ABSTRACT

We use STRATA, a stratigraphic modeling package we have developed, to describe and illustrate several classic problems in both siliciclastic and carbonate stratigraphy that are still debated. Two simulations of clastic deposition show that, given constant subsidence rate, stratigraphic sequences can be generated by either eustatic sea-level change or variations in sediment supply, and that the resulting stratigraphic architectures are extremely similar. Two examples of carbonate deposition illuminate the development of meter-scale shallowing cycles, and a mechanism for generating “cycle bundling” that results from the interaction of sea-level change and the intrinsic dynamics of the carbonate system. Ultimately, stratigraphic models are most useful as a way of testing hypotheses of stratigraphic accumulation. We have found STRATA useful in research as well as geological education (it forms an integral component of stratigraphy classes at Penn State and MIT). We are releasing it as freeware over the Internet (http://hydro.geosc.psu.edu).

INTRODUCTION

Over the past two decades there has been a tremendous improvement in our ability to observe, describe, and interpret the stratigraphic record, made possible in large part by the advent of high-resolution seismic stratigraphic methods (e.g., Vail et al., 1977; Haq et al., 1987; Posamentier and Vail, 1988; Van Wagoner et al., 1990; Van Wagoner, 1995b; Christie-Blick, 1991; Christie-Blick and Driscoll, 1995). Forward modeling, which links sediment transport with basin subsidence, has played an important role in interpreting how complex depositional processes interact through time to produce the architectures observed in stratified sedimentary rocks (Read et al., 1986; Jervey, 1988; Jordan and Flemings, 1991; Lawrence et al., 1990). Developments in these fields have been extremely rapid. As a result, the literature is voluminous, and, particularly for those not intimately familiar with seismic and sequence stratigraphy, the terminology can be formidable (Van Wagoner, 1995a).

With the caveat that forward models are no better than their assumptions, either explicit or implied, stratigraphic modeling provides an objective basis for researchers to independently test hypotheses conceived in the field, or for teachers to illustrate complex sequence stratigraphic concepts with a minimum exposure to terminology. From a pedagogical perspective, an important advantage of forward models is that they can illustrate stratigraphic development through time, whereas the rock record provides only the final result, from which previous stages of evolution must be inferred.

It is now generally accepted that the three most important variables controlling stratigraphic geometry and the distribution
IN THIS ISSUE

STRATA: Freeware for analyzing classic stratigraphic problems ............... 1

GSAToday On the Web ........................................... 3

In Memoriam .................................................. 3

Rock Stars—Charles Darwin .................................. 8

Environmental Matters ........................................ 10

Viewpoint ....................................................... 13

Medlin Grants .................................................. 13

Not all Good Bills Go to Heaven ................................ 14

GSAF Update .................................................... 16

Letter ............................................................. 17

Washington Report ............................................. 18

Book Reviews ................................................... 19

Conductor Praises Mile High Chorale ......................... 20

Award Nomination Summary .................................. 21

Northeastern Section Meeting ............................... 25

South-Central and Rocky Mountain Sections Meeting .... 31

New Members .................................................. 35

New Students ................................................... 36

New Fellows ..................................................... 37

GSAMeetings .................................................... 37

Contents of: Bulletin and Geology ............................. 38

Environmental & Engineering Geoscience .................... 39

About People ..................................................... 39

Calendar .......................................................... 39

Position Announcements ...................................... 40

Employment Service ........................................... 41

1997 GeoVentures ............................................. 41

Classifieds ......................................................... 46

STRATA continued from p. 1

of unconformities are tectonic subsidence, eustasy, and sediment flux (Christie-Blick and Driscoll, 1995). Simple as it seems, separation of these variables on the basis of field data alone, or using sophisticated inversion techniques (Kominz and Bond, 1990), can be troublesome (Kendall and Lerche, 1988). In contrast, forward numerical modeling provides the user with clear information about what the role and relative importance of the different variables can be. Despite their simplicity, forward models produce remarkably realistic results and generate many of the characteristics commonly observed in the stratigraphic record.

In this paper, we use STRATA to describe and illustrate several classic problems in both siliciclastic and carbonates stratigraphy that are still debated. We hope that these simple examples will serve as a foundation for other workers to use this stratigraphic model in their own efforts to understand the stratigraphic record.

SILICICLASTIC STRATIGRAPHY

Modeling Siliciclastic Deposition

STRATA assumes that sediment transport, or flux, is proportional to slope. When combined with the assumption of conservation of mass, the result is the diffusion equation

$$\frac{\partial h}{\partial t} = \frac{K}{x^2} \frac{\partial^2 h}{\partial x^2}$$

where $h$ is elevation, $t$ is time, $K$ is the diffusivity constant, and $x$ is horizontal position. Equation 1 states that deposition or erosion is proportional to the change in local topographic slope. Diffusive processes are those in which the time-rate of change of some property is proportional to spatial gradients in that property (e.g., heat conduction, Darcy flow, or chemical dispersion of solutes). The advantage of this approach is that a single equation can produce a broad range of stratigraphic processes that result from variations in initial and boundary conditions. The disadvantage of the diffusion-based approach is that it is a gross approximation of sediment transport behavior.

This approach has been applied in a wide variety of depositional settings. Begin et al. (1981) and Kenyon and Turcotte (1985) proposed that sediment transport could be described as a diffusive process in fluvial and deltaic environments, respectively. Jordan and Flemings (1991) linked these approaches to simulate stratigraphy in an evolving basin. Kaufman et al. (1991) proposed that the diffusion constant ($K$) declined as a function of water depth in marine settings. Paola et al. (1992) derived equation 1 for braided and meandering fluvial settings, and Rivaneaes (1992) used a multicomponent diffusion equation to describe the transport of individual grain sizes.

Siliciclastic Depositional Sequences

Shallowing-upward, siliciclastic depositional sequences, overlain by relatively deep water facies, are one of the most commonly observed signatures in the stratigraphic record. Over the past century, stratigraphers have come to understand that this basic attribute can be mapped in three dimensions and through time. For example, the depositional sequence often is interpreted to record progradation (basinward shift of facies) followed by retrogradation (landward shift of facies) driven by relative changes in sea level (Vail et al., 1977; Christie-Blick and Driscoll, 1995).

Two simulations of passive margin depositional sequences are illustrated. The first is caused by absolute (eustatic) sea-level change (Fig. 1). The second is driven by changes in sediment supply (Fig. 2). We assume for both simulations that the subsidence rate is zero at the left (landward) margin and increases linearly to the right (basinward). For the first example (Fig. 1),
sediment is supplied at a constant rate along the left-hand margin, no outflux is allowed to occur along the right margin, and sea level is varied sinusoidally with a 4 m.y. period and an amplitude of 50 m.

The model results are shown in the form of a lithostratigraphic cross section at two different times during the evolution of this basin (Fig. 1, A and B). At each point in the simulation, the depositional surface has a flat “shelf” on the landward (left) side which merges with a steeper “slope” on the basinward (right) side (Fig. 1A). This geometry is simulated by varying the diffusion constant (K) so that it decreases as a function of water depth; this approximates the more efficient sediment transport found in the fluvial and shallow-marine environment relative to that in the deeper marine environment.

Shelf sediments are deposited at shallow depths (shaded yellow to red in Fig. 1). In contrast, slope sediments are deposited in deeper water (shaded in blue). The boundary between the shelf and slope is referred to as the shelf break (Fig. 1A).

Lowering and subsequently raising absolute sea level (Fig. 1, A and B) produces progradation (migration of the shelf break basinward [right]) (Fig. 1A) followed by retrogradation (migration of the shelf break landward [left]) (Fig. 1B). Maximum progradation is coincident with the eustatic sea-level lowstand (dark blue line in Fig. 1A is 50 m below dashed line, which is a fixed datum). Maximum retrogradation occurs slightly before the highstand in sea level (Fig. 1B).

The model generates two unconformities. The first unconformity is the sequence boundary and is formed during sea-level fall; this unconformity develops on the landward side of the basin (left). As the shelf break migrates basinward during progradation, the unconformity also propagates basinward. This unconformity exposes older strata to erosion and is marked by the intersection and truncation of the timelines at the topographic surface (Fig. 1A). This unconformity is then onlapped during the ensuing retrogradation (Fig. 1B, inset). The second unconformity is a marine unconformity formed during retrogradation. During sea-level rise, the relict shelf break is eroded (Fig. 1B) before it is ultimately overlain by downlapping strata during the ensuing progradational cycle. A chronostratigraphic plot known as a Wheeler diagram (Fig. 1C; Wheeler, 1964) is particularly useful for visualizing how unconformities develop in time. Both the progradational...
(sequence boundary) and the retrogradational unconformities are clearly illustrated.

The simulated stratigraphy (Fig. 1) captures much of what we observe in depositional sequences and provides insight as to how these stratigraphic architectures might evolve. Sequence boundaries are formed during sea-level fall as the landward unconformity steps basinward (Fig. 1, A and C). When the rate of sea-level fall decreases, the unconformity is covered by sedimentation (onlapped) progressively from right to left (Fig. 1, B and C). During this time, subsidence continues in the basinward zone (right), and the old shelf break is drowned and eroded. This retrogradational unconformity is analogous to a transgressive ravinement surface (e.g., Nummedal and Swift, 1987). Above this unconformity, a marine flooding surface is formed (marked by blue over orange in Fig. 1B). Between any two progradational unconformities (which form sequence boundaries) lies one depositional sequence. Figure 1C suggests that sequence boundary unconformities shrink basinward and ultimately converge with the overlying flooding surfaces as actually observed in outcrop (e.g., Van Wagener, 1995b).

The temporal evolution of the sequence boundary unconformity portrayed here (Fig. 1C) has important implications for the interpretation of the timing of eustatic sea-level change. The approach espoused by Vail (1977) is to assume that onlap of the sequence boundary occurs slowly through time and that offlap, or formation of the sequence boundary, is instantaneous. In contrast, the results presented here suggest that erosion starts at the landward (left) side much earlier than at the basinward (right) side, as was originally predicted by Wheeler (1964). In accordance with the original prediction of Pitman (1978) and with the current Exxon approach to interpreting the timing of sea-level fall (Posamentier and Vail, 1988), the maximum rate of sea-level fall (the time of minimum creation of accommodation space) is roughly coincident with the onset of onlap of the sequence boundary (Fig. 1C) (see Christie-Blick and Driscoll [1995] for further discussion).

**Flux-Driven Depositional Sequences**

We contrast the eustatically driven depositional sequence (Fig. 1) with one driven by sediment supply (Fig. 2). Sediment supply is input from the left margin and changes sinusoidally with an amplitude of 20 m$^3$/yr and a period of 4 m.y. (Fig. 2B). Progradations and retrogradations correlate to increases and decreases in the rate of sediment supply. The progradational unconformity, or sequence boundary, is formed during times of decreasing sediment supply, while the retrogradational unconformity is formed during times of increasing sediment supply (Fig. 2B). In this case, the age of the sequence boundary (determined by the age of the first strata to onlap the unconformity) slightly postdates the maximum rate of decrease in sediment supply (Fig. 2B). This occurs in much the same manner as in the case of a sea-level–driven sequence (Fig. 1), for which the age of the unconformity immediately postdates the maximum rate of fall in sea level. The sediment-flux–driven simulation (Fig. 2) is extremely similar to the sea-level–driven example (Fig. 1).

This illustrates the complexity of the base-level concept. Variable sediment supply, coupled with constant subsidence, naturally results in stacked depositional sequences. Galloway (1989) emphasized that certain depositional sequences are driven by delta-lobe switching, rather than eustasy. STRATA (Fig. 2) clearly supports the plausibility of this alternative mechanism. Furthermore, unlike the prediction of Christie-Blick (1991), it appears to generate depositional sequences that are essentially indistinguishable from those generated by sea-level change. Jordan and Flemings (1991) showed that variable subsidence also can generate stratigraphic sequences, but we do not explore this here.

**Carbonate Stratigraphy**

Carbonate sedimentation differs fundamentally from clastic sedimentation, because most carbonate sediments are produced within, rather than external to, the sedimentary basin. Therefore, carbonate sediment generally does not undergo the extreme lateral sediment transport typical of siliciclastic sediment (Wilson, 1975). Studies of modern carbonate depositional environments show that carbonate production rates are extremely high in shal-

---

**Figure 2.** Generation of sequences by variable sediment supply. Simulation is identical to Figure 1 except that eustatic sea level does not change, but sediment supply does. A: Lithostratigraphy. B: Wheeler diagram illustrates that unconformities are formed during times of decreasing sediment supply. Note similarity of Figure 2 to Figure 1, even though the driving mechanism is different. Parameters are listed in Table 1.

**Figure 3.** The Milroy Member of the Middle Ordovician Loysburg Formation (person at lower right is about 2 m tall). Four of the six measured carbonate cycles are visible; the dashed lines delineate their tops. Darker rock is the subtidal facies; lighter rock is the intertidal facies. Cycle thicknesses are greater at the base and thinner in the middle. Located at intersection of Rt. 322 and Rt. 26, State College, Pennsylvania.
low water (1–1000 mm/yr) but decline rapidly within a few tens of meters of water depth (Schlager, 1981). STRATA approximates this behavior by assuming that carbonate production is an exponentially declining function of water depth.

Meter-Scale Shallowing-Upward Cycles

Meter-scale shallowing-upward cycles have been an essential component of carbonate platforms for at least the past 2 b.y. of Earth history. Their origin has been hotly debated (e.g., do these cycles record orbital forcing of global climate?); compare Goodwin and Anderson (1985), Algeo and Wilkinson (1988), and Koenigshofer and Read (1989). Modeling studies, beginning with those of Read et al. (1986), have helped quantify processes that occur on time scales shorter than the constraints offered by biostratigraphy and longer than human observation or radiocarbon dating can calibrate.

A simple example of how STRATA can be used to provide insight into understanding the origin of these shallowing-upward cycles is based on observations of the Middle Ordovician Milroy Member of the Loysburg Formation of central Pennsylvania (Figs. 3, 4A). Six successive shallowing-upward cycles progressively thicken and thin. Figure 4A illustrates a plot of differential cycle thickness through time (Fischer diagram) in which, through the assumption that cycle duration is constant, the progressive deviations in cycle thickness can be used to infer changes in accommodation space through time (Fischer, 1964; Read and Goldhammer, 1988; Sadler et al., 1993). One interpretation of Figure 4A is that sea level rose and then fell in a sinusoidal fashion over the 0.725 m.y. duration of these rocks. However, we note that the total number of cycles used in this analysis is well below the minimum required for the result to be rigorously valid (Sadler et al., 1993).

In a forward model of this outcrop (Fig. 4B), we impose a long-term eustatic sea-level change with an amplitude of 2.0 m and a period of 0.725 m.y. (see red curve on Wheeler diagram, Fig. 4B). On top of this we impose a high-frequency oscillation of 1.75 m and a period of 0.12 m.y. To simulate the biologic inertia associated with recolonization of the sea floor and "jump starting" the carbonate factory, we impose a lag-time of 5000 yr in carbonate production following complete shallowing to sea level (lag depth rather than lag time, or a combination of both, is possible with STRATA).

In an illustration of six modeled shallowing-upward cycles (Fig. 4B), the modeled and observed cycle thicknesses are similar; furthermore, both the observed and modeled cycles show that thicker cycles have a greater component of deeper water facies
STRATA continued from p. 5

(dark blue) than thinner cycles. All of the modeled cycles shallow asymmetrically upward, as is observed in the outcrop. The Wheeler diagram (Fig. 4B) shows that the unconformities at the top of each shallowing-upward cycle are associated with the falling limb of the high-frequency sea-level change. In contrast, the base of each cycle is associated with the rising limb of each high-frequency sea-level change. During the times of long-term rise in sea level, which correspond to the thick cycles at the bottom and top of the section, the lacunae (disconformities) present between successive cycles are of a much smaller duration than those present during the falling limb of the sea-level cycle. During the long-term fall in sea level (the middle three cycles), the majority of time is recorded by a hiatus, because sea level is falling faster than subsidence and the shelf is exposed. Significantly, the Wheeler diagram shows that over half of the geologic time represented by the section is not recorded by rocks, similar to results previously obtained by Read et al. (1986), Grotzinger (1986), and Wilkinson and Drummond (1993) for other cyclic strata deposited under conditions of minimal long-term accommodation increase. STRATA suggests that these hiatuses may be preferentially partitioned within the rock record as a function of sea-level change (however, see below and Fig. 5 for an alternative explanation of hiatal origins). Finally, we note that even with the relatively slow sedimentation rate used, it is impossible to generate deepening-upward cycles without a lag time or a lag depth, because sea level is varying by only 1 m and sedimentation can always keep up with sea level.

**Cycle Bundling**

As a last example (Fig. 5), it is interesting to couple the long-term evolution of a carbonate shelf with high-frequency sea-level change. In this case, subsidence increases linearly from left to right. Two orders of high-frequency, shallowing-upward cycles are present, consisting of thicker cycles driven by sea-level change (0.1 m.y. period, 1.0 m amplitude) and thinner cycles that arise solely from the interaction between differential subsidence and sediment production. The latter mechanism for cycle generation is often referred to as “autocyclicity” (Ginsburg, 1971; Bosellini and Hardie, 1973; Wilkinson, 1982). The thicker cycles are defined by a systematic, upward decrease in the thickness of the thinner cycles that is related to the decreasing accommodation associated with the 0.1 m.y. sea-level oscillation. Cycle asymmetry in both sets results from the intrinsic lag time in carbonate production following complete shallowing to sea level. However, the “cycle bundling” does not result from nested sea-level oscillations, but rather reflects the lag in sedimentation, following shallowing to sea level. The shelf aggrades to sea level during the 0.1 m.y. cycle, but carbonate production shuts off, and the shelf subsides for 7000 yr every time it reaches sea level. This may occur numerous times as long as accommodation space is available. Here, through a fortuitous (but not unreasonable) combination of subsidence, lag time, and eustatic periods, this results in approximately 5:1 “bundling.” This is interesting given that the observation of similar bundling in the rock record has been interpreted and modeled assuming multiple sea-level oscillations with frequencies (~0.1 and 0.02 m.y.) corresponding to the Milankovitch periods (Goldhammer et al., 1987; Goodwin and Anderson, 1985). Drummond and Wilkinson (1993) also investigated this behavior with a one-dimensional model. In Figure 5A, the upward-shallowing cycles can be seen prograding in the direction of decreasing subsidence, away from the shelf margin and toward the inner part of the shelf (right to left). This pattern results not from any dependency on slope (there is no diffusive component) or other directional sediment transport terms, but because of the influence of lag time (lately depth produces similar geometry) operating in concert with differential subsidence. As the shelf is continuously flooded following the lowstand in the 0.1 m.y. sea-level period, the lag time progressively turns on and then off, allowing sedimentation and aggradation to occur. Accordingly, the time at which the sedimentation lag turns off is diachronous and so is the time at which shallowing to sea level takes place at any given point on the shelf. Both decrease in age up dip (to the left). The final result is that sedimentation at any point is aggradational, but the geometry of the cycle is progradational and the cyclic facies are markedly diachronous. A Wheeler diagram illustrates that the prominent unconformities correspond to the times of sea-level fall associated with the 0.1 m.y. oscillation (Fig. 5B). In contrast, the high-frequency cycles are unrelated to eustatic sea level and are diachronous, crossing time lines from right to left (Fig. 5B).

**DISCUSSION**

Examples from clastic and carbonate sedimentation illustrate how simple forward models can be used in conjunction with observation to provide insight into our interpretation of the stratigraphic record. The examples presented are not original, but have been chosen to illustrate STRATA’s capabilities (and limitations) in addressing some of the classic (as well as more modern) problems in stratigraphy. The main goal of this paper is to demon-
Nummedal, D., and Swift, D. J. F., 1987, Transgressive stratigraphy at sequence-bounding unconformities:

Manuscript received August 26, 1996; revision received October 7, 1996; accepted October 9, 1996.

Each month, GSA Today features a short science article on current topics of general interest. For guidelines on submitting an article, contact GSA Today Science Editor S. M. Kay, Cornell University, (607) 255-4701, fax 607-254-4780, E-mail: kay@geology.cornell.edu.
Darwin the Geologist

Léo F. Laporte, Earth Sciences, University of California, Santa Cruz, CA 95064, laporte@cats.ucsc.edu

On January 16, 1832, shortly before Charles Darwin’s 23rd birthday, H.M.S. Beagle, with the young Darwin aboard, made its first stop at São Tiago in the Cape Verde islands off the west coast of Africa. Years later, Charles Darwin wrote:

The geology of St. Iago is very striking yet simple: a stream of lava formerly flowed over the bed of the sea, formed of triturated recent shells and corals, which it baked into a hard white rock. Since then the whole island has been upheaved. But the line of white rock revealed to me a new and important fact, namely that there had been afterwards subsidence round the craters, which had since been in action, and had poured forth lava. It then first dawned on me that I might write a book on the geology of the countries visited, and this made me thrill with delight. That was a memorable hour to me…. (Autobiography, p. 81).

Today, few people are aware that Charles Darwin (1809–1882) was an accomplished geologist before becoming renowned as a biologist with On the Origin of Species in 1859. Despite his lack of formal training as a geologist, Darwin published major works on the structure and distribution of coral reefs (1842) and geological observations on volcanic islands (1844) and on South America (1846).

INFLUENCES

The irony of Darwin’s success as a geologist was that he had little formal instruction in the subject. In his second year at the University of Edinburgh—before he dropped out—he attended the lectures of Robert Jameson, a champion of Werner’s Neterminist theory, “but they were incredibly dull. The sole effect they produced on me was the determination never as long as I lived to read a book on Geology or in any way to study the science. Yet I feel sure that I was prepared for a philosophical treatment of the subject” (Autobiography, p. 52).

Disgusted by medicine in the days of surgery performed without the benefit of anesthesia, Darwin went on to Cambridge to complete a degree that would prepare him for the Anglican clergy. At the same time Darwin continued his extracurricular pursuit of natural history and met various distinguished scholars, including John Stevens Henslow (botany), Adam Sedgwick (geology), and William Whewell (astronomy and philosophy). Darwin’s enthusiastic interest in science impressed these men, for they became his mentors in various ways. Thus, despite his initial antipathy for geology, Darwin spent the better part of August 1831 on a geological tour of Wales with Adam Sedgwick, who was studying the rocks that he would later define as the Cambrian System.

On this tour I had a striking instance of how easy it is to overlook phenomena, however conspicuous, before they have been observed by anyone. We spent many hours … examining all the rocks with extreme care … but neither of us saw a trace of the wonderful glacial phenomena all around us. (Autobiography, p. 70).

VOYAGE OF THE BEAGLE

At the end of August, Darwin returned home to discover that he had been recommended by his Cambridge professor and mentor, John Henslow, as the naturalist for the forthcoming Beagle voyage under Capt. Robert FitzRoy. Darwin was thought suitable for the position more because he was a well-bred gentleman who could socialize with the Beagle’s captain than because of his skills as a trained naturalist. As a welcoming gift, FitzRoy gave Darwin the first volume of Charles Lyell’s Principles of Geology, which had been published the year before. Closely reading this volume and the next two sent to him while on the voyage, Darwin became self-taught in geology. “I am proud to remember,” he said, “that the first place, namely St. Iago, [where] I geologized, convinced me of the infinite superiority of Lyell’s views over those advocated in any other work known to me” (Autobiography, p. 101).

Throughout the remainder of the voyage, Darwin “geologized” with excitement and enthusiasm. Writing home to his sisters, he remarked, “There is nothing like geology; the pleasure of the first day’s partridge shooting … cannot be compared to finding a fine group of fossil bones, which tell their story of former times with almost a living tongue …” (Correspondence, v. 1, p. 379), or that he “literally could hardly sleep at nights for thinking over my [geology].” (Correspondence, v. 1, p. 445).

INTRODUCTION

Bernard of Chartres, an 11th-12th century philosopher and teacher, said that we are like dwarfs on the shoulders of giants, so that we can see more than they and for a greater distance, not by any virtue of our own but because we are carried high and raised aloft by their stature.

All of us have our geological heroes, those giants on whose shoulders we stand. To encourage recognition of these luminaries and to provide inspiration for students and young professionals, the GSA History of Geology Division presents Rock Stars, brief profiles of our geological giants. If you have any comments on this or subsequent profiles, please contact Robert N. Ginsburg, University of Miami, RSMAS/MGG, 4600 Rickenbacker Causeway, Miami, FL 33149-1098, E-mail: rginsburg@rsmas.miami.edu.

Darwin’s diagram of the geological structure of the coast of St. Iago, Cape Verde Islands, A: substratum of ancient volcanic rocks. B: bright white layer of limestone, originally deposited below the sea but now raised. C: recent basaltic lava. Near the extinct volcano shown, the limestone and overlying basaltic layers dip beneath the sea, evidence of local subsidence. From Geological Observations on Volcanic Islands, 1844.

From de Beer (1964, p. 58).
In Chile, on February 20, 1835, Darwin experienced a very strong earthquake and shortly afterward saw evidence of several feet of uplift in the region. Because one important aspect of Lyell’s principles was the concept of a steady-state, nondirectional earth whereby uplift, subsidence, erosion, and deposition were all balanced, Darwin coupled in his mind this dramatic evidence of elevation with accompanying subsidence and deposition. Thus he hypothesized, before actually seeing them, that coral reefs of the Pacific developed on the margins of subsiding land masses, passing through the three stages of fringing reef, barrier reef, and atoll.

No other work of mine was begun in so deductive a spirit as this; for the whole theory was thought out on the west coast of S. America before I had seen a true coral reef. I had therefore only to verify and extend my views by a careful examination of living reefs. But it should be observed that I had during the two previous years been incessantly attending to the effects on the shores of S. America of the intermittent elevation of the land, together with the denudation and deposition of sediment. This necessarily led me to reflect much on the effects of subsidence, and it was easy to replace in imagination the continued deposition of sediment by the upward growth of coral. To do this was to form my theory of the formation of barrier reefs and atolls. (Autobiography, p. 98, 99).

When the Beagle visited the Cocos Islands in the Indian Ocean more than a year later, Darwin was able to test his hypothesis of reef formation “by examining the very interesting, yet simple structure and origin of these islands…. These low, insignificant coral-islets stand and are victorious … thus do we see the soft and gelatinous body of a polyp … conquering the great mechanical power of the waves…” (Voyage, p. 457, 459).

In his 1842 book on coral reefs, Darwin published a map of the southwest Pacific showing the distribution of fringing, barrier, and atoll reefs. Darwin noted that fringing reefs were concentrated along the coasts of continents that “are for the most part rising areas” whereas barrier and atoll reefs are found in the “central parts of the great oceans [that] are sinking areas” (Voyage, p. 478). (Knowing what we know about plate tectonics, we explain such subsidence by the cooling and accompanying increase in density of submarine volcanic rock as it moves away from active ridges or hot spots.)


Darwin continued on p. 10
Interdisciplinary Scientific Opportunities at the Newly Consolidated U.S. Geological Survey and National Biological Service—Part 2

Daniel Sarewitz, IEE Director, GSA
Mary Barber, Executive Director, Sustainable Biosphere Initiative, Ecological Society of America, 2010 Massachusetts Ave., NW, Washington, DC 20036
John Huyler, Jr. and Paul DeMorgan, The Keystone Center, P.O. Box 8606, Keystone, CO 80435

BACKGROUND

On October 1, 1996, the National Biological Service (NBS) was merged into the U.S. Geological Survey (USGS), thereby becoming the new Biological Resources Division (BRD) of the USGS. The BRD has as its mission “to work with others to provide the scientific understanding and technologies needed to support the sound management and conservation of our Nation’s biological resources.” This mission is fully consistent with the USGS’s broader mission of providing “the Nation with reliable, impartial information to describe and understand the Earth.” Consolidation and fulfillment of these missions will require not only the administrative merger of the NBS and USGS, but also the development of a framework for scientific investigation and information management that promotes the application of integrated knowledge of biological, physical, and socioeconomic processes and forces.

To help foster this goal, the Geological Society of America, the Ecological Society of America, and the Keystone Center sponsored two workshops to identify new interdisciplinary opportunities relevant to the mission of the merged agencies. Here, we summarize the results and findings of the second workshop, held in Silverdale, Washington, in July 1996. (For a summary of the first workshop, see the October issue of GSA Today.) We address the general problem of how interdisciplinary opportunities can be fostered—a pervasive concern throughout the workshop—and then outline a series of specific interdisciplinary initiatives that emerged from the workshop deliberations. Participants included scientists and natural resource managers from a wide range of sectors, including academia, private companies, state and federal agencies that work with the USGS and NBS, and the USGS and NBS themselves. Our report presents the major ideas discussed during the workshop and is neither a consensus document nor a comprehensive workshop proceedings.

ENABLING INTERDISCIPLINARY SCIENCE

The administrative, professional, and intellectual culture of science encourages and reinforces disciplinary boundaries. Successful integration of the USGS and the NBS will require administrative action aimed at breaking down barriers to interdisciplinary science. Imposing such cultural change is not easy; assessment of other interdisciplinary projects, programs, and organizations would help the USGS to recognize and define characteristics of successful efforts and past failures. Workshop participants identified a range of organizational attributes that might encourage development of a truly interdisciplinary USGS:

1. Strong research investigation leadership, including explicit mandates for integrated, interdisciplinary planning and products.
2. Standardized and integrated data management protocols that allow for the compilation of multidisciplinary data sets and a comprehensive view of physical and biological attributes. (In many cases, an integrated information infrastructure is a necessary prerequisite for effective interdisciplinary activity.)
3. An organizational demand for studies that lead to generalizable principles, rather than simply local case histories and assessments.
4. An organizational demand for comprehensive, integrated historical baseline and trends to support environmental assessments and predictive modeling.
5. Effective lines of communication between researchers and information users, including clear articulation of uncertainties dictated by data sources and interpretive procedures.
6. Problem-oriented interdisciplinary research teams. More co-location of USGS and NBS facilities and scientists will be necessary.
7. Participation of engineers and social scientists. (Humans are major agents of geological and ecological change, and efforts to understand and respond to such changes require effective integration of the physical, biological, and social sciences.)

For Further Reading


change must consider the human element.)

PROPOSED INTERDISCIPLINARY INITIATIVES

The workshop identified and described eight interdisciplinary initiatives that would contribute to the achievement of the mission of the newly merged agency. These initiatives are grouped below into three broad, crosscutting themes. Order of presentation is not meant to imply relative priority of initiatives.

I. The Environmental Knowledge Base

Effective environmental decision making requires impartial, independent, state-of-the-science data and information on the current status and past history of the nation’s energy, water, land, mineral, and biological resources.

A. Information Infrastructure

An integrated and standardized information infrastructure is an essential prerequisite for development of comprehensive environmental baseline information and for carrying out credible bioregional assessments. The USGS is now uniquely positioned to create this infrastructure. The viability of new interdisciplinary scientific opportunities will significantly depend on the existence of this infrastructure; indeed, the infrastructure may help create such opportunities.

An integrated information infrastructure will permit the effective use of existing data (from USGS, NBS, and regional, state, and other federal agencies, e.g., National Science Foundation–funded Long-Term Ecological Research network), thus preventing duplication of effort while creating a truly comprehensive assessment capability.

Implementation would be facilitated by cross-divisional teams charged with the development of database protocols, including collection, storage, retrieval, and delivery policies; coordination of information retrieval and use (“gatekeeper function”); and cultivation of linkages with appropriate external agencies. However, such protocols must be sufficiently flexible to accommodate methodological differences among scientists working on different projects and in different regions.

B. Baseline Data on Biological Communities, and the USGS-NBS Bioregional Assessment Capability

The absence of a complete baseline record, including Holocene, human-historical, and recent trend data, on the distribution and characteristics of biotic communities is a significant handicap to all efforts to effectively manage natural resources and restore degraded ecosystems. The USGS should develop a comprehensive information base on communities, for use by land managers, planners, and policy makers.

Developing the baseline record will require: (1) compiling past and recent data on distribution and abundance of species and communities and on physical conditions of the landscape (including land-use patterns, e.g., NBS Land Use History of North America project); (2) carrying out timely, efficient, scientifically credible bioregional assessments on vegetative cover; identification, distribution, and abundance of key plant and animal species; and surficial geology, topography, and surface water; (3) developing integrative, digitized baseline data maps.

Appropriate information infrastructure, combined with comprehensive baseline and trend data and bioregional assessments (including maps of present and past physical, biological, and cultural attributes), will allow the USGS to more effectively serve natural resource managers and policy makers through interdisciplinary evaluation, interpretation, and anticipation of the impacts of changing land-use practices and patterns on water quality and quantity and biological communities.

II. Responding to Biological Threats

A. Ecosystems and Health

The effects of emerging diseases, algal toxins, and natural and anthropogenic pollutants on the health of humans, wildlife, and vegetation are determined in part by the behavior of ecosystems. Disease agents are spread in the environment by physical processes in water and air, and also by organisms. Understanding the relation between ecosystem processes and health requires an interdisciplinary approach that would include monitoring and analysis of patterns of water flow and sedimentation, geochemical cycling, and invasion of disease organisms and their vectors, as well as social factors such as patterns of commerce, travel, urbanization, and agriculture.

Emerging problems of ecosystems and health are now being recognized in diverse environments and at various scales. Water quality may be adversely affected by proliferation of wildlife such as Canada geese. Unusual current regimes and eutrophication affect the timing and development of massive proliferation of toxic algae. On a larger scale, endocrine disrupters (e.g., PCBs and DDT byproducts) may represent a widespread and long-term threat to human and wildlife health, while climatic changes contribute to changes in the distribution and spread of disease-causing organisms, on land as well as in water.

Combining USGS capabilities in hydrology, geochemistry, and surface processes with NBS strengths in ecological science can lead to significant new insights into the natural history of disease. Integrative models should be developed that can more fully characterize the feedbacks that occur between environment and disease, and help anticipate and respond to new threats to the health of humans, wildlife, and vegetation.

B. Dynamics and Consequences of Species Invasions

Problematic species invasions resulting from human activities can have significant negative ecological and economic consequences. Acceleration of environmental change and ecosystem degradation at the local, regional, and global level may lead to increased invasion. Combining a long-term ecological perspective on invasions through time (e.g., as facilitated by tectonic movements and climate and sea-level change) with short-term ecological studies on modern invasions will yield new insights into the dynamics and consequences of invasions that will enhance the response capabilities of land and resource managers.

Crucial questions include: (1) Which species are most apt to invade? (2) Which biological communities are most likely to contribute invaders? (3) Which communities are most vulnerable to invasion?

Studies of invasions in the geological past and in the record of human history, together with ongoing ecological studies, will allow characterization of long-term consequences of invasion, and modeling of the spread of invasions. Interdisciplinary knowledge will be necessary to develop effective strategies for controlling the introduction and spread of problematic invaders, reducing their harmful effects, and managing the human environment to reduce the threat of invasion. This initiative should be closely linked to studies of environment and disease, because species invasion dynamics reflect many of the same physical, biological, and social processes that link ecosystems to the health of humans, wildlife, and vegetation.

III. Maintaining Viable Ecosystems

A. Ecosystem Restoration

Remediation and restoration of damaged ecosystems may be necessary to sustain biological and economic productivity, and to maintain ecosystem services (such as flood control and water-quality preservation by wetlands) that are necessary for society’s welfare. Effective remediation requires: (1) baseline data on the physical and biological condition of ecosystems, and comparison of ecosystems least
affected by human activities to those that have been modified to varying degrees; (2) integrated understanding of physical, chemical, and biological processes that control ecosystem function; (3) integrated understanding of natural and human-induced stresses on ecosystems; (4) knowledge of threshold indices for healthy systems (chemical and biological indicators); (5) knowledge of site conditions from superficial and engineering geology perspectives; (6) protocols for determining the consequences of alternative natural resource management practices (monitoring for adaptive management).

As a principal source of scientific information used by natural-resource managers dealing with ecosystem disruption, the USGS should develop a comprehensive approach to restoration that includes and integrates information on each of the above factors. This information should also be useable for decision makers seeking to design policies that can enhance the remediation process.

B. Recovery from Ecological Crises

Concern about “natural disasters” tends to focus on direct impacts to human systems, but earthquakes, volcanic eruptions, storms, floods, fires, and human-caused accidents profoundly affect species populations and even entire ecosystems, including the critical geochemical cycling on which life depends. Anticipating and successfully responding to future crises from this perspective require integration of geological, ecological, and historical knowledge about frequencies, magnitudes, spatial scales, and biological signatures of crises in the geological and human-histori
cal past. Ultimately, such knowledge may lead to strategies for enhancing the ability of ecosystems to resist and recover from natural and human-caused crises, just as natural hazards programs now focus on societal preparation and recovery.

Ecological crises can be viewed as real-time natural experiments. Scientific response to the 1981 Mount St. Helens eruption represents a successful model of effective, interdisciplinary postcrisis assessment; the 1989 Loma Prieta earthquake was less successful because biological and ecological factors were largely neglected. USGS rapid response teams should include life scientists, to ensure a comprehensive assessment capability.

Interdisciplinary analysis of the historical record of ecological crises will aug
ment study of modern crises. Analysis of past crises requires reconstruction of pre-crisis paleoecologic conditions. Similarly, effective and useful analysis of the eco
gical impacts of recent catastrophic events requires comprehensive baseline data as a basis for evaluating change.

Sub-Initiative on Fires: Millions of acres of the western United States burn annually. Restoration programs are aimed at preventing further land degradation and facilitating ecological recovery, but the effectiveness of these programs has not been adequately studied. Such analysis would include tests of the effects of various remedial treatments, systematic assessments of treatment results across a variety of landscape gradients, and retrospective study of a selection of past fires and subsequent recovery. This information would be applied to future restoration strategies.

C. Flood Plain Management

Natural resource and flood management practices on alluvial valley floors are often inadequate because research and application of knowledge has been fragment ed among disciplines and agencies. The USGS can now develop a fully integrated study of the hydrology, biology, and engineering affecting the conditions of valley floors, as well as better analytical and planning tools for decision making about land use, habitat preservation, and water quality.

Comprehensive, interdisciplinary analysis of an appropriate flood plain could lead to the development of generalizable principles applicable to resource and hazard management. A large flood plain with diverse land-use patterns should be selected for analysis that would include: (1) field study and modeling of processes that affect hydrology (flood and dry-weather) and the transport of bioactive materials from upstream and local sources, and between the channel and the valley floor; (2) field study of the linkages in space and time between valley-floor characteristics (e.g., hydrogeomorphology, infrastructure) and the distribution of wetland, riparian, and other biological communities, with the objective of generating a modeling capability and identifying generalizable principles to explain relations among biological processes, geomorphic processes, human activities, and water quality; (3) development of tools that can be used by resource managers and policy makers to quantitatively assess how changing physical processes, cultural features, and land cover affect habitat distribution, flooding, and water quality. On the basis of this program, a protocol should be developed for rapid studies of other valley floors, including mechanisms for iterative improvement of general principles and resource management tools.

D. Biologic Processes and Soil Formation

Consideration of soil is often neglected in the study of land-based ecosystems. While the U.S. Department of Agriculture (USDA) conducts soil research on arable lands, there is insufficient understanding of soil formation, degradation, and erosion processes in nonagricul
tural terrain. In particular, the role of biological factors in weathering, erosion, transport, and depositional processes is not well known. The USGS, in cooperation with other relevant agencies (e.g., USDA, National Oceanic and Atmospheric Administration), is well positioned to develop the necessary knowledge. Understanding the interactions among geologic, hydrologic, meteorologic, and biologic processes in the creation and destruction of soils will be essential to successful management of ecosystems.

Key problems include: (1) biologic controls on rates and processes of soil formation in various landscape settings, including the role of soil microorganisms; (2) biologic controls on rates and processes of soil erosion in various landscape settings; (3) effects of acid precipitation on soil quality, rates of rock weathering, and rates of soil formation, and relation to integrity of forest communities; (4) impacts of human activities on soil genesis and degradation in nonagricultural areas, and maintenance of long-term soil fertility in impacted areas.

A few important environments could be selected for interdisciplinary pilot studies—for example midwestern loess, north-eastern forest, and western peaty deltaic deposits. The long-term goal is to provide knowledge and tools for land and resource managers to maintain soil quality and ameliorate degraded soils.

Workshop Participants

Craig Allen, National Biologic Service
Mary Altalo, Scripps Institution of Oceanography
James Beach, National Science Foundation
Randy Brown, California Dept. of Water Resources
Michael W. Collopy, National Biological Service
Thomas Dunne, University of California, Santa Barbara
Milt Friend, National Biological Service
Leonard Gaydos, U.S. Geological Survey
Gordon Grant, U.S. Forest Service
Douglas Growtiz, Bureau of Reclamation
Arthur Lachenbruch, U.S. Geological Survey
Charles Logue, Unified Sewerage Agency (Oregon)
Eugene Mancini, ARCO
Lindsay McClelland, National Park Service
Eldridge Moores, University of California, Davis
Gordon Orians, University of Washington
Jonathan Price, Nevada Geological Survey
Mark Schafer, U.S. Dept. of Interior
Bruce Schmidt, Oregon Dept. of Fish and Wildlife
Marvin Shabdy, U.S. Geological Survey
Peter Stine, National Biological Service
Mark Sylvester, U.S. Geological Survey
Gerard Vermeij, University of California, Davis
John Williams, National Marine Fisheries

This series of workshops was supported in part by contributions from the Exxon Corporation, the Campini Foundation, the Bullit Foundation, the Minerals Management Service, and Michel T. Halbouty.
VIEWPOINT

Dev L. Advocate

Which Way Up?

Every once in a while, one of our brethren decides to right an old wrong or, more precisely, to invert an old ratio. The most recent example comes from Paris, the birthplace of SI, and concerns the more precisely, to invert an old ratio. The brethren decides to right an old wrong or, it since it is the “invariant, stable, normal-denominator, no one will pay attention to decided to start using the 4He/3He ratio, most isotopic ratios have the stable isotopic composition by inversion has been attempted. Seismologists have a quantity they call the seismic quality factor, or Q. For Earth's crust and mantle, it generally ranges from 10 to 1000; nice round numbers. The theory has been all worked out, and everyone was happy. One day, someone noticed that, in the theory, Q was always in the denominator, it was always on the bottom. The purists among them said hold on, Q is not fundamental; it is Q – 1 that is fundamental. They went on to define q as Q – 1 and started talking about numbers such as 0.025 and 0.0016, which did not improve the quality of life of those involved in dissipation. Thankfully, no new word was proposed, such as inequality, or seismic lack-of-quality, factor. All of this happened at about the same time as log-log graph paper started to disappear and there was an urgency to make all graphs into straight lines or fractoids.

One could equally make a case against the use of temperature. Temperature almost always occurs downstairs, particularly in plots of something vs. 1/T. Outlaw temperature? What do we then call Kelvins? Do we follow the resistance purist or theoretical point of view is the theoretic density and velocity vs. depth, seismologists think that the origin of Earth is at 4.5 Ga). By plotting volume and seismic slowness vs. radius, instead of the conventional density and velocity vs. depth, seismologists will have achieved a level of purity, and obscurity, only dreamed of by geochemists.

“A foolish consistency is the hobgoblin of little minds.” —Emerson

Coal Division Offers Medlin Award

The Coal Geology Division of the Geological Society of America announces the availability of the Antoinette Lierman Medlin Scholarship in Coal Geology for the 1997–1998 academic year. The scholarships provide full-time students who are involved in research in coal geology (origin, occurrence, geologic characteristics, or economic implications of coal and associated rocks) with financial support for their project for one year.

Scholarship funding can be used for field or laboratory expenses, sample analyses, instrumentation, supplies, or other expenses essential to the successful completion of the research project. Approximately $1500 will be available for the 1997–1998 scholarship award. In addition, the recipient of the scholarship may be provided with a stipend of up to $500 to present results of the research at the 1998 GSA Annual Meeting. For the academic year 1997–1998, the Coal Geology Division is also offering a field study award of $500.

Proposals for the scholarship and the field study award will be evaluated by a panel of coal geoscientists. Applicants may apply for the scholarship award, the field study award, or both; however, only one award will be made to a successful applicant.

Interested students should submit five copies of the following:

1. a covering letter indicating which award(s) is (are) sought;
2. a concise statement of objectives and methods, and a statement of how the scholarship funds will be used to enhance the project. The proposal would be no more than five (5) double-spaced pages in length, including references; (3) a letter of recommendation from the student’s immediate advisor which includes a statement of financial need and the amount and nature of other available funding for the research project.

Send the material to: Peter D. Warwick, Chairman, A. Lierman Medlin Scholarship Committee, U.S. Geological Survey, MS 956, National Center, Reston, VA 22092, (703) 648-6469, E-mail: pwarwick@usgs.gov.

The proposal and letter of recommendation must arrive no later than February 15, 1997. Applicants will be notified of the Scholarship Committee's decision by April 1, 1997.

The scholarship was established as a memorial to Antoinette “Toni” Medlin who, for many years dedicated her efforts toward the advancement of coal geoscience and to the encouragement of students in coal geology. Monies for the scholarships are derived from the annual interest income from the scholarship fund.

Some disciplines are more open-minded. Mineral physicists use both compressibility and incompressibility or bulk modulus, not worrying that the latter is theoretically suspect because it is upside down. What is really unpardonable from a purist or theoretical point of view is the seismologists’ insistence on the use of seismic velocity. Heavy-duty seismic computation involves inverse velocity, or slowness, and seismologists should henceforth quote to their geochemical friends, particularly in Paris, that the upper mantle slowness of 0.00012345 seconds per meter rules out pyrolite as an important component of the mantle, and also rules out inverse temperatures as high as 0.000666 snivlek.

We could continue this purifying of our science. Density should not be used, it has to be volume. Densities have gotten out of hand anyway, with kg/m3 replacing g/cm3 by SI fiat.

And of course, the origin of the Earth coordinate system is at r = 0 and only radius makes theoretical sense (geochemists think that the origin of Earth is at 4.5 Ga). By plotting volume and seismic slowness vs. radius, instead of the conventional density and velocity vs. depth, seismologists will have achieved a level of purity, and obscurity, only dreamed of by geochemists.

“A foolish consistency is the hobgoblin of little minds.” —Emerson
Society of Economic Geologists Research Grants Available in 1997

Young economic geologists throughout the world may apply for grants available in 1997 through the Society of Economic Geologists Foundation and the Society of Economic Geologists. Grants will be made available this year under three separate programs. Grants from the Hugh E. Mckinstry Fund are awarded to graduate students and/or young professional economic geologists with field-oriented projects. The Hickok-Radford Fund awards grants for field projects in Alaska and British Columbia, but with consideration given to worthwhile proposals dealing with high latitudes and rugged terrain. A third new category of grant is the Student Research Grant, which provides funds for research in economic geology that presents new descriptive data on ore deposits, mining districts, or general ore types.

The 1997 awards, totaling $20,000, will range from $500 to $2000 each. Grant applications may be made by requesting forms from the Chairman, SEG Grants Program, 5808 South Rapp Street, Suite 209, Littleton, CO 80120, phone (303) 797-0332, fax 303-797-0417. Information is also available through the SEG Web Site, http://www.mines.utah.edu/wmgg/seg.htm. Applications must be postmarked by March 1, 1997. Awards will be announced on or about May 1, 1997.

Not All Good Bills Go to Heaven

Peter F. Folger
1995–1996 GSA Congressional Science Fellow

The year in Congress ended with neither a bang nor a whimper, but rather a sense that the job is done, let’s get on the campaign trail. Typical of other end-of-the-year sessions, Congress passed a flurry of legislation in September that included bills important to geoscientists, such as the Omnibus Appropriations bill, but failed to move other key measures for earth scientists, like the Geologic Mapping Reauthorization Act of 1996. Why some noncontroversial bills live while other measures die goes beyond the normal last-minute political posturing; it speaks to the heart of the political process. For many of these bills, time simply ran out.

I puzzle over what happened in this session’s final days, and why some bills were “sent to heaven” (1600 Pennsylvania Avenue), while other bills of seemingly equal importance and bipartisan support jammed in the pipeline and never left Capitol Hill. Hill veterans show little sympathy when I indicate how perplexed I am about the life and death of different bills. Their view is colored, after all, by coarse statistics only, and do not indicate which measures die goes beyond the normal measures of a decidedly local focus, like a bill establishing the New Bedford Whaling National Historical Park (S. 608). Yet, for nearly two years various senators have placed “holds,” or threats of a filibuster, on bills reported out of committee so that only a trickle of legislation reached the Senate floor. As of September 18, two weeks before Congress adjourned for the year, the Senate had passed only 13 out of 156 measures referred to the committee; of those, only six were signed into law.

The Art of Compromise

For over a year, Senator Bill Bradley (D—NJ) placed a hold on all bills reported from the Senate Energy and Natural Resources Committee because the Resources Committee in the House of Representatives, chaired by Rep. Don Young (R—AK) was holding up one of Senator Bradley’s favorite bills: the Sterling Forest Protection Act (S. 223). S. 223 would outlaw development in a small forest on the border between New York and New Jersey. By delaying action on bills important to the other 19 senators on the committee, Senator Bradley was attempting to exert leverage on the Resources Committee in the House to act on his bill. Holding legislation hostage in the Senate is a time-honored technique used by majority and minority alike; although stretching that leverage to involve “the other body” is virtually unheard of. In response, members of the House Resources Committee offered to move Senator

Good Bills continued on p. 15
Bradley’s bill if he would drop opposition to the Utah Public Lands Management Act of 1995 (S. 884), a controversial bill that would place 1.8 million acres of southern Utah off-limits to development. The Utah Wilderness bill was opposed by members of the environmentalist community, who demanded that no less than 5.7 million acres be deemed wilderness. The resulting impasse stalled the Energy and Natural Resources Committee for months until the Senate failed to cut off debate on the Utah Wilderness bill in March, and the measure died.

Not to be outdone, both Democratic senators from Nevada, Harry Reid and Richard Bryan, placed holds on all Energy and Natural Resources Committee bills in an attempt to stall consideration of the Nuclear Waste Policy Act of 1996 (S. 1271), a bill establishing an interim storage facility for commercial nuclear waste on the Nevada Test Site near the proposed permanent repository at Yucca Mountain. Their delaying tactic worked until the Senate voted, 63-37, to pass S. 1271 on July 31, and sent the nuclear waste bill to the House. Now time grew short. Although Congress did not plan to adjourn until October 4, the August recess loomed, leaving precious little time to act on all the Energy Committee bills still pending. With Members chafing to leave Washington to campaign for reelection, and only the month of September left to complete a crushing legislative load that included annual spending bills necessary to keep the government running, Senators could exert even greater leverage to get what they wanted by placing “holds” on other bills. If a bill does not pass before Congress adjourns for the year, the game is over, at least until next year.

Democracy Without Voting

It is interesting to note that even though the Senate did not conduct a single roll-call vote on any Energy and Natural Resources Committee bill after July 31, dozens of committee bills ultimately passed the Senate to become law. How is that possible? Because the Senate conducts the bulk of its business by unanimous consent, which means that bills pass almost by default as long as not a single senator objects. But there is the rub. Bills that might ordinarily pass by unanimous consent on their merits alone, such as the reauthorization of the Geologic Mapping Act, are objected to so that the objector can extract a little leverage on another matter. As Congress nears adjournment, the desire to strike a deal gains considerable urgency, as every senator knows. This year was no different, as Energy Committee bills were held up during debate and passage of the Omnibus Appropriations package, the Omnibus Parks bill, and several other weighty measures that demanded compromise and considerable backroom dealmaking before they were ready for a vote on the floor. After various deals were struck, small packages of bills began to emerge and were passed by unanimous consent as the Senate wrapped up its affairs at day’s end.

Not all good bills go to heaven, and the 104th Congress was no different. Every Congress leaves town and abandons dozens of noncontroversial bills at the unanimous consent doorstep because nobody has the time or energy to make the deal releasing the various holds. Moreover, in the complex world of Congress, if one senator drops his filibuster threat, there remain 99 others ready to spring a hold for their own reasons. At some point, the Senate leadership declares victory and puts an end to last-minute dealmaking. In the late afternoon of October 3, Senate Majority Leader Trent Lott (R—MS) summed up this sentiment by stating: “Mr. President, the staff is working desperately to wrap up a couple of final items [in reality, this meant dozens of bills]. However, we feel that we need to go ahead and close [adjourn the 104th Congress] because as long as we stay here, there will be other opportunities to try to get something cleared.” With over 95% of the legislation introduced in the 104th Congress still waiting to “get cleared,” Senator Lott’s comment was a bit of an understatement. Well, there is always next year.

Peter F. Folger, 1995–1996 GSA Congressional Science Fellow, served on the staff of Senator Pete V. Domenici (NM). The one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, under Assistance Award No. 143495-G-2651. The views and conclusions contained in this report are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

GSA TODAY, December 1996 15

The Geological Society of America

Congressional Science Fellowship 1997–1998

The Geological Society of America is accepting applications for the 1997–1998 Congressional Science Fellowship. The Fellow selected will spend a year (September 1997–August 1998) in the office of an individual member of Congress or a congressional committee for the purpose of contributing scientific and technical expertise to public policy issues and gaining firsthand experience with the legislative process. The American Association for the Advancement of Science conducts an orientation program to assist the Fellow seeking a congressional staff position in which he or she can work on major legislative issues.

Criteria

The program is open to highly qualified postdoctoral earth scientists. Candidates should have exceptional competence in some area of the earth sciences, cognizance of a broad range of matters outside the Fellow’s particular area, and a strong interest in working on a range of public policy problems.

Award

The GSA Congressional Science Fellowship carries with it a $42,000 stipend, and limited health insurance, relocation, and travel allowances. The fellowship is funded by GSA and by a grant from the U.S. Geological Survey. (Employees of the USGS are ineligible to apply for this fellowship. For information about other programs, contact AAAS or the Geological Society of America.)

To Apply

Procedures for application and detailed requirements are available in the geology departments of most colleges and universities in the United States or upon request from: Executive Director, Geological Society of America, P.O. Box 9140, Boulder, CO 80301.

DEADLINE FOR RECEIPT OF ALL APPLICATION MATERIALS IS FEBRUARY 3, 1997
From The Ground Up

I am privileged to address you for the first time in my position as the new Director of Development at the GSA Foundation. As of this writing, I’ve been on the job only a short time, but the rich history and achievements of the organization are already evident. Equally evident is the commitment of GSA and its members to advancing the interests of the profession. Recent issues of GSA Today have included thoughtful commentaries about the social and economic forces affecting earth science professionals, and each day I learn more about GSA’s extensive outreach and educational activities to increase appreciation of the relevance of the earth sciences to our lives.

In the August GSA Today, Eldridge Moores quoted Will Durant:

Civilization exists by geological consent, subject to change without notice.

That observation is as cogent a justification as may exist for GSA’s program efforts. Whether improving opportunities for education and advancement within the profession or extending opportunities to the lay public and policy makers for learning and understanding what the geosciences mean to our common welfare, GSA’s programs address issues that are vital to the profession’s health and viability.

Thus, the support GSA receives from its members and its professional sector is a direct reflection of shared values and concerns. The rationale for contributions to GSA’s programs is not merely that the programs need funding but—more important—that the programs meet a fundamental need in contributing to what humans know about their home planet.

So, to all the members who have given their support in 1996, many thanks! For those of you who have not yet made a donation, the end of the year is a good time to consider how you can help. The ideas have been presented to you before, frequently, and may look familiar, but they cannot be reiterated too often.

Despite persistent tinkering with the tax code, the U.S. Congress has reaffirmed its commitment to private philanthropy, and favorable rules are still in place for charitable gift tax deductions. Therefore, although it may be getting a bit late in the year to commence planning a complex gift you can still complete a straightforward gift of cash or marketable securities before the December 31 deadline for 1996 tax planning.

The suggestions below demonstrate the potential advantages of a year-end gift, which may be unrestricted or may be directed to a particular program. Note that the examples assume a donor who itemizes deductions and has a combined federal and state tax liability of 35%.

Gifts of cash by check. A cash gift makes an immediate impact and generates an immediate and meaningful tax deduction. For example, a gift of $500 will realize a deduction of $175, making the net cost of the gift only $325.

Gifts of marketable securities. A gift of appreciated securities has two benefits. The market value of the gift as of the date transferred to GSA is deductible in the same manner as a cash gift, and there is no capital gains tax on the appreciation as there would be if the stock were sold. For example, a gift of stock having a market value of $10,000 and a basis of $5,000 will realize a deduction of $3,500 (35% of the gift value) and save capital gains tax of $1,400 (28% of the $5,000 gain) for a total savings of $4,900 and a net gift cost of $5,100.

A gift based on depreciated securities also has two benefits. A donor who has realized taxable capital gains in 1996 and who owns a stock that has declined in value since acquisition can sell the depreciated stock and donate the proceeds of sale to GSA. The loss on the sale can be applied to reduce taxable gains, and the donation of sale proceeds will generate a charitable gift deduction. For example, stock with a market value of $5,000 and a cost basis of $10,000 can be sold to realize a loss of $5,000 to be subtracted from capital gains, and the gift of $5,000 sale proceeds to GSA will result in a charitable deduction of $1,750.

Some of the tinkering with the tax code may affect the calculation of actual charitable gift tax benefits for high-income taxpayers and taxpayers subject to the alternative minimum tax. Donors in these categories should contact their financial advisors before making decisions about the amount and timing of gifts.

Still on the subject of tinkering with the tax code, a flat tax is one of several versions of tax reform being proposed to eliminate most of the 9,400 pages of the current tax law. In its purest form, a flat tax would create a single, low tax rate. It would probably provide generous personal exemptions but would eliminate all deductions—including the charitable gift deduction. A strong coalition has formed to present the concept of a modified flat tax, preserving the deductions for home mortgage interest and charitable donations. But the possibility of change is yet another reason to give generously while we know what the rules and benefits are.

Above all, please accept my best wishes for a happy holiday season.

__________

 enclosure described here
Calling All Cars!

GSA is the proud owner of a 1977 Oldsmobile Vista Cruiser which was bought used in 1987 and which now has 150,000 miles and a broken side window. (The window is relevant.) Owing to the age of the car, replacement parts are becoming difficult and extremely costly to obtain. (Estimated cost of a window: $500 to $800.) Aside from parts, the auto body and interior are beyond hope. The car makes roundtrips of about 10 miles from the GSA warehouse to the post office to the headquarters offices, so although daily use is not great, it’s important. The day is coming when replacing the vehicle will be urgent. (Applying Murphy’s Law, the urgency will arise on a sub-zero day in January a block away from the post office.) Before that day comes, we call upon your good will and used cars.

Does any member have a vehicle, either a station wagon or mini-van, that has served you up to or a bit beyond its time, that is somewhat less than 20 years old, that you would consider donating or offering for sale (cheap!) to GSA? If so, please contact the Foundation office at (303) 447-2020.

Winners! We’ve got Winners!

During the GSA annual meeting in Denver, the Foundation held the Second Century Fund drawing for donors who had pledged $250 or more. The big winner was Chris Mathewson, who won the free GeoHostel. Other Second Century Fund winners were Arthur A. Bookstrom, Jeremy M. Boak, Reese E. Mallette, Donald W. Boyd, Robert A. Larson, Richard H. Mahard, Joseph Gordon, Clarence R. Allen, and Ardith K. Hansel.

All 1996 contributors to the Foundation’s annual campaign were entered in a separate drawing for the prizes displayed at the booth in Denver. The winners were Ralph David, Patricia Seawald, Robert Hudson, Howard Day, William Brosge, and Peter K. Matthews.

Many thanks to those who have supported the Foundation this year!

Donors to the Foundation, September 1996

Cady Award
Jack A. Simon* (in memory of Robert M. Kosanek)

Dwornik Planetary Geoscience Award
John G. Annexstad
Ronald Greeley*
Klaus Kell

International Division Award
Cyprus Amax Minerals Company*

Operating Fund
Raymond T. Stotler, Jr. (in memory of Vaughn Rasson)

Research Grants
Cayce A. Lillesve
Cleavy L. McKnight

SAGE
John Can Brahana
Marcus E. Milling*

Michael J. Passow

Second Century Fund
Robert O. Beringer
Bonnie A. Blackwell*
Donald W. Boyd*
Keros Cartwright
Paul A. Catecosinos
Curetis A. Consolvo
Maria Luisa Crawford*
Cyprus Amax Minerals Company*
Claire B. and David F. Davidson* (in memory of Richard P. Sheldon)
Robert S. Fousek
Hubert Gabrielse*
Edward E. Geary
James A. Gibbs
William C. Gussow*
Richard L. Hay
John W. Hess, Jr.*
Catherine J. Hickson
Norris W. Jones

Konrad B. Krauskopf*
Phillip H. Manger
Kiguma J. Murata
James T. Neal
Noel M. Ravenberg*
Walter Schmidt
Daniel R. Shawe
Arthur E. Soregaroli*
Laureen C. Wagener
F. Michael Wahl*
Edmund G. Wermund, Jr.

Unrestricted - Foundation
Arthur T. Fernald
Eric Allan Lauha*
Herbert E. Wright, Jr.

Unrestricted - GSA
Liang Chi Hsu
Eugen Seibold*
Debra S. Stakes
Thomas W. Stern*

*Century Plus Roster—Gifts of $150 or more.

Reminder! Make sure your donations are mailed to the Foundation office before the end of December in order to have a 1996 tax deduction.

LETTER

Eldridge Moores mentioned in his September statement in GSA Today that in his view, we live in a time of “the apparent end of the ‘social contract’ between society as a whole and science.” It is my professional view that this social contract is in the process of renegotiation. Here is why.

The initial social contract between American society and science is rooted in the Morrill Act establishing the land grant research, education, and service (extension) funding system. This contract was driven by economic security considerations of those times, and it later included other scientific fields that were meeting, or asked to meet, national economic needs.

World War II broadened the contract to emphasize harnessing science to meet national concerns about military security, and because it was interpreted broadly, particularly in funding research, basic science was supported or was a byproduct of meeting national security goals. That contract continued through the Cold War, and most of our GSA colleagues functioned and made careers under this paradigm.

Ending the Cold War forced a review of national objectives in this social contract and is now leading to a revision focusing again on economic security, particularly in those areas where research will improve America’s economic competitiveness in the global economic marketplace. Thus, along with increased accountability, scientific research funding will be directed towards proposals and projects that enhance America’s economic competitiveness globally, foster economic security, provide a return on investment, and show measurable impacts. This revised contract represents a major paradigm shift and cultural change for the American scientific community and for GSA. In my professional view, geology, through its traditional leadership in the petroleum and mining industries, is ideally suited to move in the mainstream of the amended social contract emphasizing economic security.

So, what should GSA do? First, it could foster an evaluation of measurable economic impacts to which geology could contribute and lead during the next quarter century. Second, it should solicit manuscripts for its journals that address both basic science and economic impacts, and encourage authors with good basic science papers to address economic impacts via the editorial review process.

Third, GSA should publish a Geosciences Extension Series, ranging from one to four pages, of selected Bulletin or
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.

“Science ScoreBoard” Analyzes House of Representatives Voting Pattern on Science and Technology Issues

In presenting these findings we want to emphasize that our Representatives have not heard enough from their constituents in the scientific community. Scientists must realize that their Representatives need their advice and counsel when voting on issues of importance to science. Therefore, to the extent that they have failed to inform their Representatives, the scientific community itself is just as responsible for these voting records as the Representative.

— Roland Schmitt, Chairman, Science Watch

Several weeks ago, Science Watch, Inc., an independent science watchdog group, released its Science ScoreBoard, a new index, which can be important both in tracking Congress and as a possible future leading indicator for forecasting the long-term scientific health of the nation. “We can now for the first time rank, evaluate and appreciate our Representatives in Congress based on their actual voting records, not on just four or five issues, but on their votes all throughout the 104th Congress,” said Martin Apple, Science Watch’s CEO. He continued, “Currently the USA leads the world in science and this keeps us internationally competitive. The federal investment in science research has paid off handsomely. Dozens of studies have now agreed that the rate of return on such federal investment in science research may be over 40 percent per year, year after year, making science a highly valuable and pivotal federal investment. Federal support of science is vital to the national future.”

The report, touted as a “first of its kind,” found that, on the basis of a review of the voting records of the 437 individuals who were members of the House of Representatives during the 1995-1996 104th Congress, on 30 selected key science bills and amendments, 91 members voted in favor of science research more than 75% of the time. The report also revealed that 64 members voted against science research more than 70% of the time. Of those 64 members, 63 are Republicans. The one Democratic exception is Rep. Andrew Jacobs (IN) who voted against 73% of the scientific research legislation considered in the survey. Rep. Jim Ramstad (R—MN) had the lowest rating of all members, supporting science on only 4% of the index votes.

Science Watch selected the 30 votes (19 in 1995 and 11 in 1996) it saw as impacting science and technology, from the nearly 1,200 full House roll call votes of the entire 104th Congress (i.e., until the August 1996 recess). The 30 were selected as indicators because they do one or more of the following: (1) favorably or unfavorably impact the quality review of science; (2) proscribe or prohibit specific types of science research; (3) eliminate or increase science needed for improved national decision-making; (4) promote or curtail science education; or (5) directly increase or decrease investment in science.

Because many important votes affecting science are held in committee and do not involve all members of Congress, no committee votes or actions were included in the Science Watch compilation. Because Science Watch chose to include only 30 votes, certain important science legislation, such as the Oceanographic Partnership Act (see October 1996 Washington Report) were not included in the analysis. Substitution of other legislation for some of the 30 used to evaluate congressional support of science and technology would likely change the outcome of the analysis. However, on its own merit, the results of the Science ScoreBoard are extremely significant.

The report shows that Democrats in the House (average rating of 72%) supported science on these indicator votes about twice as frequently as the Republicans (average rating of 35%). Democratic members with support of science ratings of 90% or higher were: Ken Bentson (TX—97%), Sheila Jackson-Lee (TX—97%), Eddie B. Johnson (TX—97%), Ronald Coleman (TX—96%), Martin Frost (TX—96%), John Murtha (PA—96%), Tom Bevill (AL—93%), Rick Boucher (VA—93%), George Brown (CA—93%), Kiki de la Garza (TX—93%), Steny Hoyer (MD—93%), Gene Green (TX—92%), Joe Moakley (MA—92%), Alan Mollohan (WV—92%), Robert Bud Cramer (AL—90%), John Bryant (TX—90%), Norman Dicks (WA—90%), Solomon Ortiz (TX—90%) and Ray Thornton (AR—90%).

Republican members with support of science ratings of 50% or higher were: James Hayes (LA—71%), Amo Houghton (NY—67%), Sherwood Boehlert (NY—60%), Nancy Johnson (CT—60%), Tom Davis (VA—57%), Constance Morella (MD—57%), Jim Greenwood (PA—55%), Jim Bunn (OR—53%), Paul Gilmore (OH—53%), James Walsh (NY—53%), William Clinger (PA—52%), Vernon Ehlers (MI—52%), Philip English (PA—52%), C. W. Bill Young (FL—52%), Michael Bilirakis (FL—50%), Herbert Bateam (GA—50%), Ken Calvert (CA—50%), Wayne Gilchrest (MD—50%), Steve Horn (CA—50%), Peter King (NY—50%), Steven LaTourette (OH—50%), and William Thomas (CA—50%).

Letter continued from p. 17

Geology papers that have an economic impact and distribute these to the public and policy domain (especially elected officials). The Kansas Geological Survey instituted such a series nearly 18 months ago, hired a science writer to manage and distribute these professionally produced documents statewide. Statewide response and support have been overwhelmingly positive in terms of support for that agency, including from elected officials. GSA’s contribution of an Extension Series could lead to a similar impact and strengthen geology’s role in the USA.

No doubt, other opportunities exist for GSA to show its economic impact, relevance, and accomplishments that help the USA’s competitiveness in the global marketplace. Does GSA have the will to develop them?

George D. Klein
George D. Klein & Associates
Matawan, NJ, 07747-0944

Washington Report continued on p. 19
**BOOK REVIEWS**


These two volumes represent a benchmark and probable classic in the literature of the Middle Rocky Mountains. Produced jointly by authors mostly from the University of Wyoming and the Wyoming Geological Survey, this work represents a summary of where geologic research and understanding of the region stands as we approach the end of the 20th century. The dedication is to two of this century's greatest contributors to that understanding: Don Blackstone of the University of Wyoming and Dave Love of the USGS. Both began their streams of significant Wyoming publications in the 1930s, and both continue their geological activity in the region to the present day. There could have been no better choice for the dedication of such a volume.

For much too long there has been a void in literature on Wyoming geology. Innumerable articles deal with details of specific areas, commonly in guidebooks or other forms of gray literature. Where summary papers exist, the focus is largely on the approach of a subdiscipline to specific data and interpretation of the region. Overall syntheses exist but seem to be largely low-level books for a more general audience. Nowhere has there been a volume that one could turn to, knowing that it contained a good summary of whatever subdiscipline was of interest as well as a bibliography of the most pertinent data and publications on that subject. These volumes fill that void.

The 40-page editorial overview, by Snoke, with its 15-page bibliography, is a guide to the general literature as well as to more detailed summary sections that follow. This article is the finest and most readable summary of Wyoming geology at a highly professional level that I have seen to date, a “must read” item for any workers in the region who want information beyond their specialty or for any student starting a research project or field camp session. For details on individual topics, 26 articles by many authors are organized into sections on Precambrian, Paleozoic, Mesozoic, and Cenozoic history, and a final section on topical aspects such as ground water, oil and gas, coal, and radioactive materials. The 10-item map packet includes some new seismic and bathymetric data on Jackson Lake and the Teton fault by Smith et al.; eight balanced cross sections of the Wyoming thrust belt by Royse would be suitable for student exercises as well as regional understanding. A copy of the 1991 geologic highway map of the state at 1:1,000,000 scale links the driving geologist to the local bedrock.

This publication is the logical starting place for anyone, student or professional, who wants more detailed information on almost any aspect of Wyoming geology, be it the Yellowstone hotspot, the Heart Mountain detachment, stratigraphic nomenclature, tectonics, or the mysteries of the Precambrian. No field camp, no geology department nor its library, and no professional geologist or serious student of the region should be without it.

Donald U. Wise
Franklin and Marshall College
Lancaster, PA 17604-3003

**Mechanics in the Earth and Environmental Sciences. By Gerard V. Middleton and Peter R. Wilcock. Cambridge University Press, New York, 1994, $89.95 (hardback), $34.95 (paperback).**

A major trend, well underway, in earth science is the application of its techniques and results to solving the environmental problems besetting humankind. One sees examples of this in the newspapers every day. For instance, the proposed underground storage facility at Yucca Mountain, within the Nevada Test Site, must be certified capable of safely containing high-level radioactive waste for at least 10,000 years. To this end, numerous phenomena that might affect the integrity of this facility must be understood so well that they can be predicted into the geologic future with confidence.

Whatever the political fate of Yucca Mountain, it at least serves as a dramatic illustration of the need for improving our capability to analyze quantitatively the geologic and hydrologic processes that affect the topmost several kilometers of Earth's crust, because environmental problems of many types are not only encountered globally but, more alarmingly, are increasing in step with human population growth. Thus, this book by Middleton and Wilcock was written partly with a view to training workers to address these difficult problems, many of which, including Yucca Mountain, are so challenging as to force important new developments in the earth sciences.

As indicated by the title, this textbook, developed from courses taught by the authors, is intended to help students gain a working knowledge of applying the principles of mechanics (classical, continuum, and fluid) to understanding and modeling a broad variety of geologic pro-

---

**Washington Report continued from p. 18**

As House Speaker Newt Gingrich traditionally only votes to break deadlocks, he is not included in the ScoreBoard.

Surprisingly, the ratings of both Republican and Democratic members of the House of Representatives were below their party averages. Republican committee members supported science legislation only 33.5% of the time (vs. party average rating of 35%) while Democratic committee members supported science legislation 69.2% of the time (vs. party average rating of 72%). Committee chairman Robert Walker (R—PA) had a rating of 40%, while ranking minority member George E. Brown, Jr. (D—CA) had a rating of 93%.

On a state basis, representatives from West Virginia, Montana, Hawaii, Massachusetts, Alabama, Texas, Rhode Island, Maryland, North Dakota, Virginia, and Vermont were found more likely to vote in favor of science, 60%–80% of the time, while representatives from New Hampshire; Nevada, Wyoming, Kansas, Idaho, Wisconsin, Nebraska, Iowa, Arizona, Indiana, and Oklahoma were least likely (only 25%–38% of the time).

The press release accompanying the Science ScoreBoard report stated that “while 4/5 of the public supports the federal investment in science, only 1/5 of the members of the House of Representatives consistently vote to support science and technology research...” The 4/5 finding is based on a Louis Harris Organization poll conducted in February 1996 in California, Florida, and Texas. In the poll, 3,000 adults were asked “Do you agree the federal government should support basic scientific research, even if it brings no immediate benefits?” Eighty-one percent agreed, 12% percent disagreed, and 7% percent responded that they “did not know.” The poll findings are reported with a margin of error of 3.1%. The responses are similar to those reported from several other 1992–1995 state and national surveys.

Science Watch, Inc. is a group of nationally recognized science leaders concerned with helping educate the nation about the role and significance of science in the American future. Its members include: Roland Schmitt and James Duderstadt, both past chairmen of the National Science Board; Nobel laureates Ken Wilson, F. Sherwood Rowland, Herbert Simon, Gertrude Elion, and Leon Lederman; D. Allen Bromley, past science advisor to President Bush; Maxine Singer, president of the Carnegie Institution; Eric Bloch, past director of the National Science Foundation; and Martin Apple, the executive officer of the Council of Scientific Society Presidents.
To the members of the GSA Mile High Chorale

Gregg M. Busch, Conductor

Thank you for the truly wonderful experience of conducting you at St. John’s Cathedral. Although I was a little nervous after the first rehearsal, I was amazed at the high level of excellence you achieved in a very short time. You should all be very proud of the work you did to make the final performance a success. Each of you is a tribute to the choirs and chorales that you work with regularly.

Thanks also to those of you who attended the concert, for supporting your fellow geologists. Everyone should make sure to get a cassette tape of the performance. I have heard it myself and you will be absolutely delighted.

Finally, I urge all of you to continue this tradition at the next conference. You truly are a remarkable group, and yes, we DID make music!

ORDER FORM
GSA Mile High Chorale—October 29, 1996
Cassette Tape and Photo

Preserve the memory of this delightful performance with a full-length cassette tape and a color photo. Complete this order form, and mail it with your check to:

Geological Society of America, Attn: Angelique Espinoza
3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301

I have enclosed a check for $ ________ made out to GSA.

Please send:

☐ cassette tapes ($10 each) X _____ $________
☐ 5”x7” photos ($7.95 each) X _____ $________
☐ 8”x10” photos ($12.95 each) X _____ $________

TOTAL: $________
to describing the often complex subject matter, clear and effective figures, and instructive problems in each chapter, along with well-explained solutions. The many important numbers that crop up continuously in the earth sciences (e.g., the Rayleigh number) are explained and motivated quite effectively. Moreover, Middleton and Wilcock have demonstrated excellent scholarship by providing a lengthy and useful list of references for the reader seeking more details.

Art McGarr
U. S. Geological Survey
Menlo Park, CA 94025

**Book Reviews continued from p. 20**

Fractals in the Earth Sciences.

Fractals became a popular element of the geological jargon about a decade ago. Since that time, studies making use of the concept of fractals have proliferated, albeit without the visibility of earlier days. The lower profile of recent fractals research in earth sciences stems not from a failure of the concept nor from a lack of interesting progress, but rather, I think, from the more systematic, more applied, and more topically specific character of ongoing work (e.g., see the early 1996 special issue of *Journal of Structural Geology* on fault populations).

*Fractals in the Earth Sciences* provides a good sampling of some directions taken by researchers using fractals as a tool. The book contains 13 papers that cover a range of topics, although about half of the papers focus primarily on different aspects of fractures, faults, and/or earthquakes. The first two papers are intended to provide an overview of the techniques used to analyze geologic data and of the variety of geologic phenomena that have been addressed. The following two papers concern the systematics of a few of the most commonly used techniques for quantifying the scaling of geologic phenomena. These are particularly welcomed contributions because so few studies have adequately scrutinized the methodologies; however, the techniques covered represent only a subset of those used even in this book. For the most part, the rest of the papers present topical studies of fracture surfaces, seafloor topography, fracture network geometry, fault breccia, fault lengths and displacements, earthquake dynamics, igneous rock textures, and gold-silver mineralization. An additional paper (the most interesting of the book, I think) defies the simple classification above, and addresses the transitions of geologic phenomena that follow different scaling patterns at different scale ranges.

Barton and La Pointe have provided a volume that will interest many geoscientists with no experience in using fractals, although a couple of the papers probably are inaccessible to novices. The variety of topics offered, while not comprehensive, should at least attract a wide range of readers. Many of the topical papers are largely reviews and may well be the best places to start for those with new interests in the fractal aspects of the specific topics. In addition, discussions of the techniques

---

**CALL FOR NOMINATIONS REMINDERS**

**Penrose and Day Medals, and Honorary Fellowship**

Nominations for 1997 Penrose and Day Medals and for Honorary Fellowship in the Society are due by **February 3, 1997**.

**Young Scientist Award (Donath Medal)**

The Young Scientist Award was established in 1988 to be awarded to a young scientist (35 or younger during the year in which the award is to be presented) for outstanding achievement in contributing to geologic knowledge through original research that marks a major advance in the earth sciences. The award, consisting of a gold medal called the Donath Medal and a cash prize of $15,000, was endowed by Dr. and Mrs. Fred A. Donath.

For the year 1997, only those candidates born on or after January 1, 1962, are eligible for consideration. In choosing candidates for the Young Scientist Award, scientific achievement and age will be the sole criteria. Nominations for the 1997 award must include:
- biographical information,
- a summary of the candidate’s scientific contributions to geology (200 words or less),
- a selected bibliography (no more than 10 titles),
- supporting letters from five scientists in addition to the person making the nomination.

Deadline for nominations for 1997 is **February 3, 1997**.

**Officers and Councilors**

The GSA Committee on Nominations requests your help in compiling a list of GSA members qualified for service as officers and councilors of the Society. The committee requests that each nomination be accompanied by basic data and a description of the qualifications of the individual for the position recommended (vice-president, treasurer, councilor).

Deadline for nominations for 1998 is **February 18, 1997**.

**Distinguished Service Award**

The GSA Distinguished Service Award was established by Council in 1988 to recognize individuals for their exceptional service to the Society. GSA Members, Fellows, Associates, or, in exceptional circumstances, GSA employees may be nominated for consideration. Any GSA member or employee may make a nomination for the award. Awardees will be selected by the Executive Committee, and all selections must be ratified by the Council. Awards may be made annually, or less frequently, at the discretion of Council. This award will be presented during the annual meeting of the Society. Deadline for nominations for 1997 is **March 3, 1997**.

**John C. Frye Environmental Geology Award**

In cooperation with the Association of American State Geologists (AASG), GSA makes an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. The award is a $1000 cash prize from the endowment income of the GSA Foundation’s John C. Frye Memorial Fund. The 1997 award will be presented at the autumn AASG meeting to be held during the GSA Annual Meeting in Salt Lake City.

Nominations can be made by anyone, based on the following criteria: (1) paper must be selected from GSA or state geological survey publications, (2) paper must be selected from those published during the preceding three full calendar years, (3) nomination must include a paragraph stating the pertinence of the paper.

Nominated papers must establish an environmental problem or need, provide substantive information on the basic geology or geologic process pertinent to the problem, relate the geology to the problem or need, suggest solutions or provide appropriate land-use recommendations based on the geology, present the information in a manner that is understandable and directly usable by geologists, and address the environmental need or resolve the problem. It is preferred that the paper be directly applicable by informed laypersons (e.g., planners, engineers). Deadline for nominations for 1997 is **March 31, 1997**.

**National Awards**

The deadline is **April 30, 1997**, for submitting nominations for these four awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, Alan T. Waterman Award.
used in the papers are much more useful than the often perfunctory statements that remain in journal articles after editing.

The book probably will not be of great interest to researchers already working with fractals, except perhaps to get a broader picture of the uses of fractals in geosciences. Most of the material presented in the book has been published previously. In fact, in the rapidly evolving world of fractals, many of the articles are already dated. By my count less than 10% of the references were published during the 1990s. Nevertheless, I expect that this will be a book that I use.

Randall Marrett
University of Texas
Austin, TX 78712

**Book Reviews continued from p. 21**


The subtitle for the German edition of Hsü’s book is “A Textbook for Beginners and a Discourse with Experts,” and the publishers would have done well to keep this subtitle with the English edition, as it neatly summarizes the widely disparate levels of the text. The book is a mixture of geological detective work, historical anecdote, personal reminiscence, and detailed discussion of obscure stratigraphic arguments. It would be much simpler for geology students to follow had Hsü started the book with the overview Chapter 12, Geological Evolution of Switzerland, and then gone into detail about historical ideas on particular outcrops, rather than the other way around. At least then the interested nonexpert would have a framework on which to hang all the minutiae of historical argument.

Throughout the first half of the book, Hsü uses the concept of tectonic facies as his basis for discussion of the classic subdivisions of the Alps, working from foreland to hinterland. Unfortunately, there is no clear exposition of the concept even in the chapter devoted to the tectonic facies concept, wherein historical anecdotes and autobiographical notes leave the reader no nearer to an understanding. One is left to surmise, without much confidence, that a tectonic facies must be a recognizable group of rocks that formed in a particular tectonic environment and that can be correlated from place to place.

The early chapters on the Jura Mountains, Swiss Midlands, and Swiss Alps are fluid and clear, but in the chapters on Helvetic unconformities, flysch versus wildflysch, and Pre-Alps, the book descends into the sticky mixture of place names, tectonic event names, formation names, and geologic time zones that have bogged down non-Alpine geologists for decades. The non-Swiss purchaser of this book should be aware that it is absolutely essential to have access to both the geology and tectonic maps of Switzerland; otherwise, much of the time he or she will have no idea where in Switzerland the particular feature under discussion is to be found. Even with the aid of the geologic maps, it is not always easy to follow the arguments presented. For example, on page 55, we find: “The so-called Einsiedeln Flysch, Blattengrat Flysch, and Ragaz Flysch are not flysch formations, but schuppen zones. The Globigerina Marl, Nummulitic Limestone, and Amden Marl of these zones are not flysch, but the Blattengrat Sandstone, or the turbidite sandstone and shale interleaves above the Globigerina Marl, in the Blattengrat and Einsiedeln schuppen zones are South Helvetic Flysch.” No reference is made to the publishers would have done well to...


T he main contention of this book is that the impact (or “Alvarez”) theory of the Cretaceous-Tertiary mass extinction is (and always was) empirically bankrupt and that it has been maintained in the popular and scientific consciousness mostly by media bias and hype. Officer is one of the leading antagonists of the Alvarez theory, and such a book might have promised a genuine insider’s look at the debate. This expectation is, in part, fulfilled. There is a brief but useful summary of the principal arguments against the impact scenario and in favor of the volcanic alternative, together with an incomplete but useful bibliography. This book is disappointing, however, chiefly because it adopts much of the tone and approach it criticizes.

The history of the impact theory is indeed one filled with acrimony and what Officer and Page call “media science.” Its senior architect, physicist Luis Alvarez, did in fact dismiss most previous paleontological investigation, mostly on the grounds that physics is better and more rigorous science than paleontology. The media did make much of the evidence for the impact theory, and less about evidence to the contrary. A bandwagon effect was clearly operating, and some poor science was clearly done and published.

But to read Officer and Page, one would think that there never was any significant reason to take the impact theory seriously; that paleontologists already knew the answer to the K-T event in 1980, and that there was in fact no problem to solve; that the anti-impactors brought no biases or preconceived notions to their work, and that an Earth-based volcanic scenario is the only one possible; and that only a tiny minority of “legitimate scientists” today support the impact hypothesis. It just isn’t that simple. The truth is that in 1980 there was no consensus on either the structure of the extinction or its...
causes. Climate and/or sea-level change was perhaps the most widely accepted, but the details were not clear. Volcanism and extraterrestrial impact had been seriously suggested; Walter Alvarez actually started the K-T debate that would lead to the discovery of Chicxulub. The Alvarez hypothesis since the mid-1980s, the idea has hardly "collapsed." Some paleontologists maintain that no impact occurred. By my judgment, however, most accept that one did and are wrestling with its possible effects; many believe it had little effect, but many maintain the opposite.

Perhaps most troubling is Officer and Page's insistence that the impact theory has violated the rules of science. They suggest that if a research program spends time "accommodating known facts" instead of generating "dramatic, unexpected, stunning new predictions," then it is "degenerative" instead of "progressive." This ignores the perfectly valid activity that follows announcement of all new theories: modification in light of additional information. New theories that link and coordinate preexisting observations are also legitimate.

We need to understand what happened at the end of the Cretaceous, and we do not yet. Few problems in historical geology have generated so much complexity and contradictory evidence. It is a difficult problem. Voices of peer-review, caution, and even opposition are essential in science, especially in the early stages of development of a theory. We will continue to need authoritative yet balanced presentations of non-impact explanations as the search for the answer continues. The tone of this book does not contribute constructively to this search.
The Global Environment begins with a review of the major reservoirs and fluxes of water on Earth, and a brief description of the circulation patterns in the atmosphere and ocean. The treatment of circulation patterns and their driving forces is brief; a more satisfactory version will be found in most introductory oceanography texts. The second chapter, on air chemistry, provides an overview of the major constituents of the atmosphere and some discussion of the greenhouse effect, the ozone hole, and the problem of tropospheric ozone pollution. Again, this section is limited, and other books treat the subject more thoroughly at an undergraduate level. However, circulation patterns and atmospheric chemistry are not what this book is fundamentally about. Beginning in chapter 3, the book hits its stride, focusing on the major geochemical cycles. Chapters on precipitation, weathering, and rivers lay out the basic controls on the chemistry of these fluxes in a clear and useful fashion. In chapter 3, atmospheric deposition of anthropogenic constituents of the atmosphere is discussed in some detail using data from North America. As in all the chapters, relevant data are summarized in tables and figures that make for a clear exposition of the topic at hand. This visual representation of data makes it readily accessible to students but also a very handy summary for researchers, who might, for example, want a quick check on geographic trends in chloride content of rainwater. Chapter 4 summarizes much research into weathering focusing on macroscopic processes. The book does not develop the concepts of chemical equilibrium and kinetics in any formal way—the only weathering and precipitation equations it contains are balanced chemical reactions. Instead, the authors choose to describe the relevant chemistry in terms of the dominant processes, which may help students see the forest, rather than getting lost in reaction space. The Berners provide a significant service to the geological community by summarizing much of the available data on fluxes of river-borne material to the sea.

The final chapters on lakes, marginal marine environments, and the oceans focus on internal processes in those reservoirs, some of which are the sinks for the river- and atmosphere-borne inputs from land. The concepts of residence time and box models are introduced in the chapter on lakes, providing the only “math” found in the book. The chapter on marginal marine environments treats an area that is too often ignored in most reviews of marine chemistry, yet processes occurring there are essential for understanding the fate of river fluxes to the oceans. The review of chemical budgets for each of the major species dissolved in seawater is very useful. Estimates are made for the magnitudes of each of the significant removal processes for the major ions, information that is otherwise scattered about the geologic and oceanographic literature.

Students in a senior undergraduate class in biogeochemistry here at Cornell have responded positively to the book, as have members of a freshman seminar on environmental chemistry. The writing style is clear, and the illustrations are useful. However, as a textbook for an upper level undergraduate class, the book lacks some of the fundamental chemistry that is needed to quantify relevant chemical processes. These concepts can be provided in lecture, leaving the book to summarize a global data set and focus on the bigger picture. The Global Environment will also appeal to a wide professional audience, because it is a very useful summary of global geochemical cycles by workers who have made numerous significant contributions to this field. Many will find that the compact and clear compendium of data and key concepts will make this book an indispensable addition to their personal library. In short, I can recommend this book both as an undergraduate text and as a reference for graduate students and professionals who have some interest in geochemical cycling.

Louis A. Derry
Cornell University
Ithaca, NY 14853

Published only months before the startling announcement by NASA of the discovery of possible evidence of ancient life on Mars, Water on Mars could not be timelier. Whether or not one accepts the hotly debated assertion that organic compounds, iron mineral associations and microstructures in meteorite ALH84001 are biological in origin, interest in the possibility of past or even present life on Mars has been overwhelmingly rekindled. As a requirement for life as we know it, knowledge of the distribution and history of water on Mars is crucial to developing an effective strategy for searching for life on the Red Planet.

Water on Mars summarizes our current knowledge of the subject, both theoretical and observational. No one is better qualified than Michael Carr to tell the story—as leader of the Viking Orbiter Imaging Team, Carr played a central role in acquiring many of the essential spacecraft observations that document the current and previous effects of water on the martian surface, and his Surface of Mars (Yale University Press, 1981) remains the most accessible reference on the Viking mission imaging results. Water on Mars is written at a more technical level but is aimed at both planetary scientists and interested geoscientists, assuming only a familiarity with basic geology and geomorphology. After a brief overview of martian geology for background and context, the text describes the present water cycle and the stability of H2O under current climatic conditions as well as the evidence for and mechanisms of climate change, the initial water inventory and the evolution of the abundance and distribution of water throughout the planet’s history. Perhaps the most valuable contribution of the text is a critical review of the literature interpreting diverse surface features as evidence for water on Mars: separate chapters discuss outflow channels, valley networks, and high-latitude debris aprons and other morphologic indicators of the movement or removal of ground ice. This section includes a lively discussion of Carr’s sometimes unorthodox views on these subjects, and is well illustrated by a careful selection of pictures chosen from nearly 50,000 Viking Orbiter images to highlight fluvial, lacustrine, ground-water, and glacial or periglacial processes. A minor criticism is that the images are oriented randomly, requiring the reader to rotate and tilt the page until craters appear as depressions. In light of recent developments, most readers (like me) will probably jump to Chapter 8, “Implications for Life” and Chapter 9, “Future Mars Exploration” to look for answers to the question of where to go from here. The story is as yet incomplete, but Carr’s excellent summary of what is known about water on Mars and frank exposition of the gaps in our current knowledge will provide thought-provoking reading for those engaged in planning the next Mars missions and a useful addition to the libraries of students of planetary geology and exobiology.

Paul Geissler
University of Arizona
Tucson, AZ 85721


There is a great need for brave individuals to synthesize the flood of literature in any field of science, and fluvial sedimentology is no exception. Andrew Miall must be given due credit for undertaking this daunting task. Miall’s approach is as expected from someone who has been most closely involved with description and interpretation of fluvial sedimentary rocks, rather than with studying modern sedimentary processes. The central theme in this book is that fluvial deposits with distinctive characteristics (e.g., geometry, etc.) have members of a freshman seminar on planetary geology and exobiology.
Geologists from Bryn Mawr College, the Delaware Geological Survey, LaSalle University, Montgomery County Community College, Pennsylvania State University (Ogontz Campus), Temple University, the University of Delaware, Villanova University, West Chester University, Emrich & Associates, ERM Group, and the Pennsylvania Department of Environmental Protection will host the Northeastern Section of the Geological Society of America Annual Meeting at the Sheraton Valley Forge Hotel East and West in King of Prussia, Pennsylvania, located about 18 miles west-northwest of center city Philadelphia. The Eastern Section of SEPM, Northeastern Section of the Paleontological Society, Eastern and New England Sections of the National Association of Geoscience Teachers, and the Association for Women Geoscientists will meet with GSA's Northeastern Section. The meeting will be conducted from 8:00 a.m. Monday, March 17 to noon Wednesday, March 19. Short courses and K–12 workshops will be held on Sunday, March 16.

REGISTRATION

Preregistration discounts are given to members of GSA and the associated societies listed on the preregistration form. Please indicate your affiliation(s) to register using the member rates. Students and K–12 teachers must show a CURRENT ID card number given. Errors will delay your registration. Charge cards are accepted as indicated on the preregistration form. If using a charge card, please recheck the card number given. Errors will delay your registration. The confirmation sent to you...
Northeastern continued from p. 25

by GSA will be your only receipt. You should receive it within two weeks after your registration is submitted.

Badges are needed for access to all activities, 8 a.m. Sunday through noon Wednesday.

Guest registration is required for those attending guest activities, technical sessions, or the exhibit hall. Guest registrants MUST be accompanied by a registered professional, a student, or a K–12 teacher. A guest is defined as a nongeologist spouse or friend of a professional, student, or K–12 teacher registrant.

All registrations received after February 14 will be considered on-site registrations and charged accordingly. Absolutely no preregistrations should be mailed or faxed after February 21. All forms received after February 21, regardless of when postmarked, will be held for on-site processing. Delegates who will attend only a short course or workshop must pay at least the one-day registration fee. Badges must be worn for all activities. Registration fees do not include provisions for insurance of participants against personal accidents, sickness, theft, or property damage. Participants and accompanying guests are advised to take out whatever insurance they consider necessary.

CANCELLATIONS, CHANGES, AND REFUNDS

All requests for additions, changes, and cancellations must be made in writing and received by February 21, 1997. NO REFUNDS OR CREDITS WILL BE MADE ON CANCELLATION NOTICES RECEIVED AFTER THIS DATE. Refunds will be mailed from GSA after the meeting. Refunds for fees paid by credit card will be credited according to the card number on the preregistration form. There will be NO refunds for on-site registration, Abstracts with Programs, and ticket sales.

On-Site Registration Schedule
Sheraton Valley Forge East Hotel
Sun., March 16, 3:00 p.m. to 8:00 p.m.
Mon., March 17, 7:00 a.m. to 4:30 p.m.
Tues., March 18, 7:00 a.m. to 4:30 p.m.
Wed., March 19, 7:00 a.m. to 11:00 a.m.

ACCESSIBILITY FOR REGISTRANTS WITH SPECIAL NEEDS

The GSA Northeastern Section is committed to making this meeting accessible to all people interested in attending. If you need any auxiliary aids or services (such as an interpreter or wheelchair accessibility) because of a disability, check the appropriate box on the registration form. If you have suggestions or need further information, contact W. A. Crawford, annual meeting general chair, at the Bryn Mawr College Department of Geology, wcrawfor@brynmawr.edu. Please let us know of your needs by February 14, 1997.

WEATHER

Daytime temperatures during mid-March range from the 30s to the 60s (°F); any combination of rain, snow, sleet, and sunshine is possible.

LOCATION

Meeting registration, technical sessions, poster sessions, and exhibits will be in the Sheraton Valley Forge Hotel East, a 14-story cylindrical tower located on First Street in King of Prussia, Pennsylvania. Most Northeastern Section attendees will be lodged in the East Hotel, and some in the West Hotel.

Those arriving from any direction on the Pennsylvania Turnpike should use the Valley Forge Exit (Interchange 24) and proceed south on I-76E (Schuylkill Expressway) to US-202S (Interchange 26B) then to US-422W. Those arriving from I-76W or I-476N should proceed to US-202S then to US-422W (Pottstown, Valley Forge National Park).

Those arriving from US-202N should exit at US-422W (Pottstown, Valley Forge National Park). From US-422W, proceed 0.2 mile east on PA-23, Valley Forge Road. Turn right on Moore Road and proceed 0.6 mile to First Avenue. Turn right onto First Avenue. The hotel, 0.2 mile away, is on the right. Those arriving on US-422E should use the exit to First Avenue marked King of Prussia Industrial Park; the hotel, 0.2 mile away, is on the left.

Transportation is available from the Philadelphia International Airport to and from the Sheraton Valley Forge East Hotel; the current rate is $17. Taxi fare between the hotel and the AMTRAK 30th Street station in Philadelphia is about $40 for the 25-mile ride.

TECHNICAL PROGRAM

The technical program (oral and poster sessions) will begin Monday, March 17, and end at noon on Wednesday, March 19. Oral sessions will normally include 15 minutes for presentation and 5 minutes for questions and discussion. Two 35-mm carousel projectors, two screens, and one overhead projector will be provided for each oral session. Speakers are encouraged to bring their slides already loaded into carousel trays. A speaker-ready room (see program for room name) will be available for previewing slides. Additional carousel trays may be signed out from the speaker-ready room.

Poster sessions will allow at least three hours of display time; the authors must be present for two hours. Two 4-ft × 8-ft tackboards will be provided for each V-shaped booth. Access to electrical outlets and furniture for poster sessions must be requested well in advance.

General questions on format of sessions should be addressed to Technical Program Co-Chair Richard N. Benson, Delaware Geological Survey, University of Delaware, Newark DE 19716, (302) 831-8259, fax 302-831-3579, mbenson@udel.edu. For general questions on equipment, contact Technical Services Chair Maria Luisa Crawford, Dept. of Geology, Bryn Mawr College, Bryn Mawr, PA 19010, (610) 526-5111, fax 610-526-5086, mcrawfor@brynmawr.edu.

In addition to general technical sessions organized by discipline, the following symposia, theme sessions, and special poster sessions are planned.

Symposia

1. Finding the Adirondacks' Place in the Grenville. James Alcock, College of Earth and Mineral Sciences, Penn State University, Ogontz Campus, 1600 Woodward Road, Abington, PA 19001,
STUDENT AWARDS AND TRAVEL ASSISTANCE

Awards will be given for the best oral paper and best poster session presented by students. Although the faculty mentor may appear as the junior author, a major part of the paper or poster session must represent work by the single student author. NOTE: Only those papers designated as student author on the abstract form will be considered for this award.

The GSA Northeastern Section will award travel grants to students who give papers (oral or poster) of which he or she is the presenter and author or coauthor at the meeting. In addition, the Northeastern Section will award student research grants to undergraduate students in 1997. Applications for travel assistance and guidelines for student research grants may be obtained from Kenneth N. Weaver, Secretary-Treasurer, Northeastern Section, GSA, c/o Maryland Geological Survey, 2300 St. Paul Street, Baltimore, MD 21821-5210, (410) 554-5532, fax 410 554-5502.

K–12 TEACHER WORKSHOPS


   This workshop will explore the implications of the new National Science Education Standards for the teaching of earth science. Participants will work with colleagues from similar grade levels to explore the following areas: teaching approaches that foster inquiry and community; earth science content for elementary, middle, or high school; and assessment of inquiry-based science. The workshop will include several short demonstration lessons. Free or low-cost take-home material and software will be available.


   Cost: $20; includes morning and afternoon refreshments and lunch. Limit: 30. Preregistration required. Sunday, March 16, Park Science Center, Bryn Mawr College. Bryn Mawr College is within one-half hour driving time from the Sheraton Valley Forge Hotel. Some free transportation may be available upon advance request.

   This hands-on course addresses the needs of educators who wish to use the latest technology in their courses, but are limited by tight budgets or by lack of technical know-how. Both Macintosh and IBM PC-compatible computers will be used. This workshop is aimed at advanced high

Northeastern continued on p. 30
**REGISTRATION FEES**

<table>
<thead>
<tr>
<th>Full Meeting</th>
<th>One Day</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Professional Member</td>
<td>(01) $65</td>
<td>(02) $40</td>
</tr>
<tr>
<td>Professional Nonmember</td>
<td>(03) $80</td>
<td>(04) $45</td>
</tr>
<tr>
<td>Student Member</td>
<td>(05) $25</td>
<td>(06) $20</td>
</tr>
<tr>
<td>Student Nonmember</td>
<td>(07) $35</td>
<td>(08) $30</td>
</tr>
<tr>
<td>K–12 Professional</td>
<td>(42) $30</td>
<td>(43) $15</td>
</tr>
<tr>
<td>Guest or Spouse</td>
<td>(09) $15</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**SPECIAL EVENTS**

Lily Langtree Dinner Theatre ....................... March 18 (20) $28.50 $________

**TICKETED GROUP FUNCTIONS**

1. Paleontological Society Luncheon (60) .............. March 17 $20 $________
2. NAGT Luncheon (61) ................................... March 17 $20 $________
3. GSA Northeastern Section Annual Banquet ........ March 17 $________
   - Professional $30
   - Student $15
   - Prime Rib (62)
   - Chicken (63)
   - Vegetarian (64)
4. AWG Breakfast ....................................... March 18 $________
   - Professional (68) $15
   - Student (69) $10 _______

**CONTINUING EDUCATION**

1. Aminostratigraphy (150) ............................. March 16 $20 $________
2. Geoscience Courseware Workshop (151) PC (152) MAC .... March 16 $20 $________
3. NAGT Workshop, Teaching Geoscience (153) ...... March 16 FREE FREE

**K–12 PROGRAMS**

1. Standards-based Earth Science Teaching (302).... March 16 FREE FREE
2. Facets of Regional Geology (303) .................... March 16 $50 $________

**TOTAL FEES** $________
school to introductory level university faculty. Subjects: Hardware—how to set up an instructional facility on a shoestring budget; off-the-shelf software—effective use of commercial graphics, spreadsheets, hypertext, and the instrument control programs in traditional lab courses; custom courseware—where to find it and how to incorporate it; do-it-yourself courseware—how to create it even if you do not know the difference between three bytes and a trilobite.

Facilities will include 10 MACs and four PCs. When registering, please indicate your preference of Windows or MAC operating systems.

3. NAGT Workshop on Innovative and Effective Techniques for Teaching Geoscience. Sponsored by the National Association of Geoscience Teachers and funded partially by the National Science Foundation. R. Heather Macdonald, Dept. of Geology, College of William and Mary, Williamsburg, VA 23185; (757) 221-2443; rmad@facstaff.wm.edu; Jeffrey Niemitz, Dickinson College; and Barbara Tewksbury, Hamilton College.

Cost: Free. Limit: 35. Preregistration required. Sunday, March 16, 8 a.m.–5 p.m., Sheraton Valley Forge Hotel. Lunch will be provided.

This workshop is designed to give participants specific strategies for more effective teaching, emphasizing innovative techniques for more actively engaging students in classroom, lab, and field. It is intended for faculty and graduate students who are interested in teaching careers.

EXHIBITS

Companies or organizations wishing to display or sell publications, scientific equipment, or other products, services, or public relations materials may rent a display area for the duration of the meeting. The exhibits will be between the poster sessions and the main corridor. The 8’ × 8’ booths framed with 8-foot-high rear and 3-foot-high side drapes are available at $350 for commercial exhibitors, $250 for publishers, $200 for educational, governmental, and nonprofit organizations or institutions. A table, two chairs, and a company sign will be provided for each booth. A limited number of unsecured table-top exhibit spaces at reduced rates will be available in the corridor adjoining the registration area. The exhibits will be open from 8:00 a.m. to 6:00 p.m. on Monday and Tuesday, March 17 and 18, and from 8:00 a.m. to noon on Wednesday March 19. Application deadline for exhibit space is February 24, 1996. For information and an exhibitors brochure, contact Gil Wiswall, Dept. of Geology and Astronomy, West Chester University; West Chester, PA 19383, (610) 436-2570, fax 610-436-3036, gwiswall@wcupa.edu. Space will be allocated on a first-come, first-served basis.

SPECIAL AND GUEST ACTIVITIES

The Sheraton Valley Forge Hotel is convenient to attractions in Philadelphia and its suburbs, including numerous museums (the Philadelphia Museum of Art, the Academy of Natural Sciences, the Franklin Institute), gardens and historic estates (Longwood Gardens, Winterthur), cultural events, and of course, the historic sites around Independence Mall and Valley Forge. Brochures and knowledgeable staff will be available to assist meeting participants and guests with their plans.

Another special activity is an evening of dinner theater in the elegant Lily Langtry Theater, in the Sheraton Valley Forge East Hotel. Tickets at a special discount rate of $28.50 are available for the performance on Tuesday evening, March 18. Dinner begins at 6:00 p.m., followed by the live musical revue, “Hollywood Boulevard,” a high-energy tribute to motion pictures. Advance registration is required to obtain the discount rate.

ACCOMMODATIONS

A large block of rooms has been reserved for meeting participants at the Sheraton Valley Forge Convention Complex, which consists of the Sheraton Valley Forge Hotel East and the Sheraton Valley Forge Hotel West; the hotels are connected by an indoor passageway. The Sheraton has provided reasonable room rates. The rooms in the smaller West hotel have more amenities than those in the larger East hotel, hence the higher rate. The number of upscale rooms available is limited. Parking in the 2000-car lot around the hotel complex is free. For conference planning purposes and to ensure the guaranteed room rates, it is imperative that you reserve your room(s) before February 15, 1997. If you make telephone reservations, it is important that you state you are attending the Northeastern Section GSA meeting. Mail the housing form directly to the hotel.

SPECIAL EVENTS

GSA Northeastern Section Management Board Meeting. Sunday, March 16, 4:30 to 6:30 p.m. in the Straphord Room, Sheraton Valley Forge Hotel East.

Welcoming Reception. Sunday, March 16, 6:30 to 10:00 p.m. Sheraton Valley Forge Hotel East, Grand Ballroom North and South. Liquid refreshments and hors d’oeuvres will be served. A cash bar will be available for mixed drinks.

Northeast Section of the Paleontological Society Luncheon. Monday, March 17, 12 noon to 1:30 p.m., Sheraton Valley Forge Hotel East; see program for room. Cost: $20; preregistration required.

Eastern Section of NAGT Luncheon and Business Meeting. Monday, March 17, 12 noon to 1:30 p.m., Sheraton Valley Forge Hotel East; see program for room. Cost: $20; preregistration required.

Annual GSA Northeastern Section Reception and Banquet. Monday, March 17, 6:30 to 9:00 p.m., Sheraton Valley Forge Hotel East, Grand Ballroom, North and South. Cost: $30 for professionals; $15 for students; preregistration required. A cash bar will be available. The banquet will conclude with a short business session.

Association for Women Geoscientists Breakfast. Tuesday, March 18, 6:45 to 8:30 a.m., Sheraton Valley Forge Hotel East; see program for room. Cost: $15 for professionals; $10 for students; preregistration required.

Dinner—Live Musical Revue. Tuesday, March 18, 6:00 p.m. to ?, Sheraton Valley Forge Hotel East, Lily Langtry Theater. See the Special and Guest Activities Section for a description. Cost: $28.50; preregistration required to obtain the discount rate.

SEPM Eastern Section Business Meeting and Reception. Tuesday, March 18, 4:30 to 6:30 p.m., Grand Ballroom North, Sheraton East. President-Elect Richard F. Moiola, Mobil Oil, Dallas, Texas, will...
LOCATION
El Paso, Texas, in the corner of Texas, New Mexico, and Mexico, is easily reached along U.S. interstates 10 and 25 and has inexpensive air connections via America West, American, Continental, Frontier, Southwest, and Aeromexico.

The name El Paso is a shortened version of El Paso del Río del Norte, the name given to the river valley by conquistador Don Juan de Oñate more than four centuries ago. Through this pass, today marked as a historic monument, Spanish explorers found their way into what is now the United States, claiming it for the Spanish Crown. Visitors enjoy this city—its historic mission trail, beautiful mountain vistas and desert sunsets, Mexican cuisine, and colorful history. It offers the lure of the Old West and three distinct cultures in two nations.

SYMPOSIA
2. Precambrian Geology of the Western United States. Karl Karlstrom, University of New Mexico; Calvin Barnes, Texas Tech University; Kate Miller, UTEP.
3. Mesozoic Redbeds of Mexico. Claudio Bartolini, UTEP; Jaime Rueda Gaxiola, Universidad Nacional Autónoma de México; Mario Aranda, PEMEX; Wolfgang Stinnesback, Universidad Autónoma de Nuevo Leon.
5. Environmental Geology and Hydrogeology of Intermontane Basins. Greg Ohlmacher and John Walton, UTEP; Mike Whitworth, New Mexico Tech.

Mixed-gender rooms.

If you have special dietary needs, contact LeeAnn Srogi, Dept. of Geology and Astronomy, West Chester University, West Chester, PA 19383, (610) 436-2721, esrogi@wcupa.edu.
**South-Central–Rocky Mountain**

continued from p. 31

Tim Lawton, Kate Giles, and Nancy McMillan, NMSU.

7. Recent Advances in the Economic Geology of Mexico and Adjacent Areas. Ken Clark, UTEP.

8. Using Multimedia in the Classroom. Vicki Harder, UTEP.


11. Undergraduate Student Research. Betsy Julian, UTEP; Diane Smith, Trinity University. (Sponsored by the Geology Division of the Council on Undergraduate Research.)

12. Nuclear Waste Disposal in the Southwest. Norbert Rempe, WIPP Westinging, David LaMone, UTEP.

13. Cenozoic Palaeontoloy of the American West. Art Harris, UTEP; David LaMone, UTEP.

**FIELD TRIPS**

All trips will be after the meeting. Trip fees include all transportation during the trip and a guidebook. Other included items are noted by B—breakfast, L—lunch, D—dinner, ON—overnight lodging. Please contact the trip leaders for additional information.

1. Lower Mississippian Waulsortian Mounds, Sacramento Mountains, New Mexico. Friday, March 21, through Sunday, March 23. Kent Kirkby, Dept. of Geology and Geophysics, University of Minnesota, 310 Pillsbury Dr. SE, Minneapolis, MN 55455-0219, (612) 624-1392, fax 612-625-3819, kirkby@geo.umn.edu; Kate Giles, New Mexico State University, (505) 646-2033, fax 505-646-1056, kgiles@nmsu.edu; Steve Dorobek, Texas A&M University, (409) 845-0635, fax 409-845-6162, dorobek@tamu.edu. Cost: $175 (2 ON, 2 L, 1 D). Starts and ends each day at UTEP.

This trip will focus on Quaternary geology and soil isotopes as a means to (1) date neotectonic events, (2) understand ecologic and geomorphic thresholds, and (3) develop predictive models for archaeological surveys. Stops will be the Franklin Mountain Fault, Fort Bliss Reservation, the Desert Project, and the NSF Jomada Long Term Ecological Research Site.

2. Beginning of the Age of Dinosaurs. Friday, March 21 through Sunday, March 23. Adrian Hunt, Mesalands Dinosaurs Museum, Mesa Technical College, 911 South Tenth St., Tucumcari, NM 88401, (505) 461-4413, fax 505-461-1901, mesalands@aol.com; Spencer G. Lucas, New Mexico Museum of Natural History, (505) 841-2873, fax 505-841-2866, lucas@darwin.nmnh-abq.mus.nm.us. Cost: $170 (2 ON, 2 B, 2 L, 2 D). Leaves El Paso on Saturday morning and ends in Tucumcari, New Mexico, on Sunday evening. Buses will be available on Monday. March 24, to transport participants to the Albuquerque International Airport.

This trip will examine outcrops of various parts of the Upper Triassic Chinle Group in eastern New Mexico. These strata probably contain the most complete sequence of Late Triassic vertebrate faunas known. The fauna, dominated by tetrapods, including a variety of crocodylids (e.g., phytosaurs), has a significant dinosaurian component.

3. Facies Architecture and Stratigraphic Evolution of the Great American Bank: The Lower Ordovician El Paso Group, Franklin Mountains, El Paso, Texas. Robert K. Goldhammer, Bureau of Economic Geology, University of Texas at Austin, University Station, Box X, Austin, TX 78713-7508, (512) 475-9571, fax 512-471-0140, goldhammer@begv.beg.utexas.edu. Cost: $70 (1 ON, 1 L). Leaves from and returns to El Paso on Saturday, March 22, after an informal 1-hour geologic overview on Friday evening. This trip provides the opportunity to examine in detail superb exposures of Lower Ordovician, shallow-marine platform carbonates that accumulated during the passive-margin evolution of the lower Paleozoic of the southwestern United States. Participants will observe and interpret facies with the goal of developing sequence stratigraphic models for the El Paso Group, with control provided by measured section from nearby areas.


This trip will focus on surface exposure dating, 40Ar/39Ar chronology, paleomagnetism, major and trace element variations, and isotopic character of mafic lavas and xenoliths in this rift-related volcanic field. We will visit several maars, including Kilbourne Hole.

5. Stratigraphic Architecture of Forestepping and Backstepping Shallow Marine Sequences: The Upper Cretaceous Gallup and Hosta Sandstones, San Juan Basin, New Mexico. Dag Nummedal, Unocal Corporation, 14141 Southwest Freeway, Sugar Land, TX 77478, (713) 287-5212, fax 713-287-5403, o1094dx@endeavor1.unocal.com; Robyn Wright Dunbar, Rice University, (713) 285-5169, fax 713-285-5214, rwd@ruf.rice.edu. Cost: $215 (one way airfare El Paso–Albuquerque, 2 ON, 2 B, 2 L, 2 D). Participants will fly from El Paso to Albuquerque on Friday evening, March 21, and continue to Gallup, New Mexico, by van. Ends at the Albuquerque airport on Sunday, March 23, at 5:00 p.m.

This trip will examine Upper Cretaceous sandstones in the San Juan Basin near Gallup, New Mexico. Participants will examine the sequence stratigraphic architecture of forestepping sequences in the Gallup Sandstone and backstepping sequences in the Hosta Sandstone.

**SHORT COURSE AND FIELD TRIP**

A short course, “Industrial Minerals and Their Markets,” on Saturday, March 22, will be followed by a field trip on Sunday, March 23 to the Cementos de Chihuahua near Ciudad Juarez. Contact Peter Harben (harbenp@magnum.wpe.com) or Kenneth Clark (clark@geo.utep.edu) if you wish to be put on the mailing list for information and registration for this course.

**ABSTRACTS**

Attendees are encouraged to order Abstracts with Programs for the meeting either with their annual dues or with their preregistration. There will be only a limited number of copies available for purchase on site.

**PROJECTION EQUIPMENT**

There will be two projectors for each oral session. Please bring your own loaded carousel trays. Overhead projectors will be available upon request. Specifics of the poster session will be published in the Program.
**PREREGISTRATION FORM**

**GSA** South-Central and Rocky Mountain Sections  
March 20–21, 1997

**PREREGISTRATION**

- **GSA Member**: $50  
- **Nonmember**: $60  
- **GSA Member Student**: $25  
- **Nonmember Student**: $30  
- **K–12 Teacher**: $15  
- **Guest**: $15  
- **Abstracts with Programs**: $22.50

**SPECIAL EVENTS**

- **Mexican Dinner**: $15  
  (on-site $20)  
- **Pander and Paleontological Societies Luncheon**: $10  
  (on-site $15)

**DORMITORY HOUSING**

- $15 single per night
- $12 double per night

**FIELD TRIPS**

1. **Lower Mississippian Waulsortian Mounds**  
   March 21–March 23  
   $175
2. **Quaternary Landscape Evolution**  
   March 22–March 23  
   $195
3. **Beginning of the Age of the Dinosaurs**  
   March 21–March 23  
   $170
4. **Facies Architecture and Stratigraphic Evolution**  
   March 22  
   $70
5. **Geochnronology and Geochemistry, Potrillo Volcanic Field**  
   March 22–March 23  
   $70
6. **Stratal Architecture, Shallow Marine Sequences**  
   March 22–March 23  
   $215

**TOTAL FEES**

**MAIL OR FAX THIS REGISTRATION FORM TO:**  
Conference Services, Professional and Continuing Education  
University of Texas at El Paso  
500 West University, El Paso, TX 79968-0602  
(915) 747-5142 • fax 915-747-5538

**REMIT IN U.S. FUNDS PAYABLE TO:**

The University of Texas at El Paso  
(All preregistrations must be prepaid. Purchase Orders not accepted.)

Payment by (check one):  
☐ check  ☐ Discover  ☐ VISA  ☐ MasterCard

- card number  
- expires

- signature

**GUEST INFORMATION**  
Please print clearly  
This area is for badge

- Name as it should appear on your guest’s badge
- City  
- State or Country

Please indicate if you or your guest will need services to accommodate a disability:  
☐ Yes  
☐ No

**Cancellation Deadline:** March 1

**Please print clearly • THIS AREA IS FOR YOUR BADGE**

- Name as it should appear on your badge (last name first)
- Employer/University Affiliation
- City  
- State or Country

- Mailing Address (use two lines if necessary)
- City  
- State or Country

- ZIP Code  
- Country (if other than USA)
EXHIBITS

Exhibit facilities for business, educational, and governmental institutions will be available in the Student Union Building. On-site registration, oral and poster sessions, the welcoming party, and the Thursday evening dinner will be held in this building. Space rental of $125 will include one complimentary registration. Exhibitors are encouraged to set up Wednesday afternoon for registration and the welcoming party. For information concerning exhibits, contact Nancy Wacker, Professional and Continuing Education, Assistant Director for Conferences and Special Events, University of Texas at El Paso, 500 West University, El Paso, TX 79968-0602, (915) 747-5142, fax 915-747-5538, nwacker@mail.utep.edu.

SPECIAL EVENTS

Welcoming Party, beginning at 7 p.m. on Wednesday, March 19. On-site registration will be available, and those who have preregistered may pick up their name badges, tickets for the dinner, and Abstracts with Programs.

West Texas Mexican Dinner, on Thursday, March 20. Tickets must be purchased in advance.


STUDENT PAPERS AND TRAVEL GRANTS

Awards will be presented for the best student paper in both oral and poster formats. Awards will be based on the quality of research and effectiveness of presentation. Limited funds for travel expenses are also available. To be considered for both a travel stipend and the best paper award, student should attach a note to their submitted abstract. William Cornell, UTEP, will administer these student awards. Checks for travel grants will be given to student after his/her presentation.

PREREGISTRATION


Preregistration by mail will be handled by Professional and Continuing Education at UTEP. Please take advantage of the lower registration fees and register by February 7. All field trip participants must register for the meeting. Preregistration costs are listed on the accompanying form. On-site registration costs are as follows: GSA members—$60, Nonmembers—$70, GSA member students—$30, Nonmember students—$35, K-12 teachers—$15.

CANCELLATION POLICY

Cancellations must be received in writing by Nancy Wacker at UTEP on or before March 1, 1997. There will be a $20 cancellation fee. After March 1, there will be no refunds for cancellations. Substitutions may be made at any time at no extra cost.

HOTEL ACCOMMODATIONS AND HOUSING

The historic Camino Real Paso del Norte Hotel, a historic landmark in a 400-year-old city, was built in the golden age of expansion and progress that the railroads brought to the American Southwest. A centerpiece of the hotel is a Tiffany glass dome in the meeting area on the ground floor. The hotel is a short walk from the U.S.-Mexico border and is close to the border trolley, which allows one to shop and eat in Juarez. Staying in this grand hotel is a reason in itself to visit El Paso. A block of rooms at the special rate of $75 single and $80 double is available for the meeting. Cutoff date for this rate is February 7, 1997. Reservation requests received after that date will be accepted on a space-available basis and at the prevailing published rate. Please make your hotel reservations and cancellations directly with the hotel and indicate you are part of the GSA meeting in order to qualify for the special rate.

OTHER INFORMATION

It is our goal that this program be accessible to all persons. If you have a special dietary or physical need, please state them on the registration form or contact Nancy Wacker at the address given in the Exhibits section.

Budget Rent-a-Car has a special rate for UTEP conference attendees. Call toll free 1-800-377-0605 and tell the reservations clerk you are attending a University of Texas at El Paso conference, rate code ACE.

Nos vamos pronto! 
The following 683 Members were elected by Council action during the period from April 1996 through October 1996.
The following 312 Student Associates became affiliated with the Society during the period from April 1996 through October 1996.
1996

Denver meeting registered a high of 6501 attendees!!
See photos and story in the January issue or visit the home page for details (http://www.geosociety.org).

1997

Salt Lake City, Utah
October 20–23
Salt Palace
Convention Center
Little America Hotel

General Chair: M. Lee Allison,
Utah Geological Survey

Technical Program Chairs:
John Bartley, Erich Petersen,
University of Utah

Theme Session Proposal Deadline is January 2, 1997.
See the November GSA Today for the theme invitation or the World Wide Web for invitation and proposal form: http://www.geosociety.org.
Proposals are sent directly to John Bartley.

Field Trip Chairs:
Bart Kowallis, Brigham Young University
 Paul Link, Idaho State University

No more field trips will be accepted.

1998

Toronto, Ontario, Canada, October 26–29
Metro Toronto Convention Centre
Sheraton Toronto Centre Hotel and Towers

General Chairs: Jeffrey J. Fawcett, University of Toronto
Emlyn Koster, Ontario Science Centre

Technical Program Chairs:
Denis M. Shaw, McMaster University
Andrew Miall, University of Toronto

Call for Field Trip Proposals:
We are interested in proposals for single-day and multi-day field trips beginning or ending in Toronto, and dealing with all aspects of the geosciences. Please contact the Field Trip Chairs listed below.

Pierre Robin
University of Toronto
Dept. of Geology
22 Russell Street
Toronto, ON M5S 3B1, Canada
(416) 978-3022
Fax 416-978-3938
hhalls@credit.erin.utoronto.ca

Henry Halls
Erindale College
Mississauga, ON L5L 1C6, Canada
(905) 828-5363
Fax 905-828-3717

FUTURE MEETINGS

1999 — Denver, Colorado .......................... October 25–28
2000 — Reno, Nevada ............................... November 13–16
2001 — Boston, Massachusetts ..................... November 5–8
December BULLETIN and GEOLOGY Contents

The Geological Society of America
BULLETIN
Volume 108, Number 12, December 1996

CONTENTS
1515–1527 A tale of 10 plutons—Revisited: Age of granitic rocks in the White Mountains, California and Nevada
Edwin H. McKee and James E. Conrad

1528–1548 Petrochemical study of regional/contact metamorphism in metaclastic strata of the central White-Inyo Range, eastern California
W. G. Ernst

1549–1566 Cerro Toledo Rhyolite, Jemez Volcanic Field, New Mexico: \(^{40}\)Ar/\(^{39}\)Ar geochronology of eruptions between two calibration-forming events
Terry L. Spell, Ian McDougall, and Anthony P. Doulgeris

1567–1579 Eocene potassic magmatism at Two Buttes, Colorado, with implications for Cenozoic tectonics and magmatism in the western United States
Linda L. Davis, Douglas Smith, Fred W. McDowell, Nicholas W. Walker, and Lars E. Borg

1580–1593 Three-dimensional variations in extensional fault shape and basin form: The Cache Valley basin, eastern Basin and Range province, United States
James P. Evans and Robert Q. Oksas Jr.

1594–1607 Orogen-parallel and orogen-perpendicular extension in the central Nepalese Himalayas
M. E. Coleman

1608–1625 Ten-million-year history of a thrust sheet
Andrew J. Meigs, Jaume Vergés, and Douglas W. Burbank

1626–1644 Productivity cycles of 200–300 years in the Antarctic Peninsula region: Understanding linkages among the sun, atmosphere, oceans, sea ice, and biota
Amy Leventer, Eugene W. Domack, Scott E. Išhman, Stefanie Brachfeld, Charles E. McClennen, and Patricia Manley

1645 1996 Annual Index

Book Reviews continued from p. 25

about paleovegetation and paleoclimate. Toward the end of the book, I noted the important point that Miall made about there being few reliable lithofacies indicators of paleoclimates, and the warning about trying to link Milankovitch climatic cycles with pre-Pleistocene fluvial sedimentary cycles.

So how can knowledge of the nature and origin of fluvial deposits contribute to the exploration, production, and management of economic resources such as oil, gas, water, and placer minerals? It seems, from the catalogue of oil and gas reservoirs with particular geometries and tectonic settings in chapters 14 and 15 of Miall’s book, that all we can do is classify reservoirs in very broad terms. The reality is, of course, that detailed quantitative description and interpretation of fluvial deposits are critical to prediction of their subsurface characteristics, and to effective exploitation and management of the economic resources they contain.

Finally, regarding presentation, there is quite a lot of repetition and cross-referencing between chapters, suggesting that the organization could be improved. I noted some awkward sentence constructions and some typographical errors. The quality of the figures is variable, at least partly because most of them are lifted directly from other publications. Figure 2.20 (upper) is upside down. These minor problems with presentation should have been dealt with by the editor.

John Bridge
Binghamton University
Binghamton, NY 13902-6000

GSA TODAY, December 1996

1059 Silicothermal fluid: A novel medium for mass transport in the lithosphere
J. J. Wilkinson, J. Nolan, A. H. Rankin

1066 Were aspects of Pan-African deformation linked to Iapetus opening?
Jennie Granow, Richard Hanson, Terry Wilson

1067 Winter and summer temperatures of the early middle Eocene of France from Turritella \(^{40}\)Ar/\(^{39}\)Ar profiles
Fredrik P. Andreassen, Birger Schmitz

1071 Possible eastward extension of Chinese collision belt in Korea: The Imjingang belt
Jin-Han Lee, Moonsup Cho, Sung-Tack Kwon, Eizo Nakamura

1075 Mount Pinatubo volcano and ‘‘negative’’ porphyry copper deposits
Jill Dill Pasteris

1079 Insight into the nature of the ocean-continent transition off West Iberia from a deep multichannel seismic reflection profile
S. L. Pickup, R. B. Whitmarsh, C. M. R. Fowler, T. J. Reaston

1083 Neolith settlement distributions as a function of sea-level-controlled topography in the Yangtze delta, China
Daniel Jean Stanley, Zhongyuan Chen

1087 Extension of Delamerian (Ross) orogen into western New Zealand: Evidence from zircon ages and implications for crustal growth along the Pacific margin of Gondwana
G. M. Gibson, T. R. Ireland

1091 Meteoric water component in magmatic fluids from porphyry copper mineralization, Babine Lake area, British Columbia
Ronald Wynn Sheets, Bruce E. Nesbitt, Karl Muehlenbachs

1095 Anelasticity explains topography associated with Basin and Range normal faulting
R. Hassani, J. Chéry

1099 Trace element zoning in garnet as a monitor of crustal melting
Frank S. Spear, Matthew J. Kahn

1103 Fault scaling and 1/f noise scaling of seismic velocity fluctuations in the upper crystalline crust
Klaus Holliger

1107 Unusual ‘‘snow slurry’’ lahars from Ruapehu volcano, New Zealand, September 1995
Shane J. Cronin, Vincent E. Neal, Jérôme A. Lecointre, Alan S. Palmer

1111 Tectonic significance of 400 Ma zircon ages for ophiolitic rocks from the Lachlan fold belt, eastern Australia

1115 Tale of three cratons: Tectonostratigraphic anatomy of the Damara orogen in northwestern Namibia and the assembly of Gondwana
Anthony R. Prave

1119 Looping P-T paths and high- T, low-P middle crustal metamorphism: Proterozoic evolution of the southwestern United States
Michael L. Williams, Karl E. Kastens

1123 Late Quaternary deformation, Saddle Mountains anticline, south-central Washington
M. W. West, F. X. Ashland, A. J. Busacca, G. W. Berger, M. E. Shaffer

1127 Late Holocene faulting in the southeast Sierras Pampeanas of Argentina
Carlos H. Costa, Claudio Víto-Finzi

1131 Timing of deformation and accretion of the Antimonio terrane, Sonora, from paleomagnetic data
Roberto S. Molina Garza, John W. Geissman

1135 Evidence in pre-2.2 Ga paleosols for the early evolution of atmospheric oxygen and terrestrial biota
Pascal Ohrmo

1139 Transform fault effect on mantle melting in the MARK area (Mid-Atlantic Ridge south of the Kane transform)
Indranil Ghose, Madhilea Cannat, Monique Seyler

1143 Thrust emplacement of the Hispaniola peridotite belt: Orogenic expression of the mid-Cretaceous Caribbean arc polarity reversal?
Grenville Draper, Gabriel Gutierrez, John F. Lewis

1147 Chemistry of ore-forming fluids and mineral formation rates in an active hydrothermal sulfide deposit on the Mid-Atlantic Ridge
Rachael H. James, Henry Elderfield

1151 Tectonic model explaining divergent contraction directions along the Cascadia subduction margin, Washington: Correction

1151 Guidelines for Geology authors

1152 Suggestions to authors for producing Geology artwork

1153 1996 Annual Index
Volume II, Number 3, Fall 1996


299 Natural Hazard and Risk Assessment Using Decision Support Systems, Application: Glenwood Springs, Colorado Mario Mejia-Navarro and Luis A. Garcia

325 Rock Mass Strength Assessment for Bedrock Landsliding Kevin M. Schmidt and David R. Montgomery

339 The Effects of Positive Pore Pressure on Sliding and Toppling of Rock Blocks with Some Considerations of Impact Rock Effects Terry R. West

355 Contaminated Land: The British Position and Some Case Histories F. G. Bell, M. J. Duane, A. W. Bell, and N. Hytrits

369 The Problem of Acid Mine Drainage, with an Illustrative Case History F. G. Bell and S. E. T. Bullock

393 The Role of Gully Stabilization in Abandoned Mine Lands Reclamation Christopher P. Carlson and Greg A. Olyphant

Technical Notes:

407 Compression and Collapse Behavior of Fill Robert W. Day

415 Engineering Geological Evaluation of the Imranli Dam Site, Central Anatolia (Turkey) Ergun Karacan, Ahmet Tuuran Aslan and Feda Aral

422 The Case of the Scary Rock, Erland, China R. A. Paige

425 Alkali-Aggregate Reactivity Problems with Cambrian Dolomite and Eocene Limestones of Azad Kashmir M. Arshad Khan

Discussion and Reply:

431 Damage Due to Northridge Earthquake-Induced Settlement of Clayey Fill Robert A. Hollingsworth, Hugh S. Robertson, Stephen M. Watry and Martin E. Lieurance

Book Reviews:

433 Exploration Seismology Edward D. Billington

434 Engineering Geology of Construction Laura J. Powers-Couche

435 Handbook of Ground Water Development Bill Crawford

446 Geology and Hazardous Waste Management Morris M. Dirmenger

447 Slope Stability and Stabilization Methods Allen W. Hatheway

449 Mechanics of Porous Media Douglas F. Hambley

Memorial:

451 Memorial to Thomas Clements Bernard W. Pipkin

Environmental & Engineering Geoscience Contents

Only new or changed information is being published in GSA Today. A complete listing can be found in the Calendar section on the Internet: http://www.geosociety.org.

1997 Penrose Conferences

April 24–30, Paleocene-Eocene Boundary Events in Time and Space, Albuquerque, New Mexico. Information: Spencer Lucas, New Mexico Museum of Natural History, 1801 Mountain Road NW, Albuquerque, NM 87104, (505) 841-2873, fax 505-841-2866, E-mail: lucas@darwin.nmmnh-abq.mus.nm.us.


September 23–28, Tectonics of Continental Interiors, Cedar City, Utah. Information: Michael Hamburger, Department of Geological Sciences, Indiana University, Bloomington, IN 47405, (812) 855-2934, fax 812-855-7899, E-mail: hambur@indiana.edu.

1997 Meetings

March 22–24, Triassic Basin Initiative, (TRIB): Initial workshop and field trip, Durham, North Carolina. Information: Tyler Clark, Dept. of Geology, Duke University, P.O. Box 90227, Durham, NC 27708-0227, (919) 684-5847, fax 919-684-5833, E-mail: tclark@geo.duke.edu.

June 2–6, 14th International Conference on Basement Tectonics, Blacksburg, Virginia. Information: A. K. Sinha, Dept. of Geological Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061-0420, (540) 231-5580, fax 540-231-3386, E-mail: searches@vtvm1.cc.vt.edu or.sentelle@vt.edu, http://www.geol.vt.edu/profs/aks/basement.html.

Discussion and Reply:

431 Damage Due to Northridge Earthquake-Induced Settlement of Clayey Fill Robert A. Hollingsworth, Hugh S. Robertson, Stephen M. Watry and Martin E. Lieurance

Book Reviews:

433 Exploration Seismology Edward D. Billington

434 Engineering Geology of Construction Laura J. Powers-Couche

435 Handbook of Ground Water Development Bill Crawford

446 Geology and Hazardous Waste Management Morris M. Dirmenger

447 Slope Stability and Stabilization Methods Allen W. Hatheway

449 Mechanics of Porous Media Douglas F. Hambley

Memorial:

451 Memorial to Thomas Clements Bernard W. Pipkin

June 9–13, Changing Water Regimes in Drylands, Lake Tahoe, California. Information: Nicholas Lancaster, Desert Research Institute, P.O. Box 60220, Reno, NV 89506, E-mail: nick@maxey.dri.edu, Web: http://www.dri.edu.

September

September 12–14, Recoveries ‘97, final meeting of UNESCO IGCP Project 335 “Biotic Recoveries from Mass Extinctions,” Prague, Czech Republic. Information: Petr Cejchan, Geological Institute, Academy of Sciences, Rozvojova 135, CZ 165 02 Praha 6, Czech Republic; Petra Hovorkova, Recoveries ’97, Eurocongress Centre, Budejovicka 15, CZ 140 00 Praha 4, Czech Republic; lucas@gli.cas.cz, http://www.gli.cas.cz/conf/recovery/recovery.htm.

September 22–27, 6th International Conference on Fluvial Sedimentology, Cape Town, South Africa. Information: Conference Organiser, 6 ICFS, Postgraduate Conference Div., UCT Medical School, Observatory 7925, South Africa, phone 27-21-406-6911 or 406-6348, fax 27-21-448-6263, deborah@medicine.uct.ac.za.

About People

GSA Honorary Fellow Gabriel Dengo, Center for Geological Studies of Central America, Guatemala City, Guatemala, is the 1996 recipient of the Hollis D. Hedberg Award from the Institute for the Study of Earth and Man, Southern Methodist University, Dallas.

Fellow Gerald M. Friedman, Brooklyn College and City University of New York, has in 1996 been elected an honorary fellow of the Geological Society of London, was given the Russian Academy of Natural Sciences Kapitsa Gold Medal of Honor, and received the American Association of Petroleum Geologists Distinguished Educator Award; next spring he will be awarded the Twenhofel Medal by the Society of Sedimentary Geology.
Position Announcements (from Employers using GSA's Employment Service at the 1996 GSA Annual Meeting)

SURFACE PROCESSES BOSTON COLLEGE
The Department of Geology and Geophysics at Boston College seeks a dynamic candidate for a tenure-track faculty position (rank open) in the area of Surface Processes, with a beginning September 1997. Individuals may have research interests in any of the sub-specialties in this broad field, but those with backgrounds in geomorphology, surface hydrology, wetland dynamics, sedimentation or coastal dynamics are particularly encouraged to apply. A Ph.D. is required and post-doctoral experience desirable. The individual will be expected to teach undergraduate and graduate courses in our geology and environmental studies program. Career development is very much at the heart of our aggressive research program in his or her specialty. The Department, which also runs the nearby Weston Geophysical Observatory, is well equipped (including flume and GIS laboratories) and is housed in modern, recently renovated facilities on a suburban campus 8 miles west of Boston. Rank of appointment will be commensurate with experience.

A curriculum vitae, statement of research interests, list of references and copies of selected publications should be sent to: Dr. Stephen Marshak, Chairperson, Department of Geology and Geophysics, Boston College, Chestnut Hill, MA 02167 by January 10, 1997. For further information, contact the above at 617-552-3641 or 3642 or via E-mail: geology@bc.edu. Boston College is an equal opportunity/affirmative action employer. Qualified women and minorities are encouraged to apply.

DEPARTMENT OF GEOLOGY
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
ASSISTANT PROFESSOR OF SEDIMENTARY GEOLOGY (TENURE-TRACK)
The Department of Geology at the University of Illinois invites applications for a full-time (9-month academic year) tenure-track position in sedimentary geology. We are seeking an outstanding scientist and enthusiastic teacher for an appointment at the rank of assistant professor that will begin in August 1997. A Ph.D. is required; salary is negotiable. The successful candidate will establish an innovative, externally funded research program, preferably relating to tectonics and/or global change, and will pursue excellence in teaching and student research supervision in all aspects of our educational program.

The Department of Geology at the University of Illinois invites applications for a full-time (9-month academic year) tenure-track position in sedimentary geology. We are seeking an outstanding scientist and enthusiastic teacher for an appointment at the rank of assistant professor that will begin in August 1997. A Ph.D. is required; salary is negotiable. The successful candidate will establish an innovative, externally funded research program, preferably relating to tectonics and/or global change, and will pursue excellence in teaching and student research supervision in all aspects of our educational program. The University of Illinois at Urbana-Champaign is a major research university with 37,000 students in residence. Currently, the Department of Geology has 14 full-time faculty (see our homepage at http://www.geology.uiuc.edu/) and offers M.S. and Ph.D. degrees in geology and geophysics. Opportunities exist for collaboration with current staff in structural geology, hydrogeology, geochemistry, geophysics, clay mineralogy, and paleontology, both at the department and at the Illinois State Geologic Survey.

To apply, please send a curriculum vita, a list of publications, a brief letter describing research and teaching interests and plans, and the names of three references to: Dr. Stephen Marshak, Search Committee Chair, Department of Geology, University of Illinois, 1301 W. Green St., Urbana, IL 61801. In order to ensure full consideration, applications must be received by December 10, 1996. For further information, contact Dr. Marshak by E-mail at smarshak@uiuc.edu, by telephone at 217-337-7703 or by FAX at 217-333-0475. The University of Illinois is an Equal Opportunity/Affirmative Action Employer.

DEPARTMENT OF GEOLOGY/UNIVERSITY OF PUGET SOUND/TACOMA, WASHINGTON
Two Sabbatical replacement teaching positions are anticipated to become available for the 1997-1998 academic year, and possibly for the Fall of the 1998-1999 year, in GEOMORPHOLOGY/QUATERNARY GEOLOGY (Position #1) and PETROLOGY/STRATIGRAPHY (Position #2). Depending upon leave schedules yet to be finalized, each position may last anywhere from 1 semester to 3 semesters in length. Position #1 will teach a one-semester course in geology-major course in geomorphology and Quaternary geology; position #2 will teach either a one-semester sophomore-level majors course in mineralogy or a sophomore-level introduction to sedimentary rocks course in igneous and metamorphic petrology, or both.

Both positions will also participate in teaching introductory Physical Geology classes for non-majors, as well as contribute to the interdisciplinary team-taught Science in Context program.

Appointments will be at the Assistant Professor level; a Ph.D., a minimum of 1 year of college-level teaching, and a commitment to excellence in teaching and liberal arts education are required. When the nature of these positions has been finalized, individuals on our mailing list will receive official vacancy announcements and application procedures. The University of Puget Sound is a private, liberal arts college with 2800 undergraduates.

WESTERN WASHINGTON UNIVERSITY
TENURE-TRACK POSITIONS: GEOPHYSICS AND GEOLOGY/SCIENCE ED.
For details see http://www.wwu.edu/~casdept/pages/geology.html or contact Jim Talbot at talbot@cc.wwu.edu

SEDIMENTOLOGIST ASSISTANT PROFESSOR Position #1
The Department of Geology at Smith College invites applications for a full-time, tenure-track position in sedimentology at the rank of Assistant Professor. The successful candidate will teach an intermediate-level course in sedimentology as well as geology courses at the introductory and advanced levels. This initial appointment is for a three-year term and begins in September, 1997. A Ph.D. is required.

Applicants should forward a letter of application before November 15, 1996. Include a concise statement of current and long-term teaching, research, and career goals, transcripts, a current curriculum vitae, and names of three references.

All materials should be addressed to Geography Search Committee, c/o Dr. Robert Horton, Chair, Department of Geology, Smith College, Northampton, MA 01063. Smith College is an Equal Opportunity/Affirmative Action Institution.

HYDROGEOLOGIST, SAN FRANCISCO STATE UNIVERSITY
The Department of Geosciences invites applications for a tenure-track faculty position at the assistant professor level in hydrogeology, beginning in 1997 in San Francisco. The position requires a Ph.D. in geology and a strong commitment to excellence in both teaching and research. Some background in teaching and in industry is preferred. The successful candidate will be expected to teach all academic levels and will be primarily responsible for teaching undergraduate and graduate courses in hydrogeology, groundwater contamination, and environmental geology. Responsibilities will include maintaining an active research program and an active teaching program with undergraduate students. We seek someone who will work with local environmental firms and agencies and assist in building our new graduate program in Applied Geosciences and an interdisciplinary undergraduate environmental studies program.

The Department of Geosciences includes geology, meteorology, and oceanography and consists of 13 faculty members from these fields. The department offers BS and BA degrees in geology and, beginning Fall 1996, a MS degree in Applied Geoscience.

To apply, send curriculum vitae including a statement of teaching and research interests, and names and addresses of three references to: John Monteverdi, Dept. of Geosciences, San Francisco State University, San Francisco, CA 94132. Applications should be received before January 15, 1997. San Francisco State University is an Equal Opportunity/Affirmative Action Employer.

WESLEYAN UNIVERSITY
The Department of Earth & Environmental Sciences at Wesleyan University invites applications for a tenure-track position in the field of limnology, to commence with the 1997-98 academic year at the Assistant Professor rank. The successful candidate will be responsible for teaching the following types of courses on a regular basis: an introductory course for non-science majors, a major-level course in limnology, an upper-level course in their specialty; and occasionally alternate with other faculty in the teaching of one of the following: environmental chemistry, marine geology, or oceanography. Candidates should have good quantitative skills and should be prepared to incorporate these in their teaching. All requirements for the Ph.D. should be completed by the time of appointment.

Applications are encouraged to apply for this position. Wesleyan University is an affirmative action employer. Letters of application should be accompanied by a statement of research and teaching interests, a recent vitae, and the names and addresses of at least three referees; these should be sent by January 1, 1997, to: Gregory S. Horton, Chair, Department of Earth & Environmental Sciences, Wesleyan University, Middletown, CT 06459

AMHERST COLLEGE
ENVIRONMENTAL GEOScientIST
The Department of Geology is seeking applications for a one-year faculty position at the level of Assistant Professor beginning in the fall semester, 1997. Possible fields of expertise include one or more of the following: aqueous geochemistry, biogeochemistry, paleoecology, hydrology, surficial, an environmental geology. A Ph.D. or A.B. is desirable, those near completion of that degree are encouraged to apply.

Candidates should have a strong interest in graduate teaching as well as research interests that can incorporate undergraduate students. Teaching responsibilities will consist of: one one-year faculty position in course and one intermediate-level course that stress environmental and surficial processes. In addition the candidate is expected to teach one upper-level course in his/her specialty. Amherst College has opportunities to teach in interdisciplinary programs.

Submit a résumé, three letters of recommendation, and a brief statement of your research interests to: Professor M. Thies, Chair, Department of Physics and Geology, Amherst College, Amherst, MA 01002-5000, tel: (413)542-2712. Review of applications will begin on 15 January 1997, but applications will be accepted until a pool of qualified candidates is identified. Amherst College is an equal opportunity/affirmative action employer. Women and minorities are particularly encouraged to apply.

CALIFORNIA STATE UNIVERSITY AT BAKERSFIELD
AQUEOUS GEOCHEMIST
Subject to approval of funding, the Department of Physics and Geology at CSU Bakersfield anticipates a tenure-track position in aqueous geochemistry/hydrology to be filled at the assistant professor level. A Ph.D. in geology is required, with a related geoscience background. Research experience and interest in teaching is mandatory. Responsibilities include teaching graduate and undergraduate courses in geochemistry, aqueous geochemistry, contaminant transport, and related topics of the successful candidate’s choosing. Successful candidate will also be expected to teach some general education geology and/or physics courses and to develop a research program in their specialty involving undergraduate and master’s level graduate students.

Hydrogeology and soft rock geology are department specialties. Housed within the Geology Department at CSU Bakersfield, the department is equipped with field hydrology equipment, a mini/micro-computer lab with MINTEQ and MODFLOW software, an automated XRD, and SEM-EDX, research petrography lab, and field geophysics equipment. The laboratory has well-equipped GC, MS, AA, and NMR instruments in the Chemistry Department and the campus has GIS access. The San Joaquin Valley is an area of intensive agricultural activity and environmental development. There are many geologic opportunities that are readily available and connections are easily made with local industry and government agencies.

The starting date is September 1, 1997. Review of applications will begin after December 1, 1996. Candidates should submit a letter of application, a current curriculum vita, and names of at least three references to: Dr. Robert Horton, Chair, Department of Physics and Geology, California State University, 9001 Stockdale Highway, Bakersfield, CA 93311-1099.
Future...

GeoVentures are a special benefit created for members, but are open also to guests and friends. GeoVentures is the overall name for adult educational and adventure experiences of two kinds: GeoTrips or GeoHostels. Both are known for expert scientific leadership. Fees for both are low to moderate (relative to the length of time and destination) and include lodging and meals as designated. The venues, however, are quite different.

Choose from two types of GSA GeoVentures

<table>
<thead>
<tr>
<th>GeoHostels</th>
<th>GeoTrips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>6 days</td>
</tr>
<tr>
<td>Cost</td>
<td>Under $700</td>
</tr>
<tr>
<td>Site</td>
<td>College campuses or resort towns, North America</td>
</tr>
<tr>
<td>Time of Year</td>
<td>Summer</td>
</tr>
<tr>
<td>Traveling</td>
<td>Limited to local areas</td>
</tr>
<tr>
<td>Physical Requirements</td>
<td>None</td>
</tr>
<tr>
<td>Education</td>
<td>Daily educational programs and field excursions</td>
</tr>
<tr>
<td></td>
<td>1 to 3 weeks</td>
</tr>
<tr>
<td></td>
<td>$1000 and up</td>
</tr>
<tr>
<td></td>
<td>Worldwide</td>
</tr>
<tr>
<td></td>
<td>Anytime</td>
</tr>
<tr>
<td></td>
<td>Daily change of site</td>
</tr>
<tr>
<td></td>
<td>May be physically demanding</td>
</tr>
</tbody>
</table>

Mount St. Helens and Mount Rainier
Packwood and Kelso, Washington
June 21–26, 1997, 6 days, 6 nights

GeoHostel

Scientific Leaders
Patrick Pringle, Washington Department of Natural Resources, Olympia, Washington

Both leaders have many years of geological field experience, summarized in numerous scientific publications about Mount St. Helens and Mount Rainier, as well as extensive experience at other Cascade and Alaskan volcanoes.

Description
This GeoHostel will focus on field trips to Mount St. Helens, especially to explore processes and effects of the cataclysmic eruption of May 18, 1980. Among them are: decapitation of former summit; world’s largest historic landslide; tsunami wave as high as 800 feet on Spirit Lake; gigantic pyroclastic surge (so-called “lateral blast”) that in four minutes moved down 235 square miles of mature forest; great muddy floods (lahars). The ever-changing processes of revegetation, reforestation, and re-entry of fauna to the devastated area are part of the scientifically unique experience, one of the reasons Congress set aside the heart of the affected area as Mount St. Helens National Volcanic Monument. Two days will be devoted to the east and southeast sides of Mount St. Helens, and two days to the south and west sides, including two stunning new visitor facilities in the heart of the devastated area, and one day will be at spectacular Mount Rainier (northeast, east, and south flanks) in Mount Rainier National Park. While at Mount St. Helens, we will hike through a remaining stand of old-growth coniferous trees, many as tall as 230 feet. Each day involves a hike through a unique landscape; none of the hikes is longer than about three miles nor with an altitude change of more than about 900 feet. Because snow will still be visible on the higher mountain peaks, June will be stunning for photography.

Lodging, Meals, and Ground Transportation
The group will stay on Saturday, Sunday, and Monday at the Inn of Packwood, Packwood, Washington, and on Tuesday, Wednesday, and Thursday nights at the Red Lion Inn in Kelso, Washington. All lodging is based on double occupancy. GSA will do its best to find roommates for single travelers. Meals will include plenty of hors d’oeuvres at the Welcoming Reception and Orientation on Saturday evening, daily breakfasts, sack lunches, and a hearty farewell dinner on Thursday evening. Field trip transportation will be provided in air-conditioned, 15-passenger vans.

Fee and Payment

$650 for GSA Members
$700 for Nonmembers
$100 deposit is due with your reservation and is refundable through April 28, less $20 processing fee. Total balance is due: April 28.

Included: Classroom programs and materials; field trip transportation; lodging for six nights (double occupancy); meals outlined above; welcoming and farewell events.

Not included: Transportation to and from Portland, Oregon; transportation during hours outside class and field trips; and other expenses not specifically included.
### Description

The geology of the Yellowstone-Beartooth country is some of the most spectacular in North America, from Archean metamorphic rocks to Quaternary glacial deposits. The GeoHostel will include field trips to look at Archean through Quaternary geology of the Beartooth plateau via the famous Beartooth Highway, layered mafic intrusions at the Stillwater Mine, Absaroka volcanics in the upper Clarks Fork drainage, the Heart Mountain detachment and Phanerzoic stratigraphy of the Sunlight Basin and Dead Indian Hill region, and volcanics of the northeastern edge of the Yellowstone plateau. The trips are full days. Enjoy the spectacular scenery of the Yellowstone-Beartooth country.

### Lodging, Meals, and Ground Transportation

The group will be lodged at the Best Western Lu Pine Inn in double occupancy motel-type rooms. GSA will do its best to help find a suitable roommate for single travelers. Meals will include plenty of hors d’oeuvres at the Welcoming Reception and Orientation on Saturday evening, daily breakfasts and sack lunches, dinner on Monday evening at the Grizzly Bar, and a hearty farewell dinner on Thursday evening. Field trip transportation will be provided in air-conditioned, 15-passenger vans.

### Fee and Payment

| Deposit Per Person | No. of Persons | Total Paid
|-------------------|----------------|-------------
| GT971—Italy       | $250           | $           |
| GT972—Canyonlands | $200           | $           |
| GH971—Mount St. Helens | $100   | $           |
| GH972—Yellowstone | $100           | $           |
| GH973—Sky Islands | $100           | $           |
| **TOTAL DEPOSIT** |                | $           |

- **$100 deposit is due with your reservation and is refundable through May 28, less $20 processing fee. Total balance is due: May 28.**
- **Included:** Classroom programs and materials; field trip transportation; lodging for 6 nights; double occupancy, meals outlined above; welcoming and farewell events.
- **Not included:** Transportation to and from Red Lodge, Montana; transportation during hours outside class and field trips; and other expenses not specifically included.

### Registration Form

- **Send a deposit to hold your reservation; please pay by check or credit card. You will receive further information and a confirmation of your registration within one week after your reservation is received.**

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Institution/Employer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mailing Address</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>City/State/Country/ZIP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phone (business/home)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Guest Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>GSA Member #</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

### Deadline for Registration

- Registrants are encouraged to use the GSA Meetings Department fax number: 303-447-0648.
- **MAKE CHECKS PAYABLE TO:** GSA 1997 GeoVentures

**Please mail or fax registration form and check or credit card information to:**

1997 GSA GeoVentures, GSA Meetings Department,
P.O. Box 9140, Boulder, CO 80301.

**Check for updates:** http://www.geosociety.org

**Call today for more information:** 1-800-472-1988, x134, or (303) 447-2020, E-mail: ecollis@geosociety.org • fax 303-447-0648.

**Check for updates:** http://www.geosociety.org
Description

Above the grasslands of southeastern Arizona, isolated ranges, the “sky islands,” rise to heights of 8,000–9,000 feet. The geology and natural history of these mountains have stronger affinities with the Sierra Madre of Mexico than with the Rocky Mountain cordillera, making the region unique in the United States. The monsoons of late July and August bring cooling—and sometimes drenching—afternoon rains and an array of Sierra Madre wildflowers to the higher elevations. The geology of the Chiricahua, Mule, and Huachuca mountains records Paleozoic marine deposition, Jurassic-Cretaceous crustal extension and basin formation, latest Cretaceous mountain building and basin inversion of the Laramide orogeny, and catastrophic volcanism in the Tertiary. Within and among these ranges are the mining camps—Tombstone, Bisbee, and Gleeson, among others—that generated the early wealth of Arizona and sowed the seeds of conflict recorded by U.S. Army forts Huachuca and Bowie.

This GeoHostel, which includes a program of ambitious hikes, will explore this geology and the natural and human history of the area by means of a series of field trips and half-day hikes to several ranges and mining centers. Located within 50 miles of the Mexican border, the area is a world-renowned mecca for birdwatchers. Daily field trips will allow plenty of time for birding. Participants will see Ocotillo and cacti of the Chihuahuan Desert, oak woodland and Arizona sycamore—Arizona cypress riparian habitat, and Douglas fir and Apache pine of the high mountains. The towns of Bisbee, Benson, and Tombstone offer a variety of tourist attractions, including a train ride out of Benson, gift shops, and restaurants. Visits to nearby ghost towns, mining camps (including the Penrose Mine), old military forts, and the Butterfield Trail will offer glimpses of the spirit and allure of this last holdout of the old Southwest.

Lodging, Meals, and Ground Transportation

The group will be lodged at Cochise College in dormitory style, single occupancy (doubles for couples) type rooms. Meals will include plenty of hors d’oeuvres at the Welcoming Reception and Orientation on Saturday evening, daily breakfasts and sack lunches, and a hearty farewell dinner on Thursday evening. Field trip transportation will be provided in air-conditioned, 15-passenger vans.

Fee and Payment

$540 for GSA Members $590 for Nonmembers
$100 deposit is due with your reservation and is refundable through June 28, less $20 processing fee. Total balance is due: June 28.

Included:
- Classroom programs and materials
- Field trip transportation
- Lodging for six nights: single occupancy (double for couples), meals outlined above; welcoming and farewell events.

Not included:
- Transportation to and from Douglas, Arizona
- Transportation during hours outside class and field trips
- Other expenses not specifically included.

Register Today!

Space will go quickly, so get in touch with us if you are interested. Detailed information on itineraries, registration fees, and travel arrangements will be sent on request. No obligation. Questions welcomed.

For details on the 1997 GeoVentures, contact Edna Collis, GSA Meetings Department

1-800-472-1988, ext. 134  303-447-2020  303-447-0648
E-mail: ecollis@geosociety.org  http://www.geosociety.org

GSA TODAY, December 1996
**GeoTrip**

**Scientific Leaders**

**Haraldur Sigurdsson**, Graduate School of Oceanography, University of Rhode Island  
**Mauro Rosi**, Department of Geology, University of Pisa, Italy

Haraldur Sigurdsson is a leading volcanologist with an international reputation for his research on many aspects of volcanism and other studies of Earth. His studies include research on volcanoes in Italy, Iceland, Mexico, Colombia, the United States, Indonesia, Cameroon, Greece, Japan, the West Indies, and the Galapagos Islands. He has also investigated volcanoes on the ocean floor of the North and South Atlantic oceans and the eastern Pacific, Mediterranean, and Indian oceans.

Mauro Rosi is well-known for his Ph.D. dissertation on volcanism of the continuously erupting island of Stromboli. He has researched the eruptions of Vesuvius, the volcanic deposits in the Campi Flegrei caldera, and other active Italian volcanoes. He has also worked extensively in South America.

**Description**

This unique trip has been requested dozens of times. At last it’s here, with extraordinary leaders! It begins with air travel to Rome, connecting to Naples, and a tour of Vesuvius volcano. The trip continues with visits to the archaeological sites of Pompeii and Herculaneum, destroyed by the famous A.D. 79 eruption. The group takes a ferry to the island volcano of Stromboli, which has been continuously active for more than 2,500 years. Additional ferry trips go to the adjacent volcanic islands of Lipari and Vulcano. The group continues to Sicily and ascends Mount Etna, Europe’s largest active volcano.

**Schedule**

- **May 2**  | Air travel to Italy
- **May 3**  | Arrival in Naples and overnight on Sorrento coast, southwest of Vesuvius
- **May 4**  | Pompeii and Vesuvius
- **May 5**  | Vesuvius Volcano Observatory and crater rim
- **May 6**  | Herculaneum, Naples Archaeological Museum and overnight boat trip to Stromboli
- **May 7**  | Hike to the summit crater of Stromboli
- **May 8**  | Scenic areas and geology of the island of Stromboli
- **May 9**  | Vulcano Island and Il Faraglione fumaroles and mudbaths
- **May 10** | Sicily Island and Il Faraglione fumaroles and mudbaths
- **May 11** | Sicily to flank of Etna
- **May 12** | Ascent of Etna
- **May 13** | Return from Etna to Catania
- **May 14** | Air travel to home

**Physical Requirements**

No special physical requirements, although we will ask that everyone provide verification of health care coverage.

**Included:** The trip fee includes all lodging, meals, ground transportation (including ferries), and fees. Accommodations are based on double occupancy in “Superior Tourist” class hotels, and one night aboard a ferry on May 6. Every day includes full breakfasts, box lunches, and full dinners. Meals are included for the arrival night on May 3 and continue through the departure breakfast on May 14. Transportation is provided by deluxe air-conditioned motorcoach for eight days (Naples, Lipari, and Sicily); none is required in Vulcano and Stromboli. Ferry transportation is included for island travel. Also included are field guides and maps, wine with dinner, gratuities, taxes, and all fees. Just pack your bags!

**Not Included:**

- Airfare, airport departure taxes, travel insurance, lodging in Newark, personal expenses such as soda pop and alcoholic beverages, laundry, excess baggage fees, transfers for passengers arriving and departing independently, and other expenses not specifically included.

**Air Travel**

Group reservations on Alitalia Airlines are offered at $876 plus tax between Newark and Naples-Catania-Newark. An add-on fare using Continental airlines from selected United States gateways to Newark to connect with Alitalia is available. Of course, air miles on other airlines can be used. We strongly encourage you to talk with TR Consultants about your air reservations at 1-800-923-7422.

**TR Consultants and Volcano Tours, Inc.**

All arrangements for the ground parts of this trip have been made by TR Consultants, Inc. and its partner company, Volcano Tours—both in Providence, Rhode Island. They will answer specific questions about the tour.

**Fee, Payment, and Cancellation**

**GSA Member Fee:** $2375  
**GSA Nonmember Fee:** $2475

The single supplement is $350, based on availability of rooms—many of the places we are visiting have very limited lodging. We will do our best to provide single travelers with a suitable roommate.

GSA IS HANDLING TRIP RESERVATIONS; call 1-800-472-1988 or (303) 447-2020, ext. 134. A deposit of $250 is due with your reservation. The deposit is refundable (less a 50% processing fee) through February 28. The total balance is due February 28. (Because of the limited access to some of the sites, we have to make payments to the Italian providers 60 days in advance of departure.) The fee is nonrefundable after February 28. Information on reasonable travel insurance will be sent to you.

Additional reservations may be made after February 28 if space is available, and the total fee will be due at the time of the reservation.

See registration form (page 43) or call 1-800-447-2020, x134.
GeoTrip
Scientific Leader
Jack Campbell,
Department of Geology,
Ft. Lewis College,
Durango, Colorado

Jack Campbell has
his credit 30 years of
research and publications
on the Paleozoic geology of
the Southern Rocky Moun-
tains and the Colorado
Plateau. Jack has conducted
short courses on the geol-
yogy of the San Juan Moun-
tains and the Colorado
Plateau for many organiza-
tions. He has also led field
trips and/or lectured on field trips for GSA, the Rocky Mountain
Geological Society, the Colorado Scientific Society, Four Corners
Geological Society, New Mexico Geological Society, and the Utah
Geological Survey. You’ll find him a personable, experienced, and
engaging leader.

Description
This trip is an exceptional educational opportunity for the
physically active person. The itinerary includes geologic features
found nowhere else. More than 1,500 natural stone arches stand in
Arches National Park, which has the world’s highest concentration
of these remarkable features. Nearby is Canyonlands, Utah’s largest
national park, a unique area of sandstone pillars and mazes of
incredible beauty that have been formed into three districts by the
Colorado and Green rivers. We will be hiking the rim area of the
Canyonlands as well as traveling down the Colorado River by raft.
We will go through Cataract Canyon, a major whitewater experi-
ence.

Moab is within driving distance of Natural Bridges, Capitol
Reef, Bryce Canyon, the recently established Grand Staircase-
Escalante National Monument, Zion Canyon, Grand Canyon, and
the Lake Powell Recreation Area.

Schedule
May 30  Travel day to Moab. Orientation and dinner at 7:30 p.m.
May 31  Van to Fisher Towers and Professor Valley
June 1   Van and hike through Arches National Monument
June 2   Moderate hike from rim at Upheaval Dome to the Green
         River. Meet motorized J-rig rafts. Easy raft trip to camp
         site at Spanish Bottom.
June 3   Moderate steep hike up from Spanish Bottom in Canyon-
         lands Maze District.
June 4   Raft downriver to beach campsite at base of Surprise
         Valley.
June 5   Raft heavy whitewater through Cataract Canyon to beach
         camp at mouth of Dark Canyon.
June 6   Rigorous hike from river to rim up through the water
         seeps, pools, and broad ledges of incredibly beautiful Dark
         Canyon. Picked up by van and taken to Hite Marina for
         sunset overflight of Canyonlands. Return to Moab for final
         celebration meal.
June 7   Return home or continue journey.

Lodging, Meals, and Transportation
Travel will be by vans, motorized rafts (J-rigs) or on foot. Dur-
ing the days on the rim, transportation will be by van. Lodging in
Moab will be in a comfortable motel. Camping near the river for
several nights will be in tents and sleeping bags provided by the
rafting outfitter. Meals are provided except for the arrival night and
the departure morning.

Physical Requirements
Especially because of the heat in southwestern Utah at this
time of year (~90–100 °F), individuals must be in excellent health.
The trip includes several substantial hikes for which each person
will carry a day pack with camera, water, and snacks. The longest
hike will be 5 miles with a 2000-ft. elevation gain. Although taken
at a reasonable pace with many points to rest and to explore the
geology, these hikes should be undertaken only by persons who are
in good health and physically active. Verification of health care cov-
erage will be required. No rafting experience is necessary; however,
Cataract Canyon offers some of the biggest and most challenging
whitewater in the United States.

Fee and Payment
GSA Member: $1445  Nonmember: $1545
A $200 deposit, due with your reservation, is refundable
through March 28, less $50 processing fee. Total balance due:

Included: All meals except breakfast on the departure day;
comfortable four-wheel van transportation; double-occupancy lodg-
ing in Moab; tents, sleeping bags, and pads when camping; geologi-
cal reading materials and guidebook; overflight of Canyonlands; and
of course, the companionship of expert scientific leaders.

Not included: Gratuities for raft guides. Airfare from Grand
Junction, Colorado, or transfer to Moab. We will arrange for an
optional group pick-up and return.

Description
This trip is an exceptional educational opportunity for the
physically active person. The itinerary includes geologic features
found nowhere else. More than 1,500 natural stone arches stand in
Arches National Park, which has the world’s highest concentration
of these remarkable features. Nearby is Canyonlands, Utah’s largest
national park, a unique area of sandstone pillars and mazes of
INDIANA UNIVERSITY

MINERALOGY/PALYEOLOGY

A Ph.D. or A.B.D. is necessary. Teaching duties include 3 undergraduate/graduate classes per semester or will be received until the position is filled.

Applications, including three references and complete vita, should be sent to: Wm. A. Crawford, Chairman, Geology Department, Indiana State University, Pocatello, ID 83209-8072. Position is contingent on funding, and applications will be reviewed beginning February 15, 1997. ISU is an EO/AA Employer.

SITUATION WANTED

1997-1998 academic year. The successful candidate will teach one or both appointees in the general education program. One or both appointees shall provide core curriculum instruction that is administered by the School of Arts and Sciences. Woman and minority candidates are encouraged to apply.

The successful candidate will be expected to establish a vigorous research program involving undergraduate and graduate students. Duties will include supervision of MS theses and qualified instruction of undergraduate and graduate courses in the subject areas of structural geology, geomorphic mapping, summer field geology, neotectonics, tectonic problems, geophysics, and engineering geology. Interested individuals with Ph.D. or D.Sc. degrees should apply. Deadline for applications is January 20, 1997. A Ph.D. is required at the time of employment.

Applications should include vita and a statement of teaching interests. Applicants should arrange to have reference sent to Dr. Stephen D. Stahl, Chairman, Geology Department, Central Michigan University, Mt. Pleasant, MI 48859. All application materials must be received by January 15, 1997. CMU (AA/EO institution) encourages diversity, and resolves to provide equal opportunity and non-discriminatory practices, and does not discriminate in employment or provision of services on the basis of disability, sexual orientation, or other irrelevant criteria.

DEPARTMENT OF EARTH AND ENVIRONMENTAL SCIENCE

The Department of Earth and Environmental Science invites applications for a visiting professor position for the 1997-1998 academic year. The successful candidate will teach courses from the Department of Earth Science, Physical Geology, Historical Geology, Mineralogy, Igneous and Metamorphic Petrology, and Environmental Geology. Candidates with specialized training in areas of environmental geochemistry, mineralogy/petrology are preferred. A Ph.D. is required at the time of employment. Application should include vita and a statement of teaching interests. Preferred are those who have Ph.D. degrees in engineering geology and applied geophysics. Deadlines include 3 undergraduate/graduate classes per semester or will be reviewed until the position is filled. Applications should be sent by Chair: Search Committee, Department of Earth and Environmental Science, Long Island University, C.W. Post Campus, Brookville, Long Island, NY 11548. Long Island University is an affirmative-action/equal opportunity employer.

CALIFORNIA STATE UNIVERSITY, LOS ANGELES

TWO TENURE-TRACK FACULTY POSITIONS, DEPARTMENT OF GEOLOGY

ENGINEERING GEOLOGIST / GEOPHYSICISTS. Ph.D. required with training in hydrogeology. Preference will be given to candidates with interest in geohydrology and groundwater hydrology. Applicants should arrange to have reference sent to: Wm. A. Crawford, Chairman, Geology Department, Indiana State University, Pocatello, ID 83209-8072. Position is contingent on funding, and applications will be reviewed beginning February 15, 1997. ISU is an EO/AA Employer.

Applications, including three references and complete vita, should be sent to: Wm. A. Crawford, Chairman, Geology Department, Indian
SURFACE PROCESSES—BOSTON COLLEGE

The Department of Geology and Geophysics at Boston College seeks a dynamic candidate for a tenure-track faculty position (rank open) in the area of Surface Processes, beginning Sept. 1997. Individuals may have research interests in any of the sub-specialties in this broad field, but those with backgrounds in geomorphology, surface hydrology, and engineering geology are particularly encouraged to apply. A Ph.D. is required and post-doctoral experience desirable. The individual will be required to teach geology and graduate and undergraduate courses in our geology and environmental programs and to carry an aggressive research program in his or her specialty. The Department, which also runs the nearby Western Geophysical Observatory, is well equipped (including flume and GIS laboratories) and is housed in a recently renovated facility. The campus is 8 miles west of Boston. Rank of appointment will be commensurate with experience.

The Department of Geology, University of Florida, is seeking applications for an Assistant/Associate Professor position in Marine Geology and Sedimentology, with particular strengths in: deep marine fan deposition, basin analysis, and slope, clastic shallow marine and mixed fluvial/aeolian sedimentology, with particular strengths in: deep marine fan deposition, basin analysis, and slope, clastic shallow marine and mixed fluvial/aeolian sedimentology. Appointments in this area of specialty are due no later than January 10, 1997. Further information may be obtained from the above at 617-552-3541 or via E-mail hepburn@bu.edu.

Boston College is an affirmative action/equal opportunity employer. Qualified women and minorities are encouraged to apply.

Z&S CONSULTANTS, INC.
GEOLoGY AND GeoCHEMISTRY ViCIES IN HOUSTON, TXaRS

The Z&S Group, through its unique combination of geo- scientific, software, and engineering expertise, is the market leader in the provision of well log processing software and associated geological and petrophysical services. With strategically located offices in London, Aberdeen, and Houston, and access to over 550 consultants, the groups expertise is readily available throughout the world.

The Z&S Group are industry leaders in the development of innovative interpretation approaches for the evaluation of borehole image and dipmeter data. Our particular strengths in well log interpretation, core analysis and well testing are backed by our unique lab, based in Houston, U.S.A. but applicants must be willing to travel and work abroad.

Sedimentologists. We seek people who are educated to post-graduate level and have interest in marine geology and sedimentology, with particular strengths in: deep marine fan and slope, clastic shallow marine and mixed fluvial/aeolian deposition.

Structural Geologists. Individuals, educated to post-graduate level with experience in the analysis of outcrop or core scale structural features, including fractured car- bonates and fault systems in clastic rocks. Experience of multi-scale investigations (petrographic to seismic scale) and fault population studies would be advantageous. For these posts we expect individuals who are self- motivated, with an ability to work in a team environment and to produce results within tight deadlines. A working knowl- edge of UNIX and some programming experience would be a distinct asset, but is not essential. Training will be provided for all applicants. Applicants are expected to multi-task in a team environment and to produce results within tight deadlines. Applicants are expected to multi-task in a team environment and to produce results within tight deadlines. Applicants are expected to multi-task in a team environment and to produce results within tight deadlines.

MARINE STRATIGRAPHY/SEDIMENTOLOGY

The Department of Earth Sciences, University of California, Santa Barbara invites applications for a tenure-track faculty position in marine stratigraphy/stratigraphy/sedimentology to begin September 1997. We seek an accomplished academic researcher with experience in marine sedimentary rocks, linking global paleoenviron- mental and historical change through study of the stratigraphic record. A strong background in field research orienta- tion is desirable, as well as the ability to integrate one or more analytical approaches. The successful candidate will be expected to work with colleagues to design and conduct research projects in oceanic geology, sedimentology, and related areas. Applications are invited from interested scientists, with the names and the addresses of three references should be sent directly to: Professor Charles E. Corfield, Chair, Department of Earth Sciences, University of California, Santa Barbara, CA 93106. Review of applications will begin January 15, 1997; how- ever, they will continue to be accepted until the position is filled. SUNY Oswego is an Affirmative Action Employer.

ENVIronMENTAL GEOLoGY

The Department of Earth Sciences, University of California, Los Angeles, offers a tenure-track faculty position in Environmental Geology. We are especially interested in candidates who are able to contribute to Environmental Sciences. In addition to teaching, the successful candidate will be expected to continue scholarly development, research and to seek external funding.

Our department has a strong commitment to under- graduate liberal arts education. Within the department we have a strong commitment to graduate and undergraduate research and course work, computational facilities include networked Macintoshes and PCs. The department houses equipment for research and class in sedimentary petrology, and provides the opportunity for research in marine geology and its applications.

The successful candidate will be expected to teach in the Department of Earth Sciences and to contribute fully to the development of the environmental sciences component of the Program. For detailed information about this posi- tion refer to the Program’s home page: www.ucla.edu/earth-sciences.

The Ph.D. is required at the appointment and the successful candidate will be required to hold fellowship privileges, i.e., professional registration (PGeo, PENG) in BC. The appointment will commence in September 1997.

In accordance with Canadian Immigration this adver- tised position is open to Canadian Citizens and Permanent Residents. Simon Fraser University is committed to the principle of equity in employment and offers equal employ- ment opportunities to all applicants.

Applicants should send a curriculum vitae, a letter describing current and near-term research interests, and copies of appropriate reprints. Please provide an E-mail address, fax number and the names of at least three refer- ees together with their complete addresses and fax numbers. Completed applications with references should arrive no later than 1st June 1997.

MARINE STRATIGRAPHY/SEDIMENTOLOGY

The Department of Earth Sciences, University of California, Santa Barbara invites applications for a tenure-track faculty position in marine stratigraphy/stratigraphy/sedimentology to begin September 1997. We seek an accomplished academic researcher with experience in marine sedimentary rocks, linking global paleoenviron- mental and historical change through study of the stratigraphic record. A strong background in field research orienta- tion is desirable, as well as the ability to integrate one or more analytical approaches. The successful candidate will be expected to work with colleagues to design and conduct research projects in oceanic geology, sedimentology, and related areas. Applications are invited from interested scientists, with the names and the addresses of three references should be sent directly to: Professor Charles E. Corfield, Chair, Department of Earth Sciences, University of California, Santa Barbara, CA 93106. Review of applications will begin January 15, 1997; how- ever, they will continue to be accepted until the position is filled. SUNY Oswego is an Affirmative Action Employer.

ENVIronMENTAL GEOLoGY

The Department of Earth Sciences, University of California, Los Angeles, offers a tenure-track faculty position in Environmental Geology. We are especially interested in candidates who are able to contribute to Environmental Sciences. In addition to teaching, the successful candidate will be expected to continue scholarly development, research and to seek external funding.

Our department has a strong commitment to under- graduate liberal arts education. Within the department we have a strong commitment to graduate and undergraduate research and course work, computational facilities include networked Macintoshes and PCs. The department houses equipment for research and class in sedimentary petrology, and provides the opportunity for research in marine geology and its applications.

The successful candidate will be expected to teach in the Department of Earth Sciences and to contribute fully to the development of the environmental sciences component of the Program. For detailed information about this posi- tion refer to the Program’s home page: www.ucla.edu/earth-sciences.

The Ph.D. is required at the appointment and the successful candidate will be required to hold fellowship privileges, i.e., professional registration (PGeo, PENG) in BC. The appointment will commence in September 1997.

In accordance with Canadian Immigration this adver- tised position is open to Canadian Citizens and Permanent Residents. Simon Fraser University is committed to the principle of equity in employment and offers equal employ- ment opportunities to all applicants.

Applicants should send a curriculum vitae, a letter describing current and near-term research interests, and copies of appropriate reprints. Please provide an E-mail address, fax number and the names of at least three refer- ees together with their complete addresses and fax numbers. Completed applications with references should arrive no later than 1st June 1997.

MARINE STRATIGRAPHY/SEDIMENTOLOGY

The Department of Earth Sciences, University of California, Santa Barbara invites applications for a tenure-track faculty position in marine stratigraphy/stratigraphy/sedimentology to begin September 1997. We seek an accomplished academic researcher with experience in marine sedimentary rocks, linking global paleoenviron- mental and historical change through study of the stratigraphic record. A strong background in field research orienta- tion is desirable, as well as the ability to integrate one or more analytical approaches. The successful candidate will be expected to work with colleagues to design and conduct research projects in oceanic geology, sedimentology, and related areas. Applications are invited from interested scientists, with the names and the addresses of three references should be sent directly to: Professor Charles E. Corfield, Chair, Department of Earth Sciences, University of California, Santa Barbara, CA 93106. Review of applications will begin January 15, 1997; how- ever, they will continue to be accepted until the position is filled. SUNY Oswego is an Affirmative Action Employer.
Smithsonian Offers Research Fellowships

Fellowships

The Smithsonian Institution research fellowships for 1997 include the fields history of science and technology, biological sciences, and earth sciences.

Smithsonian Fellowships are awarded to support independent research in residence at the Smithsonian in association with the research staff and using the Institution's resources. Under this program, senior, predoctoral, and postdoctoral fellowships of three to twelve months and graduate student fellowships of ten weeks are awarded. Proposals for research in the following areas may be made.

History of science and technology: industrial archaeology, natural history, physical sciences.

Anthropology: archaeology, cultural anthropology, physical anthropology.

Biological sciences: ecology, environmental studies, evolutionary biology, marine biology, natural history, paleobiology, systematics.

Earth sciences: meteoritics, mineralogy, paleobiology, petrology, planetary geology, sedimentology, and volcanology.


For more information and application forms, write to Smithsonian Institution, Office of Fellowships and Grants, 955 L’Enfant Plaza, Suite 7000, Washington, DC 20560, siofg@sivm.si.edu. Indicate the area in which you propose to conduct research and give the dates of degrees received or expected.

THE CRETACEOUS-TERTIARY EVENT AND OTHER CATASTROPHES IN EARTH HISTORY

edited by G. Ryder, D. Fastovsky, S. Gartner, 1996

This volume attempts to explore and clarify the relationships among the geological records, the extinctions, and the causes of catastrophes for life in Earth's history. Most of the papers address the geological record and the extinctions across the Cretaceous-Tertiary boundary, and the buried Chicxulub structure that is now consensually deemed to be of impact origin and to be intimately related to that boundary. Some of the papers are devoted to paleontological, stratigraphical, structural, petrological, geochemical, and theoretical analyses of this boundary and to what happened at Chicxulub. Other papers address other catastrophic boundaries or events, and extinctions that are not related to impact.

SPE307, 530 p., indexed, ISBN 0-8137-2307-8, $149.00, Member price $119.20

Volumes are 8 1/2” x 11”. Prices include shipping & handling.

BASEMENT AND BASINS OF EASTERN NORTH AMERICA

edited by B. A. van der Pluijm and P. A. Catacosinos, 1996

The mid-continent region of North America is arguably the best studied cratonic interior, but our knowledge of it is limited, compared with ancient and present-day plate margins. Continental interiors, or cratons, consist of exposed Precambrian basement rocks or regions covered by a relatively thin veneer of Phanerozoic sediments. In basic plate tectonic theory, cratons are considered tectonically inactive (i.e., the rigid portion of plates) relative to active plate margins. However, the geologic record shows that continental interiors are seismically active and that they preserve a record of tectonic activity following initial cratonization that includes the formation of intra-cratonic basins and arches, large-scale tilting, reactivation of faults and associated folding, regional strain patterns, and chemical processes. This volume includes new contributions on the geology, geophysics, and geochemistry of the mid-continent region of North America, and illustrates that continental interiors are subtle, yet sensitive recorders of past tectonic activity.

SPE308, 220 p., indexed ISBN 0-8137-2308-6, $62.00; Member price $49.60

1-800-472-1988 FAX303-447-1133

GSA Publication Sales
P.O. Box 9140, Boulder, CO 80301

http://www.geosociety.org