earth & Space Sciences, University of California, Los Angeles, 405 Hilgard Ave., Los Angeles, CA 90024-1567.

Nominators are requested to supply a curriculum vita of the applicant, and the names of at least two additional people who can evaluate the nominee.

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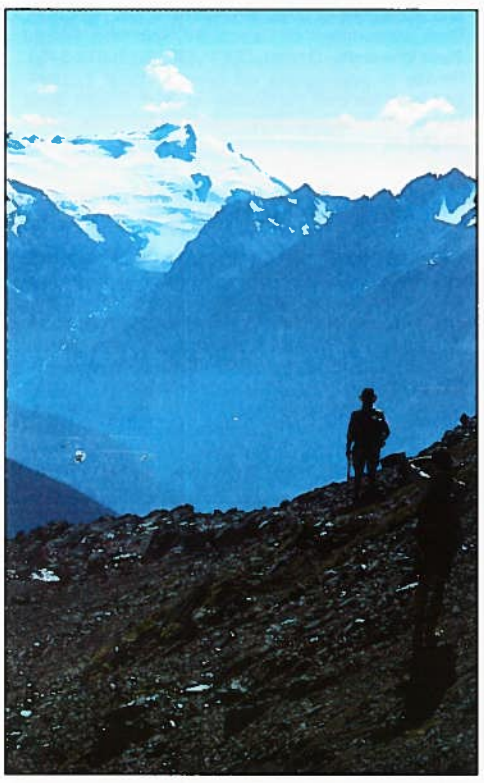

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