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GSA TODAY

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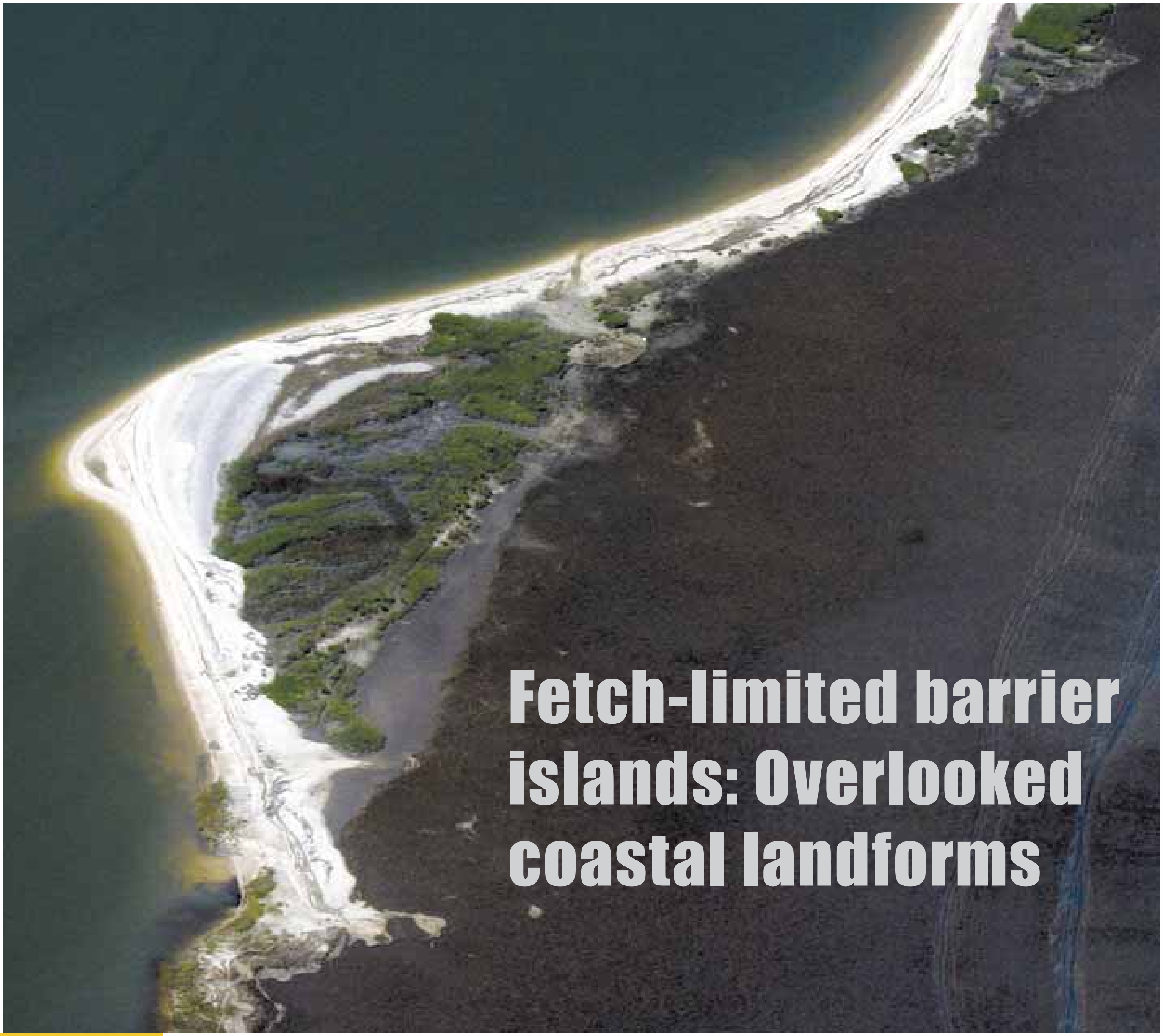

Fetch-limited barrier islands: Overlooked coastal landforms

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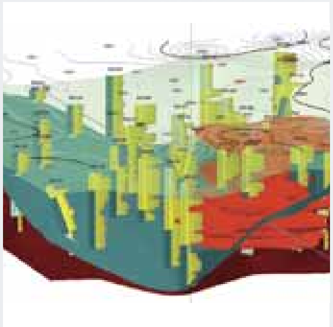

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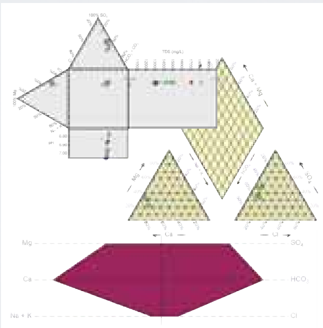

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Cover: A fetch-limited barrier island fringing the marsh of Ashe Island in St. Helena Sound, South Carolina, USA. The sandy island is very low (<2 m elevation), lacks dunes, and is active mainly during storms via overwash processes (note multiple overwash fans). See "Fetch-limited barrier islands: Overlooked coastal landforms" by Cooper et al., p. 4–9.

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Fetch-limited barrier islands: Overlooked coastal landforms

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ABSTRACT

The barrier islands of sheltered, low–wave energy coastal environments are an important, unstudied, and previously undocumented landform category. Globally, >15,000 such sandy fetch-limited barrier islands exist, compared to only 2200 open-ocean barrier islands. Fetch-limited conditions develop in the sheltered waters of fjords, bays, barrier island lagoons, and behind coral reefs. Fetch-limited barrier islands are typically short (1 km), narrow (10–100 m), and low (1–3 m) relative to ocean barriers and can be divided into approximately equal numbers of active and inactive forms. The inactive islands are locked in by salt marshes or mangroves and are only slightly impacted in the short term by modern marine processes. The evolution of active fetch-limited barrier islands is largely driven by storm events, and the impact of these storms is strongly influenced by the presence of marshes or mangroves.

Islands originate in diverse ways, including alteration of antecedent topography, spit breaching, and onshore transport of sand to marsh rims. Many are relict islands from higher Holocene and Pleistocene sea levels. The abundance of fetch-limited barrier islands is highly variable: 600 islands occur in the 2000 km² Laguna Madre of México compared to only 65 in the 6600 km² Pamlico–Albemarle Sound. They have a high geological preservation potential and may have been misidentified in the stratigraphic record because of a lack of appreciation of their morphology and structure. Because of unprecedented development pressure on open-ocean barrier islands, the new frontier of coastal development in the United States and elsewhere may well be these low-energy islands whose formative processes and temporal evolution are virtually unstudied.

INTRODUCTION

Globally, the length of low-energy shorelines far exceeds that of high-energy shorelines (Jackson et al., 2002); however, the bulk of scientific understanding of shorelines is based on open

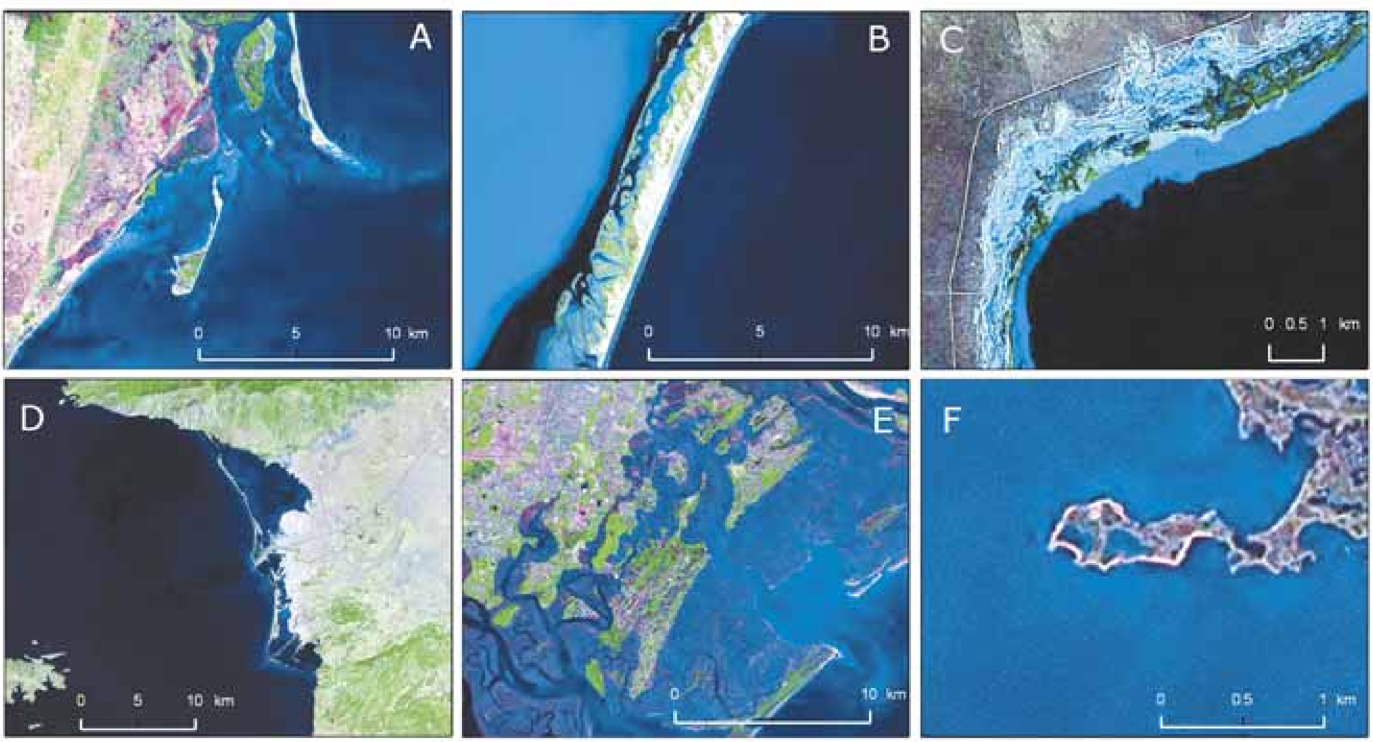

Figure 1. Six examples of fetch-limited barrier islands. (A) Xefina Island, Maputo Bay, Mozambique, probably formed from spit breaching. (B) A chain of fetch-limited barrier islands parallel to the lagoon side of the open ocean barrier of Laguna Madre, México. (C) A sequence of six barrier islands, five of which were stranded by Holocene sea-level fall in the upper Spencer Gulf, Australia. (D) Deltaic fetch-limited barrier islands at the mouth of the Menderes River, western Turkey, in sheltered, rocky bays. (E) An inactive fetch-limited barrier island surrounded by marsh behind the open-ocean barrier islands of Georgia, USA. (F) A wraparound marsh fringe island in Chesapeake Bay, USA. Photos courtesy the National Aeronautic and Space Administration's Earth Science Scientific Data purchase program, LANDSAT 4/5 and 7, https://zulu.ssc.nasa.gov/mrsid (accessed Dec. 2005).

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ocean studies. Around 2200 barrier islands comprise ~10% of the length of the world's open-ocean shoreline (Stutz and Pilkey, 2001), and their evolutionary processes are well studied. In this paper, we report the occurrence of more than 15,000 barrier islands in sheltered, low-energy settings that represent a hitherto unreported type of landform. Investigation of these islands has been bypassed in favor of the larger and societally more important open-ocean barrier islands, which are often subject to intense development pressure (e.g., Miami Beach, USA), while barriers in low-energy settings are seldom developed and then usually only lightly (e.g., Cedar Island, Pamlico Sound, USA). As open-ocean island beaches near development capacity, sheltered islands are becoming increasingly attractive for development purposes. Understanding the processes of island evolution is important for managing future development on these islands. Already, a number of U. S. fetch-limited barrier islands, such as Harkers Island, North Carolina; Johns Island, South Carolina; and Skidaway Island, Georgia, are extensively developed. In South Carolina, bridge-building to fetch-limited islands in coastal lagoons is currently at the forefront of a statewide environmental debate, and plans have been announced at the time of this writing for a massive tourism development on the Laguna Madre of México.

Figure 2. Marsh peat outcrops (marked by arrows) form temporary headlands that control the planform of barrier islands in low-energy settings, such as in this example from Chesapeake Bay.

Fetch-limited barrier islands occur in bays (e.g., Delaware Bay, USA), in back barrier lagoons (e.g., Laguna Madre, México; Fig. 1B), within drowned thermokarst topography (e.g., North Slope, Alaska, USA), in the lee of offshore islands (e.g., Western Turkey; Fig. 1D), or behind coral reefs (e.g., Queensland, Australia). The use of the descriptor "barrier island," modified by the adjective "fetch-limited," is appropriate for these features because the sheltered sand bodies considered in this study have all the components of open-ocean barrier islands as identified by Oertel (1985). The designation "fetch-limited" simply recognizes that these islands are not exposed to open-ocean high-energy swell wave conditions and that they are affected by only locally generated wind waves. In most cases, the fetch distance over which waves are generated is <25 km, although in the case of large lagoons like the Pamlico Sound, the largest potential fetch distance is up to 100 km. Following Jackson et al. (2002), we define fetch-limited as areas where waves are usually <1.0 m under non-storm conditions.

Some fetch-limited barrier islands are identical in physical appearance to ocean islands (e.g., Xefina Island in Maputo Bay, Mozambique; Fig. 1A). Others are quite irregular in shape or have sharp shoreline angles and corners, usually because of vegetative (salt marsh or mangroves) control of shoreline processes (Lewis et al., 2005, Chesapeake Bay; Fig. 1F). Marsh peat can also form temporary headlands that influence island plan form (Fig. 2). A small number have a near-circular plan view shape because the fetch is similar in all directions.

Fetch-limited barrier islands are found on every continent except Antarctica (Table 1). Like ocean barriers (Glaeser, 1978; Pilkey, 2003), they are found predominantly along trailing edge margins, where large lagoons are common. Nonetheless, as much as 10% of the world's total is located along active margins (e.g., Golfo de Tehuantepec, México). Fetch-limited barrier islands exist under tidal conditions ranging from megatidal (e.g., King Sound, Australia) to virtually tideless (e.g., Pamlico Sound, USA). They also exist in all types of coastal climates, from the polar Arctic (e.g., Obskaya Guba, Russia) to hot arid regions (e.g., Bardawil lagoon, Egypt), but are most abundant in temperate (e.g., Atlantic Coast, USA) and humid subtropical zones (e.g., Mozambique).

The abundance of fetch-limited barrier islands in a given setting depends on several factors, including the size and bathymetry of the bay, fetch, availability of sand, sea-level history, storm frequency and direction, vegetation, salinity, tidal range, and antecedent morphology. Depending on all these factors, the abundance of islands within lagoons varies considerably. For example, Pamlico–Albemarle Sound, a lagoon of 6600 km^2, contains only 65 islands, while the 2000 km^2 Mexican Laguna Madre has over 600 islands, the highest density of fetch-limited barrier islands we have observed anywhere.

Fetch-limited barrier islands fall into three main categories: active, inactive, and anthropogenic. Globally, there are approximately the same number (7500) in each of the first two categories.

- Active fetch-limited barrier islands form and continue to evolve (erode, accrete, and migrate) under present sea level and fetch-limited oceanographic conditions.
- Inactive fetch-limited barrier islands (Fig. 1E) are those trapped by salt marshes or mangroves extensive enough

to protect the islands from most storms. Subaerial processes play an important role in the evolution of these islands.

- Anthropogenic islands comprise mostly dredge spoil piles from the creation of navigation channels. These are globally abundant and are frequently difficult to distinguish from active or inactive islands.

Fetch-limited barriers form by the same mechanisms as ocean-facing barriers; for example, through spit breaching, inundation, erosion of preexisting topography, and sediment inputs from offshore and/or longshore drift. The levels of energy involved in their formation are much lower than those of their open-ocean counterparts; consequently, they are much smaller. Some fetch-limited barrier islands are ancient ocean barrier islands left stranded from a higher sea-level stand (e.g., Roanoke Island, North Carolina). Holocene fetch-limited barrier islands are particularly common in the Southern Hemisphere, where they were stranded as sea level dropped during the past 2000–4000 yr. For example, in Spencer Gulf, Australia (Fig. 1C), there are up to six lines of fetch-limited barrier islands behind an active seaward island, each at a slightly lower elevation in a seaward direction. In this situation, the landward islands may still be active during high tides and storms, but many such islands are now isolated from their formative processes by the most recent barrier islands. Some fetch-limited barrier islands are surrounded by salt marsh (e.g., Skidaway Island, Georgia) or mangroves (e.g., Mangoky River Delta, Madagascar) and are essentially inactive, while others remain subject to periodic wave reworking under fetch-limited conditions.

The findings reported here relate only to the world's 7500 active islands and are based on analysis of satellite imagery, charts, maps, aerial photos, and field reconnaissance of more than a dozen fetch-limited coastal environments, including sites in Turkey, Mozambique, Australia, México, and the USA. Our goal is to provide a global perspective on the morphology, origin, and distribution of these islands as revealed by our ongoing research program.

TABLE 1. GLOBAL DISTRIBUTION OF ACTIVE FETCH-LIMITED BARRIER ISLANDS

	Number	Percent of total	Total length (km)	Avg. length (km)
Northern Hemisphere	4481	63.8%	4912	1.1
Southern Hemisphere	2542	36.2%	2498	1.0
Africa	728	10.4%	802	1.1
Atlantic Ocean	208	3.0%	234	1.1
Indian Ocean	83	1.2%	139	1.7
Mediterranean Sea	9	0.1%	11	1.2
Mozambique Channel	337	4.8%	345	1.0
Red Sea	91	1.3%	73	0.8
Australia	1710	24.3%	1475	0.9
Arafura Sea	325	4.6%	332	1.0
Gulf of Carpentaria	65	0.9%	90	1.4
Indian Ocean	1075	15.3%	555	0.5
Pacific Ocean	245	3.5%	498	2.0
Eurasia	2005	28.5%	2483	1.2
Arctic Ocean	857	12.2%	1250	1.5
Atlantic Ocean	37	0.5%	32	0.9
Baltic Sea	22	0.3%	33	1.5
Black Sea	107	1.5%	116	1.1
Indian Ocean	506	7.2%	460	0.9
Mediterranean Sea	160	2.3%	194	1.2
North Sea	3	0.0%	4	1.3
Pacific Ocean	231	3.3%	295	1.3
Persian Gulf	58	0.8%	58	1.0
Red Sea	1	0.0%	2	2.0
South China Sea	23	0.3%	39	1.7
North America	2181	31.1%	2109	1.0
Arctic Ocean	378	5.4%	489	1.3
Atlantic Ocean	485	6.9%	400	0.8
Beaufort Sea	77	1.1%	124	1.6
Bering Sea	30	0.4%	34	1.1
Caribbean Sea	21	0.3%	24	1.1
Gulf of California	108	1.5%	99	0.9
Gulf of Mexico	818	11.6%	656	0.8
Pacific Ocean	264	3.8%	283	1.1
South America	399	5.7%	541	1.4
Atlantic Ocean	286	4.1%	373	1.3
Caribbean Sea	91	1.3%	114	1.3
Pacific Ocean	22	0.3%	54	2.5
Total	7023		7410	1.1

ISLAND CHARACTERISTICS AND CONTROLS

Fetch-limited barrier islands are typically short (1 km), narrow (10–100 m), and low (1–3 m). Fifty meters is an arbitrary minimum island length established in the study, although many islands smaller than this exist. The average island length of the 105 islands along the shores of Delaware Bay, USA, is 1.1 km, compared to an average length of 0.4 km for the 340 islands in Spencer Gulf, Australia (Fig. 1C). The longest island in Delaware Bay is 20 km; the shortest is just 100 m. Likewise, the longest island in the Spencer Gulf is 8 km; the shortest is 50 m. By contrast, the average lengths of Texas and North Carolina ocean barriers are 54 km and 21 km, respectively. The small size is attributed to several factors, including low availability of sediment, shallow depths of wave penetration on the shoreface, infrequency of sedimentary activity, limited height of wave runup and hence overwash, and limited accommodation space. These factors combine to produce thin, linear sand accumulations in a low-energy setting.

Inlets and tidal deltas are less important in the evolution of fetch-limited islands compared to those in open-ocean settings. Ebb tidal deltas, when present, are usually small, extending seaward a few tens of meters, and flood tidal deltas are generally absent altogether (Fig. 3). Inlet migration and the formation of new inlets do occur but are not common (Fig. 4).

Islands can exist in a number of different locations within the fetch-limited environment, including immediately behind ocean inlets (e.g., Tapora Bank, New Zealand), fringing marginal salt marshes (e.g., Neuse River Estuary, USA), on the rim of deltas that empty into bays (e.g., Menderes Delta, Turkey; Fig. 1D), and in spectacular chains lagoonward of and parallel to oceanic barriers (e.g., Laguna Madre, México; Fig. 1B).

Orientation of low fetch-limited barrier islands can be highly variable, much more so than ocean-facing islands, because relatively significant fetch may come from almost any direction (Fig. 5). Lagoon bathymetry (shoals and deeps) and patches of vegetation may determine effective fetch. Often there is a strong vegetative control on island planform that may be locally more important than fetch or dominant wind direction. The ends of some fetch-limited barrier islands are highly curved,

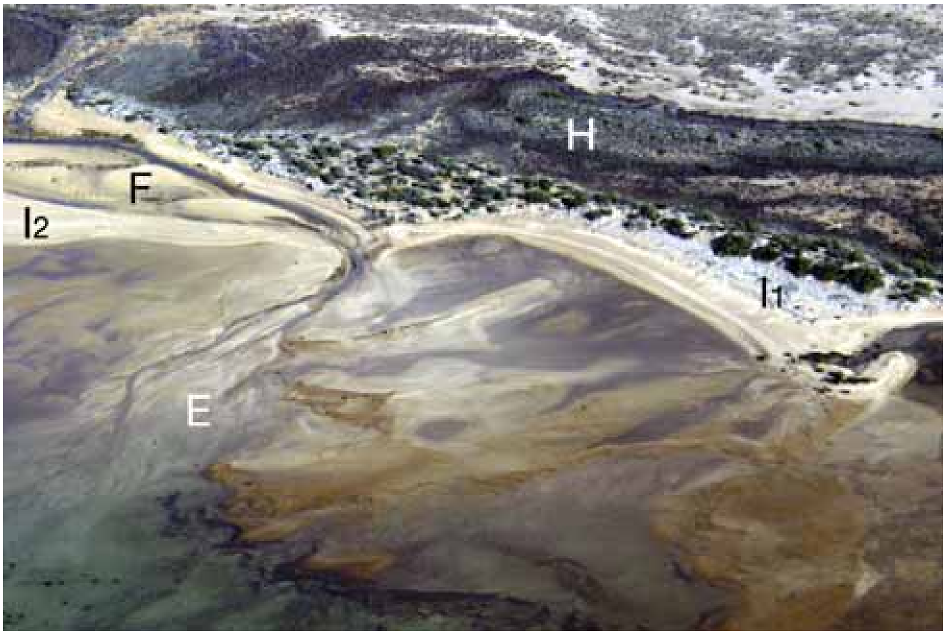

Figure 3. Ebb-tide delta (E) and flood-tide delta (F) developed at a tidal inlet in a fetch-limited barrier island chain (I1, I2) in upper Spencer Gulf, South Australia. The islands are backed by an intermittently flooded supratidal flat (H).

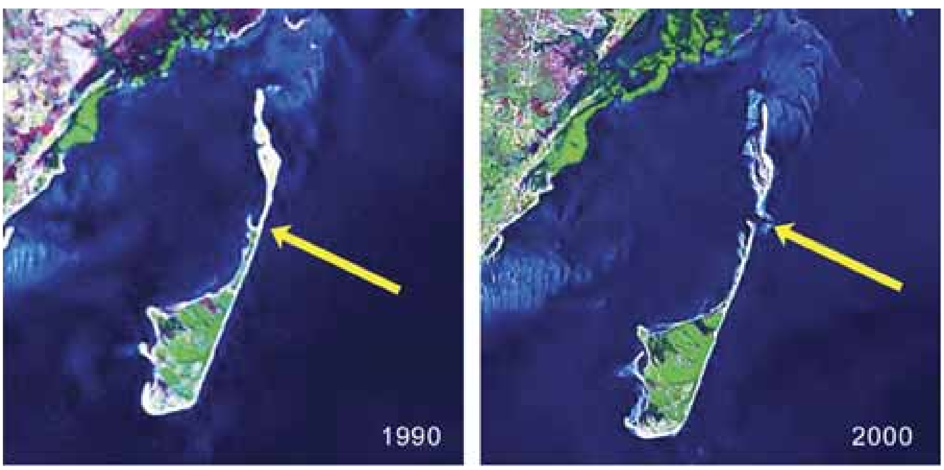

Figure 4. Satellite images from 1990 and 2000 record the formation of a tidal inlet and ebb delta (arrowed) in Xefina Island, Maputo Bay, Mozambique. The southern, landward margin of the island also shows evidence of modification during this period. Unvegetated sand is white; vegetation is green. Photos courtesy the National Aeronautic and Space Administration's Earth Science Scientific Data purchase program, LANDSAT 4/5 and 7, https://zulu.ssc.nasa.gov/mrsid (accessed Dec. 2005).

Figure 5. Island in central Laguna Madre, Tamaulipas, México, affected by wave approach from two sides. The resulting fetch-limited sandy barriers, which face opposite directions, have enclosed a central lagoon.

a reflection of variable and even opposing fetch directions (e.g., Tangier Island, Chesapeake Bay, USA), but the islands may also form chains with little curvature of individual islands (e.g., Gulf of Ob, Russia; Delaware Bay, USA). In macro- and megatidal environments some fetch-limited islands are only intermittently surrounded by water; at low tide, they are surrounded by intertidal flats. Some are backed by supratidal flats that are cyclically flooded on a spring tide and/or storm and/or seasonal basis, and mangroves are commonly found seaward of the islands (e.g., Gulf of St. Vincent, Australia; Maputo Bay, Mozambique).

Processes that form and maintain fetch-limited barrier islands are the same as those on open-ocean islands, but their relative importance as well as their absolute magnitude are different. In a bay or lagoon with restricted fetch, the direction of locally generated wind waves is the dominant dynamic variable, similar to low-energy beaches (Jackson et al., 2002). The evolution of fetch-limited barrier islands is strongly dependent upon storms because wave energy is too low to induce much change under fair-weather conditions. For example, according to Jennings and Coventry (1973), physical changes in the intermittent islands of Point Torment, Australia (surrounded by water only at high tides), take place only during typhoons, which occur once every five years on average.

Widening of the fetch-limited islands occurs primarily by storm-driven overwash and/or beach ridge formation and, like all barriers, lengthening is accomplished by alongshore currents. Extensive dune formation is rare, and many islands lack dunes entirely. An important exception to the rule of minor dune formation is islands inside lagoons at the mouth of ocean barrier island inlets, where dunes with heights up to 10 m (e.g., Bogue Sound, North Carolina) may develop.

Biological control on fetch-limited island morphology is much more important than on ocean-facing barriers. For example, salt marshes, sea grasses, and mangroves can grow in front of and behind active fetch-limited barrier islands, acting to stabilize the islands, baffling the impact of storm waves, and encouraging sediment accumulation (Fig. 6). In addition, preexisting salt marshes (Chesapeake Bay, USA) and mangroves (Maputo Bay, Mozambique) commonly provide platforms for island development. Sand accumulated along the margins of a patch of salt marsh results in the circular shape of some islands in the southern Chesapeake Bay, USA. Such biological control is seldom seen on open-ocean islands because greater wave energy prevents establishment of salt marshes and mangroves on the seaward margin of barrier islands. Salinity probably plays an additional role in island evolution through its control on the type and abundance of vegetation. Under high salinity conditions, such as existed in Laguna Madre, México, before artificial inlets were constructed through the ocean barrier chain (Tunnel and Judd, 2002), vegetative control was likely less important and physical processes more dominant than at present.

Existing topographic features frequently provide the sand supply and the initial base for islands to form. Such geologic control is afforded by a variety of topographic irregularities, such as drowned natural river levees (e.g., Manzala Lagoon, Nile Delta, Egypt), rims of Carolina Bays (e.g., Chesapeake Bay, USA), Pleistocene barrier islands (e.g., Cedar Island,

Figure 6. Dense mangrove stands (M) developed in front of and behind islands, upper Spencer Gulf, South Australia.

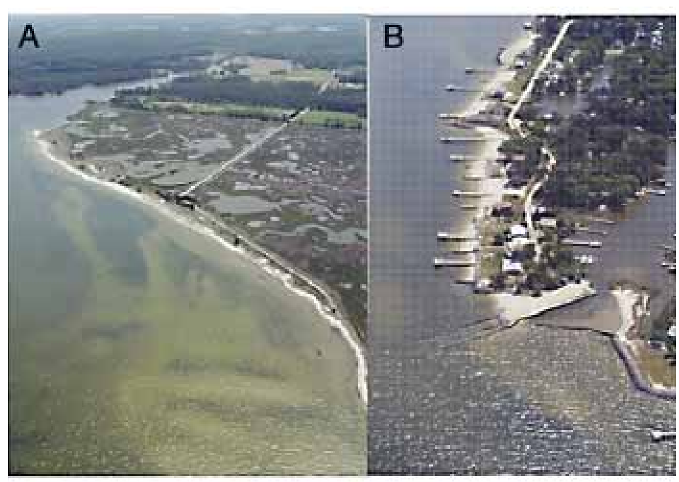

Figure 7. (A) Small-scale development on low-energy barrier island in Chesapeake Bay has been facilitated by construction of a causeway. The scale of development on the adjacent Maryland coast (B) of Chesapeake Bay shows the demand for development in such settings.

Pamlico Sound, USA), drowned dune fields (e.g., King Sound, Australia), and overwash fans at the back of the open-ocean barriers (e.g., Laguna Madre, México). With time, the original drowned topographic feature may be altered beyond recognition. For example, the "clay dunes" (Price, 1963) of Laguna Madre are being eroded and their sediment reworked into new islands under contemporary wave action.

GEOLOGICAL SIGNIFICANCE

The preservation potential of these features is high because the infrequency of wave activity enhances the possibility of overstepping and in situ drowning and burial by fine-grained lagoonal sedimentation under rapid transgressive situations. During sea-level fall, the stranding of islands (as in the Spencer Gulf) that are flanked by high tidal flat and supratidal sedimentary environments also provides a relatively high preservation potential as the islands are blanketed by high marsh facies. It is entirely possible that thin beds of sand within lagoonal facies recorded in the geological record and interpreted as creek point bars, tidal deltas, and stream mouth bars represent former fetch-limited barrier islands. They do contain distinctive internal sedimentary structures that, in combination with their gross geometry and setting, should enable identification in the geological record.

THE FUTURE

Few fetch-limited barrier islands are intensively developed, although many have small-scale habitation (Fig. 7A). Fetch-limited islands are likely to be subjected to development pressure in the immediate future because ocean-facing barrier islands in the first world are already extensively developed, and there is great demand for coastal land even in low-energy environments (Fig. 7B). The environmental and social impact of development of these low-energy islands will differ from that of their ocean-facing counterparts in several ways. Construction at low elevations, which typifies such islands, is a hazard from the standpoint of storm surges. The loss of a beach due to seawall emplacement may turn out to be more societally acceptable for seldom-used lagoon beaches, but the potential for damage to marshes from such seawalls is locally very high. Beach nourishment to restore eroded fetch-limited island beaches will probably be much less costly because of lower wave energies. In addition to these predictable responses, there will likely be unexpected impacts: the lack of knowledge of these features precludes their identification at this stage. Because of the imminent threat of development, however, it is important to rapidly increase our understanding of the complex and widely variable evolutionary processes of these islands.

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THE GEOLOGICAL SOCIETY OF AMERICA

Message from the GSA Nominations Committee

GSA thanks each Member who volunteered or nominated another Member to serve on a committee starting July 2007. We received an outstanding slate of candidates to fill a limited number of committee vacancies, and the decisions were difficult. Volunteers or nominees not selected this year will remain on active status for future consideration over the next two years. The Nominations Committee would further like to encourage you to volunteer or nominate another Member for additional committee openings in the coming year. You may view the complete list of upcoming committee vacancies at www.geosociety.org/aboutus/commtees/, or see page 18 of this issue.

GSA could not operate without its Members' participation, and we are grateful for your willingness to get involved in the affairs of the Society.

CALL FOR ABSTRACTS

CIRCUM-PACIFIC TECTONICS, GEOLOGIC EVOLUTION, AND ORE DEPOSITS

A symposium in honor of William R. Dickinson

September 24-30, 2007 • Hilton El Conquistador Golf and Tennis Resort • Tucson, Arizona

Sponsored by the Arizona Geological Society

Although most oral sessions have been filled, we plan to prominently feature posters and displays of specimens from mines and prospects.

POSTERS will have the same status as oral papers and manuscripts based on posters will be included in the proceedings volume. Abstracts should be submitted through our online submittal process.

CORE SHACK DISPLAYS do not require abstracts, but display space must be requested online.

ATTENTION STUDENTS! Financial assistance for student attendance. To apply for a grant, please go to **http://agssymposium.org/pages/just-for-students.php**

The symposium is shaping up as a major international scientific event that will also be *fun* for participants and their families. Offerings include a variety of special social and networking events, in addition to our core programs, field trips, and special SEG, SME, and UNESCO events. So plan now to attend with your family.

Abstract Deadline: April 1, 2007

Consider Sponsoring, Exhibiting, or Advertising with Ores & Orogenesis.
*For more information, see our website at **www.agssymposium.org***

Attention Voting Members: GSA Elections Start 8 March 2007

The success of GSA depends on you, the Members, and on the work of the elected officers who serve on GSA's Executive Committee and Council. All GSA member types are eligible to vote. Please make your wishes for GSA known by voting for the nominees listed here.

In late February, you'll have received a postcard with instructions on how to access a secure Web site and your electronic ballot. Biographical information on each candidate is available for review at www.geosociety.org. Paper versions of the ballot and candidate information are available for those unable to vote online.

JULY 2007 OFFICER AND COUNCILOR NOMINEES

PRESIDENT	VICE PRESIDENT	TREASURER
(July 2007–June 2008)	(July 2007–June 2008)	(July 2007–June 2008)
John M. (Jack) Sharp Jr.	**Judith Totman Parrish**	**Robbie R. Gries**
University of Texas at Austin, Austin, Tex., USA	University of Idaho, Moscow, Idaho, USA	Priority Oil and Gas LLC, Denver, Colo., USA

COUNCILOR Position 1	COUNCILOR Position 2	COUNCILOR Position 3
(July 2007–June 2011)	(July 2007–June 2011)	(July 2007–June 2011)
John J. Clague Simon Fraser University Burnaby, B.C., Canada	**G. Randy Keller** University of Oklahoma Norman, Okla., USA	**Yildirim Dilek** Miami University–Ohio Oxford, Ohio, USA
Jacqueline E. Huntoon Michigan Technological University Houghton, Mich., USA	**Allen J. Dennis** University of South Carolina Aiken, S.C., USA	**Monica E. Gowan** University of Canterbury Christchurch, New Zealand

Ballots must be submitted electronically or postmarked by 6 April 2007.

THE GEOLOGICAL SOCIETY OF AMERICA

COMMENT

When did the life of plate tectonics begin?

Shoufa Lin, *Department of Earth Sciences, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada, shoufa@uwaterloo.ca*

The question of when plate tectonics began, and in particular whether it began in the Archean, is the focus of several recent articles (e.g., Cawood et al., 2006; Witze, 2006) and a recent GSA Penrose Conference (Condie et al., 2006). I support the idea that "modern-style" plate tectonics "evolved" from an earlier form of proto–plate tectonics, and I have suggested that the Neoarchean might represent a period of transition during which vertical tectonism (diapirism and sagduction; "plume regime"?) and horizontal tectonism ("plate regime") operated synchronously and potentially interactively (Lin, 2005; Parmenter et al., 2006). In support of the "evolutionary" view, I would like to offer the following comments, originally presented in a plenary discussion at Precambrian'95, held in Montreal in 1995.

Most, if not all, geologists agree that plate tectonics is a part of the earth system now. We should also agree that plate tectonics did not exist at the very early stages of Earth. (Before that, there was even no Earth!) If we agree on this, we should also agree that there must have been a period during the early stages of Earth's evolution when the process of plate tectonics was conceived and "embryo" plate tectonics began. The embryo grew into a baby, the baby into a teenager, and the teenager into an adult: "modern-style" plate tectonics. The embryo and the baby might have looked, behaved, and functioned quite differently from the adult. Therefore, we cannot say plate tectonics did not exist in the Archean just because there is no blueschist in the Archean record or no komatiite in the Phanerozoic record.

So when did the life of plate tectonics begin? Some might say that it began the moment the embryo was conceived, while others would say that it did not begin until the baby was born. I suggest we had embryo and the baby plate tectonics in the Archean, and the answer to the question of when plate tectonics began will depend on how mature you believe the process had to be before it could be called "plate tectonics."

REFERENCES CITED

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doi: 10.1130/GSAT01703C.1

YOU CAN CONTRIBUTE TO *GSA TODAY*

Comments on *GSA Today* Science Articles

Comments should be sent directly to the science editors (Gerry Ross, lavaboy@hawaiiantel.net, and Stephen Johnston, stj@uvic.ca) within two to three weeks of the science article's publication date. Comments, including references, should be no more than 350 words long. If your comment is accepted, the *GSA Today* science editors will forward it to the first author of the original article, who may wish to contribute a reply (also restricted to 350 words). Accepted comments that are longer than 350 words will be published online-only but are limited to the equivalent of one printed page, including references, tables, and figures (without tables and figures: no more than 850 words).

Letters to the Editor

Letters regarding items published in *GSA Today* are restricted to a total of 300 words and should be submitted to the managing editor (kasmus@geosociety.org) no more than three weeks after the publication of the original article. If the number of letters received exceeds the print space available, they will be posted to the *GSA Today* Web page (www.geosociety.org/pubs/gsatoday/letters.htm).

Commentary

A commentary, a brief discussion of an item of import to GSA and GSA Members (see an example on page 17 of this month's issue), should be no more than 850 words long and may be submitted to the managing editor (kasmus@geosociety.org) for consideration.

Groundwork

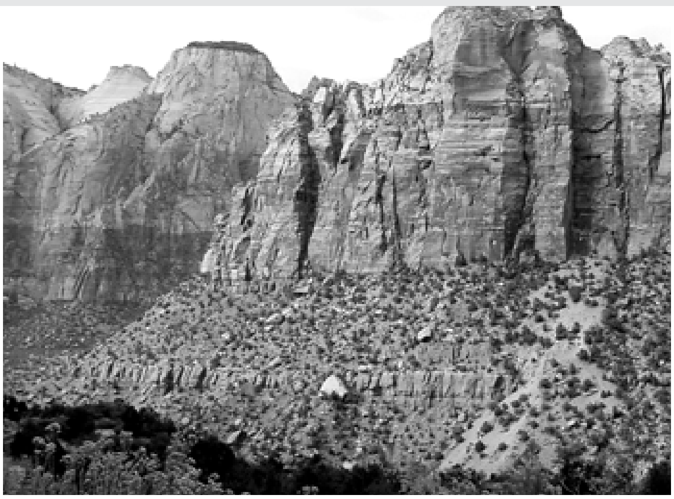
Groundwork is *GSA Today's* new forum for articles that lay the groundwork for furthering the influence of earth science on education, policy, planning, and funding. For more information and submission guidelines, see page 17 of this issue.

THE GEOLOGICAL SOCIETY OF AMERICA

ROCKY MOUNTAIN

59th Annual Meeting
Rocky Mountain Section, GSA
Dixie Center, St. George, Utah, USA

7–9 May 2007



Zion National Park, courtesy St. George Chamber of Commerce, www.stgeorgechamber.com/Zion,%20mountain.jpg.

REGISTRATION

Early Registration Deadline: 2 April 2007
Cancellation Deadline: 9 April 2007

Register online at www.geosociety.org/sectdiv/rockymtn/07rmmtg.htm#reg or at the Dixie Center during the meeting. GSA is committed to making its meetings accessible to all people interested in attending; please indicate special requirements (wheelchair accessibility, etc.) when you register. Accommodations listings and reservation codes are on the meeting Web site, www.geosociety.org/sectdiv/rockymtn/07rmmtg.htm.

Registration Fees

	Full Meeting		One Day	
	Early	Standard	Early	Standard
Professional Member	US$125	US$135	US$85	US$95
Professional Mbr >70	US$95	US$105	US$55	US$65
Professional Nonmember	US$135	US$145	US$95	US$105
Student Member	US$75	US$80	US$65	US$70
Student Nonmember	US$85	US$90	US$75	US$80
K–12 Professional	US$40	US$45	US$30	US$35
Guest or Spouse	US$25	US$30		
Field Trip or Short Course Only	US$25	US$25		

STUDENT TRAVEL GRANTS

Grants Deadline: 26 March 2007

Undergraduate and graduate students seeking funding for travel to the Rocky Mountain Section Meeting in St. George should apply online at www.geosociety.org/sectdiv/rockymtn/07rmmtg.htm#tg. Contact Ken Kolm, kkolm@bbl-inc.com, if you have any questions.

TECHNICAL SESSIONS

For information about the technical sessions, please contact technical program chair Mark Colberg, +1-435-865-8331, colberg@suu.edu. Symposia and field trip listings and descriptions are on the meeting Web site.

MENTORING PROGRAMS

Roy J. Shlemon Mentor Program in Applied Geoscience. Sponsored by *GSA Foundation.* Mon.–Tues., 7–8 May 2007, 11:30 a.m.–1 p.m.

The John Mann Mentors in Applied Hydrogeology Program. Sponsored by *GSA Foundation*. Tues., 8 May 2007, 5–6:30 p.m.

For more information, see www.geosociety.org/students.htm or contact Jennifer Nocerino, jnocerino@geosociety.org.

CALL FOR SPONSORS

The Rocky Mountain Section of The Geological Society of America welcomes sponsors: We seek partial or full support for the welcoming party (Dixie Center, 6 May 2007), morning and afternoon refreshments (7–9 May), and general meeting expenses. When your company or organization sponsors an event, it will be prominently recognized at the event, bringing attention to your services. Please contact Jerry D. Harris, +1-435-652-7758, jharris@dixie.edu, to learn more about sponsoring events at the Rocky Mountain Section Meeting.

EXHIBITOR INFORMATION

Exhibitor Registration Deadline: 2 April 2007

Our meetings attract a wide array of both applied and academic geoscientists and students from the American West and elsewhere, providing exhibitors with an excellent opportunity to interact with potential customers, colleagues, and skilled employees. The exhibit area will be inside the beautiful Dixie Center in the midst of all technical sessions, ensuring maximum exposure to meeting attendees. Fees: US$100 per unit plus an additional US$65 if you need power. These flat fees cover the entire meeting and are not prorated per day. Each unit includes one table, one 8′ back drape, two chairs, and one wastebasket. Please direct all inquiries to Jerry D. Harris, +1-435-652-7758, jharris@dixie.edu.

CONTACT INFORMATION

If you have questions or special requirements, please contact local committee chair Jerry D. Harris, +1-435-652-7758, jharris@dixie.edu, or technical program chair Mark Colberg, +1-435-865-8331, colberg@suu.edu. The following Web sites host information on St. George and activities in surrounding Washington County: www.sgcity.org, www.utahsdixie.com, and www.stgeorgechamber.com. See the meeting Web site, www.geosociety.org/sectdiv/rockymtn/07rmmtg.htm, for further details.

2007 GSA Section Meetings

Northeastern Section
12–14 March 2007
University of New Hampshire
Durham, New Hampshire

Information: Wally Bothner, University of New Hampshire, Dept. of Earth Sciences, James Hall, 56 College Rd., Durham, NH 03824-3578, USA, +1-603-862-3143, wally.bothner@unh.edu.

Southeastern Section
29–30 March 2007
Hyatt Regency Savannah on the Historic Riverfront
Savannah, Georgia

Information: Pranoti Asher, Georgia Southern University, Dept. of Geology and Geography, Statesboro, GA 30460-8149, USA, +1-912-681-0338, pasher@georgiasouthern.edu.

Joint Meeting
South-Central and North-Central Sections
11–13 April 2007
Kansas Memorial Union, University of Kansas
Lawrence, Kansas

Information: Greg Ludvigson, +1-785-864-2734, gludvigson@kgs.ku.edu—or—Greg Ohlmacher, +1-785-749-4502, ohlmac@kgs.ku.edu; both at Kansas Geological Survey, University of Kansas, 1930 Constant Ave., Lawrence, Kansas 66047-5317, USA.

Cordilleran Section
4–6 May 2007
Western Washington University
Bellingham, Washington

Information: Bernie Housen, Western Washington University, Dept. of Geology, MS 9080, 516 High St., Bellingham, WA 98225-5946, USA, +1-360-650-6573, bernieh@cc.wwu.edu.

Rocky Mountain Section
7–9 May 2007
Dixie Center
St. George, Utah

Information: Jerry Harris, Dixie State College, Science Building, 225 South 700 East, St. George, UT 84770-3875, USA, +1-435-652-7758, jharris@dixie.edu.

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Mentoring—Don't Miss This Rewarding Experience!

"I have enjoyed volunteering as a mentor and realize the significance of sharing information with students."

"The students' questions were thought-provoking and they made me realize what a satisfying job I've got. I'd like to do this again!"

The **Roy J. Shlemon Mentor Program in Applied Geoscience** is designed to acquaint advanced undergraduate and beginning graduate students with careers in applied geoscience. Volunteer mentors provide real-world information and insight based on their career experience—wisdom students may not glean from their regular academic training.

The **John Mann Mentors in Applied Hydrogeology Program** provides a forum for undergraduate and graduate students interested in hydrogeology or hydrology as a career to participate in informal conversations with professionals currently practicing in these fields. These programs are relaxed, small-scale, focused events.

If you are interested in serving as a mentor at one of the GSA Section Meetings, please contact Jennifer Nocerino, jnocerino@geosociety.org. See the program schedule at www.geosociety.org/science/mentors/07programs.htm.

THE GEOLOGICAL SOCIETY OF AMERICA

SCIENCE ▪ STEWARDSHIP ▪ SERVICE

CALL FOR NOMINATIONS

Sixteenth Annual Biggs Award

for Excellence in Earth Science Teaching for Beginning Professors

GSA established the Biggs Award to reward and encourage teaching excellence in beginning college-level earth science professors.

ELIGIBILITY

Earth science instructors and faculty from all academic institutions engaged in undergraduate education who have been teaching full-time for 10 years or fewer (part-time teaching is not counted in the 10 years) may be nominated for this award.

AWARD AMOUNT

The award of US$750 is made possible as a result of support from the Donald and Carolyn Biggs Fund (maintained by GSA Foundation), the GSA Geoscience Education Division, and GSA's Education and Outreach Programs. In addition, this award includes up to US$500 in travel funds to attend the award presentation at the GSA annual meeting.

DEADLINE AND NOMINATION INFORMATION

Nomination forms (*and updated nomination guidelines*) for the 2007 Biggs Earth Science Teaching Award are posted at www.geosociety.org/aboutus/awards/biggs.htm. Or, contact the Program Officer of Grants, Awards, and Recognition at +1-303-357-1028, awards@geosociety.org. Nominations must be received by **9 June 2007.**

Mail nomination packets to Program Officer, Grants, Awards, and Recognition, Geological Society of America, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA.

UPCOMING AWARD DEADLINES

Funds are administered by the GSA Foundation.

NOMINATIONS DUE

31 Mar. 2007: **John C. Frye Environmental Geology Award.*** For details, follow the link at www.geosociety.org/aboutus/awards/ or see the October 2006 issue of *GSA Today.*

2 Apr. 2007: **Don J. Easterbrook Distinguished Scientist Award.**** Quaternary Geology and Geomorphology Division. Send nominations to Jack F. Shroder Jr., Dept. of Geography & Geology, University of Nebraska, Omaha, NE 68182-0199, USA, jshroder@mail.unomaha.edu.

2 Apr. 2007: **Farouk El-Baz Award for Desert Research.**** Quaternary Geology and Geomorphology Division. Send nominations to Lisa L. Ely, Dept. of Geological Sciences, 400 E University Way, Central Washington University, Ellensburg, WA 98926, USA, +1-509-963-2821, ely@cwu.edu.

THE GEOLOGICAL SOCIETY OF AMERICA

*You may also contact Grants, Awards, and Recognition P.O. Box 9140, Boulder, CO 80301-9140, USA, +1-303-357-1028 awards@geosociety.org.

**Award details are in the January 2007 issue of *GSA Today* and at www.geosociety.org/aboutus/awards/.

COMMENTARY

Next time you are asked to review a manuscript…

John Geissman, *University of New Mexico; Chair, GSA Publications Committee; jgeiss@unm.edu*

Hugh Jenkyns, *University of Oxford; Editor, Geology; geology@herald.ox.ac.uk*

Yildirim Dilek, *Miami University; Editor, GSA Bulletin; dileky@muohio.edu*

G. Randy Keller, *University of Oklahoma; Editor, Geosphere; grkeller@gcn.ou.edu*

The timely, effective publication of science requires that the peer-review process functions in an expeditious, thorough, accurate, and fair manner. A critical element of this process is the willingness of individual scientists to conduct informed, objective, and helpful manuscript reviews in a timely fashion. During two meetings at the recent GSA Annual Meeting in Philadelphia, science editors for numerous journals had the opportunity to voice concerns about their all-important volunteer jobs. A unifying theme in these discussions was the inability to find appropriate and, of course, willing reviewers for a significant percentage of the manuscripts submitted. All too often, if potential reviewers actually do provide a reason for declining a manuscript, the common one given is "too busy." Well, most of us are too busy! Yet most (if not all) of us would like to have our own manuscripts reviewed in a timely (and fair and objective) fashion. The difficulty in finding willing reviewers is nothing new, but we are wondering if the level of difficulty, for a myriad of reasons, is increasing. Then add those delinquent reviewers who accept the task but never turn in a review, despite repeated reminders from the editorial office, hence delaying the whole process by weeks, if not months, and causing aggravation for all involved.

We view this problem, which is one that has been gathering increasing attention (e.g., the 29 November 2006, *Washington Post* article, "Journal editors are urged to demand more evidence," by Rick Weiss, and the 16 December 2006, *Science News* article, "Peer review under the microscope," by Christen Brownlee), as potentially compromising the whole peer-review process. The rewards for an effective and timely review are, unfortunately, not great, as we all know. However, next time you are asked to review a manuscript, we suggest that you consider taking one of the following three actions, in order of importance and usefulness:

1. Accept, and carry out your review in a timely manner.
2. Decline, but provide a reasoned explanation for declining to review the manuscript, and suggest at least two good potential alternative reviewers for the editor to contact.
3. Decline, but contemplate the possibility that the system is not so flawed that it does not have a memory of those who consistently decline to review manuscripts!

Timely dissemination of the results of good and exciting science in journal articles is only possible through the collective efforts of keen editors and effective referees. GSA Publications honors "Exceptional Reviewers" (see the December 2006 and January 2007 issues of *GSA Today*) and will continue to do so in the future. Please be one to be recognized!

Call for Papers:

GROUNDWORK: Furthering the Influence of Earth Science

GSA Today seeks articles that lay the groundwork for furthering the influence of earth science on education, policy, planning, and funding. Articles can include in-depth geoscience commentary, short observations and analysis of hot topics, and discussion of policy news and issues.

CHARACTERISTICS OF A "GROUNDWORK" ARTICLE:

❶ The printed article should be a **complete, stand-alone article.** (Ongoing or serial commentary or meetings summaries are not appropriate for this series.)

❷ Supplemental information may be included as a **GSA Data Repository item.**

❸ **Length:** No longer than 1400 words with two small figures or 1600 words with one figure. The philosophy behind this is twofold: (1) keeping an article short can increase the clarity and quality of the writing; and (2) a short article encourages readers to engage and seek more information.

❹ **Color figures** may be included at no cost to authors.

❺ *GSA Today* science editors will be responsible for **review and acceptance** of the articles.

❻ **Frequency:** Accepted articles will be published on a space-available basis.

To submit a "Groundwork" article, send your manuscript and figures via e-mail to *GSA Today* science editors Gerry Ross, lavaboy@hawaiiantel.net, and Stephen Johnston, stj@uvic.ca.

Call for GSA Committee Service

Stimulate Growth and *Change*

Serve on a GSA Committee!

2008–2009 COMMITTEE VACANCIES

Terms begin 1 July 2008 and run for three years (unless otherwise indicated).

GSA is seeking candidates to serve on Society committees and as GSA representatives to other organizations. Contribute to our science by volunteering yourself or nominating others you think should be considered for any of the following openings. Younger members are especially encouraged to become involved in Society activities. (**Graduate Students:** You are eligible to serve on GSA committees as full members, and Council encourages you to volunteer or nominate others for committee service.) If you volunteer or make recommendations, please give serious consideration to the specified qualifications for serving on a particular committee. **Please be sure that your candidates are GSA Members or Fellows and that they fully meet the requested qualifications.**

Volunteer or nominate online! The nomination form and instructions are available at www.geosociety.org/aboutus/commtees. Click on the **Nominate Online for 2008–2009** button to access a secure form. If you prefer, you may download and complete the paper nomination form, also located at this site, and return it to Pamela Fistell, GSA, P.O. Box 9140, Boulder, CO 80301-9140, USA, fax +1-303-357-1070. If you have questions, please contact Pamela Fistell, +1-303-357-1000 ext. 0, 1-800-472-1988 ext. 0, or pfistell@geosociety.org.

Nominations received at GSA headquarters by **15 July 2007** on the official one-page form will be forwarded to the Committee on Nominations. Please use one form per candidate. Information provided on the form will assist the committee members with recommendations for the July 2008 committee vacancies. The committee will present at least two nominations for each open position to GSA Council at its fall meeting. Appointees will then be contacted and asked to serve, thus completing the process of bringing new expertise into Society affairs.

Academic and Applied Geoscience Relations Committee (AM, T/E)
Three member-at-large vacancies

Strengthens and expands relations between GSA Members in the academic and applied geosciences. Proactively coordinates the Society's effort to facilitate greater cooperation between academia, industry, and government geoscientists. **Qualifications:** Members from academia, industry, and government who are committed to developing better integration of applied and academic science in our meetings, publications, short courses, field trips, and education and outreach programs.

Arthur L. Day Medal (T/E)
Two member-at-large vacancies

Selects candidates for the Arthur L. Day Medal. **Qualifications:** knowledge of those who have made "distinct contributions to geologic knowledge through the application of physics and chemistry to the solution of geologic problems."

Geology and Public Policy (AM, B/E, T/E)
Two member-at-large vacancies

Translates knowledge of earth sciences into forms most useful for public discussion and decision making. **Qualifications:** experience in public-policy issues involving the science of geology; ability to develop, disseminate, and translate information from the geologic sciences into useful forms for the general public and for GSA Members; familiarity with appropriate techniques for the dissemination of information.

GSA Public Service Award (T/E)
One member-at-large vacancy

Generates, receives, and evaluates candidate nominations for the GSA Public Service Award and the AGI Outstanding Contribution to the Public Understanding of the Geosciences Award. Each award is given in recognition of outstanding individual contributions to either the public awareness of the earth sciences or the scientific resolution of earth-science problems of significant societal concern. **Qualifications:** knowledge of those whose contributions and accomplishments have enhanced the general public's understanding of earth science.

Honorary Fellows (T/E)
Two member-at-large vacancies

Selects candidates for Honorary Fellows, who are usually non–North Americans. **Qualifications:** knowledge of geologists throughout the world who have distinguished themselves through their contributions to science.

Membership (B/E)
Three vacancies: One member-at-large; one member-at-large, government-employment category; one member-at-large, student category

Evaluates membership benefits and develops recommendations that address the changing needs of the Society's membership, attracts new members, and reviews GSA Fellowship nominations. **Qualifications:** experience in benefit, recruitment, and retention programs is desired.

July 2008 Committee Vacancies: *Extensive time commitment required AM—Meets at Annual Meeting B/E—Meets in Boulder or elsewhere T/E—Communicates by phone or electronically

Minorities and Women in the Geosciences (AM)
Three member-at-large vacancies

Stimulates recruitment and promotes positive career development of minorities and women in the geoscience professions. **Qualifications:** familiarity with the education and employment issues of minorities and women; expertise and leadership experience in such areas as human resources and education desired.

Nominations (B/E, T/E)
One member-at-large vacancy

Recommends nominees to Council for the positions of GSA Officers and Councilors, Committee members, and Society representatives to other permanent groups. **Qualifications:** familiarity with a broad range of well-known and highly respected geological scientists.

Penrose Conferences and Field Forums (T/E)
One member-at-large vacancy

Reviews and approves Penrose Conference proposals and recommends and implements guidelines for the success of the conferences. **Qualifications:** past convener of a Penrose Conference or a Field Forum.

Penrose Medal (T/E)
Two member-at-large vacancies

Selects candidates for the Penrose Medal. Emphasis is placed on "eminent research in pure geology, which marks a major advance in the science of geology." **Qualifications:** familiarity with outstanding achievers in the geosciences who are worthy of consideration for the honor.

Professional Development (T/E)
Two member-at-large vacancies

Directs, advises, and monitors GSA's professional development program, reviews and approves proposals, recommends and implements guideline changes, and monitors the scientific quality of courses offered. **Qualifications:** familiarity with professional development programs or adult education teaching experience.

Research Grants* (B/E)
Seven member-at-large vacancies

Evaluates student research grant applications and selects grant recipients. **Qualifications:** should have experience in directing research projects and in evaluating research grant applications.

***Treatise on Invertebrate Paleontology* Advisory Committee (AM)**
One member-at-large (paleontologist) vacancy

Advises Council, the Committee on Publications, and the *Treatise* editor on matters of policy concerning this publication. **Qualifications:** must be a paleontologist.

Young Scientist Award (Donath Medal) (T/E)
Two vacancies: One member-at-large; one councilor/former councilor

Investigates the achievements of young scientists who should be considered for this award and makes recommendations to Council. **Qualifications:** should have knowledge of young scientists with "outstanding achievement(s) in contributing to geologic knowledge through original research which marks a major advance in the earth sciences."

GSA REPRESENTATIVES TO OTHER ORGANIZATIONS

GSA–AAAS Consortium of Affiliates for International Programs (CAIP) (AM, B/E)
One GSA Representative vacancy (1 Jan. 2009–31 Dec. 2011)

Encourages cooperation on projects with international aspects and facilitates networking in its member societies. Meets twice yearly, providing a forum for scientific societies to discuss their international activities and exchange information on the status of international science.

AAPG Publication Pipeline Committee (B/E)
One GSA Conferee vacancy (1 July 2008–30 June 2011)

Provides the best-possible advice to assist the committee in its efforts to improve the task process and to spread the word of its activities to retired GSA Members or others who wish to dispose of books for donation to overseas libraries.

North American Commission on Stratigraphic Nomenclature (NACSN) (AM, possibly B/E)
One GSA Representative vacancy (Nov. 2008–Nov. 2011)

Develops statements of stratigraphic principles, recommends procedures applicable to classification and nomenclature of stratigraphic and related units, reviews problems in classifying and naming stratigraphic and related units, and formulates expressions of judgment on these matters.

THE GEOLOGICAL SOCIETY OF AMERICA

COMMITTEE, SECTION, AND DIVISION VOLUNTEERS: COUNCIL THANKS YOU!

The GSA Council acknowledges the many Member-volunteers who, over the years, have contributed to the Society and to our science through involvement in the affairs of The Geological Society of America.

July 2008 Committee Vacancies: *Extensive time commitment required AM—Meets at Annual Meeting B/E—Meets in Boulder or elsewhere T/E—Communicates by phone or electronically

Thank You So Much!

On behalf of the Foundation Trustees and staff, I would like to express our ***sincere appreciation*** to each of you who donated to the GSA Foundation during 2006. Your support of the GSA Foundation and GSA programs comes at a critical time in the geoscience world.

GSA Member contributions are vital if the Foundation is to do the greatest service in helping to fund the advancement of the geosciences. While membership in GSA has grown over the past few years, and the science in our world has changed, the challenge of providing continued support to the geosciences remains.

Thank you for making a difference in the future of the science.

We have provided an insert in this issue listing all of the 2006 GSA Foundation donors.

Most memorable early geologic experience:

I attended my first GSA meeting in Chicago, Illinois (1948?), by riding my then new Indian Scout motorcycle 350 miles, 180 of which were in a severe snowstorm.

—Richard D. Harvey

Update on the Cornerstone Initiative

In November 2006, the Foundation launched the **Cornerstone Initiative** as part of our extended twenty-fifth anniversary celebration. The intent of this initiative is to generate support for GSA programs.

The initiative goal of US$545,000 will provide additional funding for the following priority programs:

- **Student Research Grants**—$150,000
- **Mentor Programs**—$100,000
- **GeoCorps America Program**—$120,000
- **Field Forums**—$50,000
- **Penrose Conferences**—$40,000
- **Congressional Science Fellow**—$75,000

We ask that every GSA Member become a part of this initiative by making a donation to the Foundation. You can make a stretch gift (gifts that may be pledged over two years) at any of the following levels:

Penrose Circle—$500

Cornerstone—$1,000

Founders—$2,500

Legacy—$5,000

For your convenience, you may make your gift on the coupon below or go to the Foundation's Web site—gsafweb.org—to make a secure online donation or for more information.

I thank you in advance for your support of the GSA Foundation Cornerstone Initiative!

GSA FOUNDATION
A QUARTER CENTURY HELPING GSA SERVE YOU
25 YEARS

3300 Penrose Place, P.O. Box 9140
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drussell@geosociety.org

www.gsafweb.org

Enclosed is my contribution in the amount of $____________________.
Please credit my contribution for the:
☐ Cornerstone Initiative
☐ Greatest need ☐ Other: ____ Fund
☐ I have named GSA Foundation in my will.
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Address ______________________________

City/State/ZIP ______________________________

Phone ______________________________

In Memoriam

Howard F. Albee
Grand Junction, Colorado
5 January 2006

Robert E. Baker
Eureka, California
1 August 2006

Andrew W. Berg
Spokane, Washington
1 February 2006

Morton Bigger Jr.
Dallas, Texas
16 August 2006

J. Greg Cahill
Huntly, Virginia
Notified 5 December 2006

Ralph S. Cannon Jr.
Woodstock, Illinois
Notified 15 December 2006

Rhodes W. Fairbridge
New York, New York
8 November 2006

Victor F. Hollister
Mission, British Columbia
11 October 2006

George N. Huppert
La Crosse, Wisconsin
23 June 2005

James R. Jones
Tucson, Arizona
15 November 2006

Thor H. Kiilsgaard
Spokane, Washington
19 October 2006

James A. McCarthy
Houston, Texas
24 November 2006

Henry M. Morris
Santee, California
Notified 29 November 2006

Richard Rezak
Houston, Texas
10 November 2006

Neil H. Twelker
Seattle, Washington
6 July 2006

Hiroshi Ujiie
Tachikawa City, Tokyo
26 April 2006

Jack A. Wolfe
Tucson, Arizona
12 August 2005

Erratum: The January issue of *GSA Today* (v. 17, no. 1, p. 33) incorrectly reported that John P. Craddock was deceased; in fact, it was Craddock's father, J. Campbell Craddock, who died on 23 July 2006. *GSA Today* deeply regrets the error.

Please contact the GSA Foundation at +1-303-357-1054
or drussell@geosociety.org
for information on contributing to the Memorial Fund.

ANNOUNCEMENTS

ICS Stratigraphy Prizes

The International Commission on Stratigraphy (ICS), an entity of the International Union of Geological Sciences (IUGS), awards two ICS prizes to outstanding geoscientists every four years, during an International Geological Congress (IGC). The first awards were given at the thirty-second IGC in Florence in 2004; the second will be made at the thirty-third IGC in Oslo in 2008. **Nominations are due by 1 October 2007.**

The **Digby McLaren Medal** is awarded to honor a significant body of internationally important contributions to stratigraphy sustained over a number of years. The **ICS Medal** is awarded to honor high-quality research in stratigraphy by recognizing a single major achievement in advancing stratigraphical knowledge.

Nominations for either award are solicited from any source, not just members of IGS or other entities within IUGS. Nominations should include a brief biography of the nominee, a reasoned case based on the nominee's contributions, and, if necessary, translation into English of at least the abstracts of this material so that independent judgment can be made. Please contact Stan Finney, scfinney@csulb.edu, for further nomination and award details.

Submit nomination documents to Stan Finney, ICS Stratigraphy Prizes Committee Chair, Dept. of Geological Sciences, California State University at Long Beach, Long Beach, CA 90840, USA, +1-562-985-8637, scfinney@csulb.edu.

2007 GeoVentures — Travel & Tours for Geoscience Enthusiasts

Denali National Park.

Alaska: Changing Glaciers—Changing Landscapes

21–28 July 2007 (8 days)
Location: Southern and Central Alaska, USA
Scientific Leader: Bruce Molnia, U.S. Geological Survey

Trip Cost: US$2,700 for GSA Members and spouses and US$2,800 for nonmembers. **Deposit:** $300; **deposit deadline:** 1 June 2007.

Trip Overview: The objective of this tour is to introduce participants to the unique, dynamic, and rapidly changing glaciers of south-central Alaska with an examination of their role in triggering the landscape evolution of the area, all while enjoying the spectacular landscapes and geology of the region. Bruce Molnia is an expert on Alaska's glaciers and the effects of climate change.

2007 GSA GeoVentures

Participants must be 18 or older and in good health. Any physical condition requiring special attention, diet, or treatment must be noted in writing when reservations are made. GSA is committed to accommodating special needs. Deposits and payments are refundable under certain conditions. Please check www.geoventures.org for our refund policy. Please do not make flight reservations until GSA has confirmed that the trip will run. Contact Wesley Hill, whill@geosociety.org, +1-303-357-1005, if you need further information.

THE GEOLOGICAL SOCIETY OF AMERICA

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Send a deposit to hold your reservation; please pay by check or credit card. You will receive further information soon.

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❏ Single Room ❏ Double Room with__________

	DEPOSIT PER PERSON	NO. OF PERSONS	TOTAL PAID DEPOSIT
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CALIFORNIA	US$300	____	US$________
CHINA	US$500	____	US$________
MONTANA (STUDENTS)	US$200	____	US$________
	TOTAL DEPOSIT		US$________
	REMAINING BALANCE		US$________

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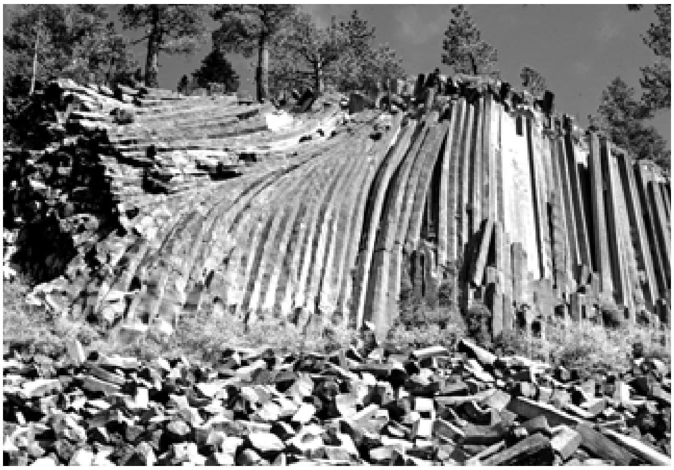
Credit Card # ______________________ Exp. Date

Signature ______________________ (print name)

MAIL OR FAX REGISTRATION FORM AND CHECK OR CREDIT CARD INFORMATION TO:

GSA GeoVentures, GSA Sales and Service
P.O. Box 9140, Boulder, CO 80301
Fax: +1-303-357-1071

MAKE CHECKS PAYABLE TO: GSA GeoVentures



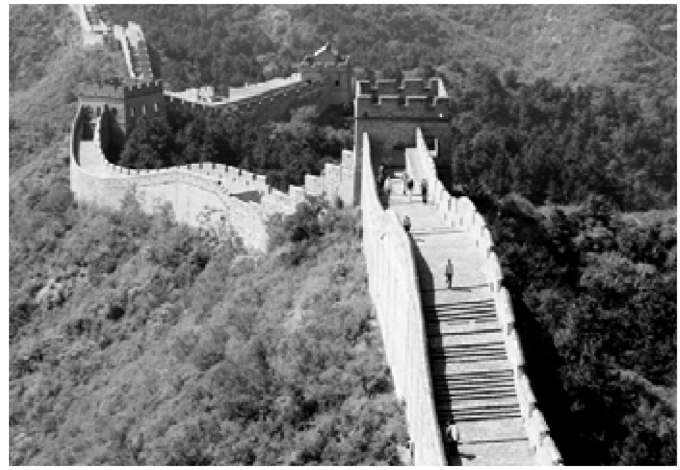
Devils Postpile, Devils Postpile National Monument, California.

Geology of the Sierra Nevada and White-Inyo Range, California, USA

GeoHostel, 4–11 August 2007 (8 days); **Location:** Mammoth Lakes and Crooked Creek Research Station, California, USA; **Scientific Leaders:** Steve Lipshie and Gary Ernst

Trip Cost: US$1,295 for GSA Members and spouses and US$1,395 for nonmembers. **Deposit:** US$300; **deposit deadline:** 2 July 2007.

Trip Overview: The first days of this GeoHostel will be spent exploring the Quaternary geology of the east-central Sierra Nevada region of California; the final few days will focus on the structural, stratigraphic, igneous, and metamorphic geology of the White-Inyo Range across the Owens Valley. At Mono Lake, participants will walk amongst the tufa deposits that form even today. Farther south, the group will walk upon lava domes and craters that are less than 700 years old and visit the classic columnar jointing at Devils Postpile National Monument.



Great Wall, China.

China's Feathered Dinosaurs—Paleo Expedition

20–29 July 2007 (10 days); **Location:** Western Liaoning Province, China; **Scientific Leader:** Hailu You

Trip Cost: US$2,800 for GSA Members and spouses and US$2,900 for nonmembers. **Deposit:** US$500; **deposit deadline:** 14 May 2007.

Trip Overview: Following the discovery of the first feathered dinosaur in 1996, the western Liaoning Province in northeastern China has yielded exceptionally well-preserved late Mesozoic biota. The discovery and study of numerous specimens of feathered dinosaurs in this area has greatly advanced our understanding of the relationship between dinosaurs and birds. On this tour, participants will have the opportunity to see the fossil museums in Beijing and Liaoning Province, to search and dig with Hailu You, and to study sedimentology and taphonomy based on the exceptionally well-exposed rocks in the western Liaoning Province. The group will also tour the Great Wall and other areas.

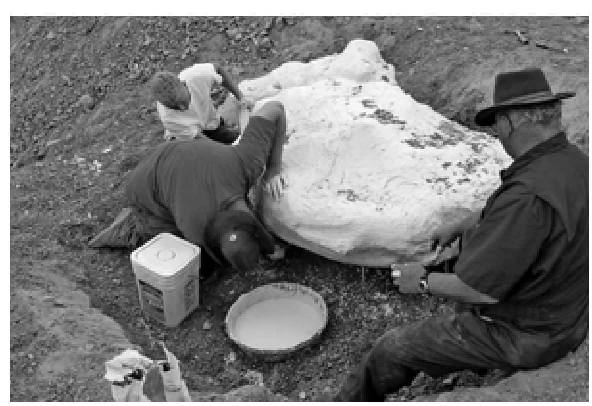
Montana Dinosaur Expedition for Students—Paleo Dig

7–16 July 2007 (10 days); **Location:** Hell Creek Formation, Jordan, Montana, USA; **Trip Leader:** Joseph Hatcher

Trip Cost: US$1,150—you must be a GSA Student Member to attend. **Deposit:** US$200; **Deposit deadline:** 28 May 2007.

Trip Overview: This 100% hands-on expedition will focus on field-based research, including the importance of data analysis using fossils documented and collected in the field. Expert paleontologists will cover subjects like taphonomy, taxonomy, osteo-anatomy, sedimentology, fossil prep lab techniques, and geologic time using real-life examples and museum artifacts. This program is NOT a tour, but a hands-on dig. As a research team member, you are given the opportunity to learn and take part in actual field techniques used to find, collect, and preserve dinosaur fossils.

View trip details and daily itineraries at www.geoventures.org and join us!



Jordan, Montana: fossil plaster casting.

GEOLOGIC PAST

Highlighting Articles from *GSA Bulletin*

"THE GLACIAL NIGHTMARE"

***GSA Bulletin*, March 1926**

W.B. Scott: *Geological Climates*

In the archives of *GSA Bulletin*, this article on geological climates, generated from W.B. Scott's 1925 Presidential Address (v. 37, p. 261–278), stands out as particularly pertinent today. No summary of Scott's words would be as effective as the following excerpts, reproduced, unedited, from the original text:

> Until Louis Agassiz propounded his Glacial theory in 1840, it was assumed that the Recent epoch, or present time, was, climatically speaking, something altogether exceptional in the history of the earth, as before that, according to the universally accepted belief of the time, there had been throughout the ages an unbroken succession of mild and genial climates, without polar accumulations of ice and snow and with no well-marked distinctions of latitude. Agassiz's conception introduced an entirely new factor into the problem and was, indeed, so novel and revolutionary in character that it was long rejected by most geologists; and even so late as 1895 Sir Henry Howarth, a trustee of the British Museum, stigmatized it as "the Glacial Nightmare." The theory made but slow progress toward general acceptance until, eventually, the evidence became so cogent that nearly all geologists were converted to it. Nowadays, it is taken as a matter of course and is taught in all the elementary textbooks. Thus it became necessary to account for a time of exceptional cold, though this was a matter of debate among those who accepted the Glacial hypothesis. (p. 262)

Scott's paper closes with a summation of the status of geological climate study in 1925–1926:

> I should, perhaps, apologize to the members of the Society for selecting as the topic of this address so hackneyed a problem as that of geological climates, in which it is hardly possible to suggest anything that has not been suggested many times. It is, indeed, a threshing over of old straw. Yet there has been so emphatic a revival of interest in the problem of late years that I thought it might serve a useful purpose to offer a brief consideration, in classified form, of the many factors of climatic change which have been brought forward in many lands and by many writers. (p. 278)

William B. Scott (1858–1947) was a vertebrate paleontologist and served as president of GSA in 1925.

Classified Rates—2007

Ads (or cancellations) must reach the GSA Advertising office no later than the first of the month, one month prior to issue. Contact Advertising Department: advertising@geosociety.org; +1.800.472.1988 x1053; +1.303.357.1053. Complete contact information, including mailing and email address, must be included with all correspondence.

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To estimate cost, count 54 characters per line, including all punctuation and blank spaces. Actual cost may differ if you use capitals, centered copy, or special characters.

Positions Open

ASSISTANT PROFESSOR
GEOLOGIST/SOIL SCIENTIST
THE UNIVERSITY OF WISCONSIN–RIVER FALLS

The Department of Plant and Earth Science seeks a dynamic teacher to complement our diverse programs. Course responsibilities will include geomorphology, pedology, meteorology and other courses in geology and soil science dependent on expertise of the successful candidate. Interest in global systems and sustainability is desirable. This is a full-time, nine-month, assistant professor level, tenure-track faculty position starting in August 2007. Compensation is based on qualifications, including education and experience. The normal teaching load is 12 units. Other expectations include advising, scholarly activity and service. Required qualifications include a Ph.D. and teaching and/or field experience. Review of applications will begin on April 1, 2007 and continue until the position is filled. See the University's Web site at www.uwrf.edu/hr for the application process, deadlines, complete position description and qualifications.

LAKE SUPERIOR STATE UNIVERSITY
ASSISTANT PROFESSOR OF GEOLOGY

Lake Superior State University invites applicants for a full-time, tenure track position beginning August 2007. We seek an excellent teacher with expertise in hydrogeology, geo-environmental systems, or earth surface processes to teach in an innovative, project-oriented, field-based undergraduate curriculum. The successful candidate will teach geo-hydrology, environmental geology, and other courses, according to expertise.

Qualifications: A Ph.D. in geology or closely related field is required. Ability to teach introductory oceanography and climatology is a plus. Participation in student-faculty research and advisement of senior thesis projects are encouraged.

Send a letter of application with current curriculum vitae, statement of teaching philosophy, statement of research interests pertinent to collaborative work with undergraduate students, and at least three letters of reference to: Geology Search Committee; Lake Superior State University, 650 W. Easterday, Sault Ste. Marie, MI 49783. Application material may also be faxed to +1-906-635-2111 or e-mailed to humanresurces@lssu.edu. Visit www.lssu.edu for additional information about the University. Review of applications will begin immediately and continue until the position is filled.

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We encourage a diverse work force

BILLY AND ANN HARRISON ENDOWED CHAIR
DEPARTMENT OF GEOLOGY AND GEOPHYSICS, LSU

The Department of Geology and Geophysics at LSU invites nominations and applications for the Billy and Ann Harrison Endowed Chair in Geology and Geophysics. We seek an outstanding individual with an internationally recognized scientific reputation who will develop a strong, externally-funded research program in the field of sedimentology and who will complement existing faculty expertise. The successful candidate will be expected to publish in highly ranked journals, teach undergraduate and graduate courses in his or her area of specialization, and develop strong M.S. and Ph.D. programs. **Required Qualifications:** Ph.D. in geological sciences or another relevant discipline; a strong record of published research in topics of relevance to sedimentology; demonstrated ability to attract funding. This appointment would normally be made at the rank of Full Professor. However, exceptional candidates at the Associate Professor level will be considered.

The Department of Geology and Geophysics consists of 18 tenured and tenure-track faculty members having a wide range of expertise and offers B.S., M.S., and Ph.D. degrees in geology. The department has excellent analytical and computational facilities, a strong record in research and graduate training, an ongoing industry-funded M.S. program in Applied Depositional Geosystems, and a strong alumni base. The successful candidate will become part of a broader geosciences community within LSU, which includes faculty within the Department of Petroleum Engineering, the Department of Oceanography and Coastal Sciences, the Louisiana Geological Survey, and the Department of Geography and Anthropology. For more information, see our Web site, www.geol.lsu.edu.

The review process will begin March 15, 2007 and continue until a candidate is selected. Nominations or inquiries should be directed to Professor Jeff Hanor, Harrison Search Committee Chair, at +1-225-578-3418 or hanor@lsu.edu. An offer of employment is contingent on a satisfactory pre-employment background check. Applicants should send a copy of their curriculum vitae (including e-mail address), a statement of their research and teaching interests, and the names, addresses, phone numbers, and e-mail addresses of at least three references to: Harrison Chair Search Committee, Department of Geology and Geophysics, Louisiana State University, Ref: #006147, Baton Rouge, LA 70803.

LSU Is An Equal Opportunity/Equal Access Employer.

ASSISTANT/ASSOCIATE RESEARCH PROFESSOR
GROUNDWATER MODELER, HYDROLOGIC SCIENCES
DESERT RESEARCH INSTITUTE, LAS VEGAS, NEV.

The Division of Hydrologic Sciences at the Desert Research Institute, Las Vegas, Nev., seeks an outstanding individual with a specialty in numerical groundwater modeling. Candidates must have a Ph.D. in hydrogeology, civil engineering or related field; broad understanding of hydrogeologic processes; demonstrate a track record of publication and funded program development; excellent communication skills. Applicants must submit curriculum vitae, description of prior research experience, statement of research interests and goals, and contact information for three professional references to recruit@dri.edu. For full position details visit http://jobs.dri.edu or call +1-775-673-7332. AA/EEO.

HYDROLOGIST
MIDWESTERN STATE UNIVERSITY

Geosciences Assistant/Associate Professor—tenure track, Fall 2007. Required: Ph.D. in geosciences with a broad professional background. Preferred: teaching and field experience, and refereed publication record. Teach Introductory Geology, Hydrology, GIS, Remote Sensing, and Geomorphology. MSU, a member of COPLAC, is a comprehensive public university serving more than 6000 students. Send application letter, vita, and contact information of three references to: Dr. Brent Elliott, Department of Geosciences, Midwestern State University, 3410 Taft Blvd., Wichita Falls, TX 76308, e-mail: brent.elliott@mwsu.edu. Screening starts immediately. Applications will be taken until position is filled. EEO/ADA. www.mwsu.edu.

EARTH SYSTEMS SCIENCE FACULTY POSITION
THE UNIVERSITY OF TEXAS AT ARLINGTON

The Department of Earth and Environmental Sciences at the University of Texas at Arlington anticipates hiring an Earth Systems Scientist. The tenure-track appointment will be made at the Assistant Professor level, starting September 2007. Appointment at the Associate or Full Professor ranks may be considered for highly qualified candidates.

We encourage applications from candidates with interdisciplinary research interests that integrate data obtained from atmospheric, oceanic, terrestrial, or glacial processes of modern and/or ancient systems. Areas of expertise may include, but are not limited to: (1) climatology and/ or paleoclimatology, (2) environmental geochemistry, (3) surficial processes, and (4) oceanography and/or paleoceanography. The ideal candidate will develop an active research program designed to understand regional to global-scale systems. Priority will be given to applicants who complement existing strengths in the Department of Earth and Environmental Sciences.

Successful candidates are expected to establish independent research programs, obtain outside funding and contribute to undergraduate and graduate teaching.

Completed applications consist of: a curriculum vitae; statement of research plan; statement of teaching interests and evidence of teaching excellence; names and contact information of at least five persons who can provide letters of recommendation, and reprints of recent publications.

Review of applications will begin immediately and continue until the position is filled. Applications should be in Adobe PDF format and sent electronically to earthsystems@uta.edu. Reprints can be scanned and sent electronically, or mailed to: Chair, Search Committee, Earth Systems Science, Department of Earth and Environmental Sciences, University of Texas at Arlington, 500 Yates St., Arlington, Texas 76019.

Additional information about the Department can be found at www.uta.edu/ees/.

Underrepresented groups are encouraged to apply. The University of Texas at Arlington is an Equal Opportunity and Affirmative Action employer.

ISES

***Announcement:* A Summer School in Integrated Solid Earth Sciences (ISES)**

Topic: Tectonic Exhumation

Sponsored by a grant from the National Science Foundation

Application Deadline: April 1, 2007
Decision date: April 15, 2007
Location: The Colorado College, Colorado Springs, CO.
Dates of school: July 27 to Aug. 3, 2007

A 7-day workshop for advanced graduate students addressing different aspects of tectonic exhumation. A panel of experts will present rapid advances in this topic from many different avenues of geological research (listed on website). The short course will also involve lectures, activities, and fieldtrips. More information is posted on the web site.

Topics: History of Uplift and Exhumation / Tectonic sedimentation / Thermochronology / Structural associations and controls / Metamorphic petrology / Numerical Approaches / Tectonic geomorphology.

Web site & on-line application:
http://acad.coloradocollege.edu/dept/gy/ises/ISESSummerProgram.php

Applications will start being accepted on February 1, 2007.

For more information, please contact
Basil Tikoff (basil@geology.wisc.edu) or Christine Siddoway (CSiddoway@ColoradoCollege.edu).

ASSISTANT PROFESSOR OF GEOLOGY
NORTHWEST MISSOURI STATE UNIVERSITY

The Department of Geology/Geography seeks a tenure-track position beginning August 22, 2007. The successful candidate will have a Ph.D. in Geology, strong communication and interpersonal skills, and a strong commitment to and demonstrated excellence in undergraduate teaching. Teaching responsibilities will include entry-level courses in geology and earth science as well as the ability to teach structural geology and tectonics. Knowledge of geophysics and economic geology is desirable. Review of applications began February 5 and will continue until the position is filled. For more information contact our Web site at www.nwmissouri.edu/hr/JOBS/INDEX.HTM. Northwest is an Equal Opportunity Employer.

UNIVERSITY OF NEW ORLEANS
DEPT. OF EARTH AND ENVIRONMENTAL SCIENCES
TENURE-TRACK FACULTY VACANCY
COASTAL PLANT ECOLOGIST

The Department of Earth and Environmental Sciences (EES) at the University of New Orleans invites applicants to fill a tenure-track position as an Assistant Professor in the field of Coastal Plant Ecology starting in the 2007 calendar year. EES is particularly interested in an individual whose work focuses on coastal wetland and barrier island vegetation and plant response to changes in salinity, inundation and/or fertility.

Applicants with research interest at the landscape scale of the Mississippi River delta plain are highly desirable. Scientists with experience in working with multidisciplinary teams using remote imaging and geospatial tools are also highly desirable. Other desirable talents and expertise include: The Coastal plant community's response to changes in physical environment, climate, sea level and wildlife; Coastal restoration ecology; Environmental controls on plant recruitment and succession; Wildlife habitat use, and Seabird habitat and population dynamics.

This position is well-supported with start-up funds commensurate with the successful candidates experience, publication record and funding record. Research facilities will be available for the successful candidate in the UNO Geology Building and/or UNO Research and Technology Park. This position will hold a joint position with the Pontchartrain Institute foe Environmental Sciences. EES is well endowed with research facilities for fieldwork in coastal plant communities as well as laboratory investigations. We seek an individual committed to research, teaching and graduate training. A Ph.D. is required.

Interested applicants should send their resume', selected publications and three letters of reference to: Dr. Shea Penland, Chair, Department of Earth and Environmental Sciences, University of New Orleans, 2000 Lakeshore Dr. New Orleans, LA 70148, +1-504.280.6325 spenland@uno.edu.

The University of New Orleans, a member of the Louisiana State University System, is an EEO/AA employer.

UNIVERSITY OF NEW ORLEANS
DEPT. OF EARTH AND ENVIRONENTAL SCIENCES
TENURE-TRACK FACULTY POSITION
PETROLEUM GEOLOGIST

The Department of Earth and Environmental Sciences (EES) at the University of New Orleans invites applicants to fill a tenure-track position as an Assistant Professor in the field of Petroleum Geology anticipating starting in the 2007 calendar year. Commensurate with this position, the successful candidate could also be awarded the Braunstein Professorship in Petroleum Geology reflecting the successful candidate's distinguished career in the petroleum geosciences. The mission of EES is to build a center of excellence in earth and environmental sciences in the heartland of America's energy coast, Louisiana's Mississippi River delta.

UNO is seeking an experienced petroleum geologist with broad experience in the Gulf of Mexico Basin. Previous experience within the oil and gas industry is highly desirable. Other desirable talents and expertise we seek in a candidate include: Structural geology-tectonics, Sedimentary basin analysis, Subsurface exploration, and Reservoir characterization-evaluation.

This position is well-supported with start-up funds commensurate with the successful candidate's experience, publication record and funding record. Research facilities will be available for the successful candidate in the UNO Geology Building and/or UNO Research and Technology Park. EES is well-endowed with field and laboratory resources. We seek an individual committed to research, teaching and graduate training. A Ph.D. is required.

Interested applicants should submit a curriculum vita, a statement of research and teaching interest, selected publications and three letters of reference by March 30, 2007 to: Dr. Shea Penland, Chair, Department of Earth and Environmental Sciences, University of New Orleans, 2000 Lakeshore Drive, New Orleans, LA 70148, +1.504.280.6325, spenland@uno.edu.

The University of New Orleans, a member of the Louisiana State University System, is an EEO/AA employer.

VISITING ASSISTANT PROFESSOR OF GEOLOGY
CENTENARY COLLEGE OF LOUISIANA

Centenary College of Louisiana invites applications for a two-year position at the assistant professor or instructor level in the Department of Geology, beginning August 2007. We are seeking candidates who are interested in teaching geology in a liberal arts environment and involving undergraduate students in research experiences. Recent Ph.D.'s and ABD's are encouraged to apply. The teaching responsibilities will depend on the background of the successful candidate but should involve some subset of Physical Geology, Environmental Geology, Historical Geology, and Sedimentary Geology; a special topics course in the successful candidate's field of interest is also a possibility. Centenary College (**www.centenary.edu**) is a selective liberal arts institution with a student/faculty ratio of 12 to 1 and is a member of the Associated Colleges of the South (www.acs.org). The college has a $100 million endowment and is located in a metropolitan area with a population of more than 350,000. To apply, send a letter of application, statement of teaching philosophy, vita, copies of transcripts, and three letters of recommendation to: Dr. Scott Vetter, Chair, Department of Geology and Geography, Centenary College of Louisiana, P. O. Box 41188, Shreveport, LA 71134-1188. Review of applications will begin March 1. Centenary College of Louisiana recognizes that diversity is essential to its goal of providing an educational environment where students explore the unfamiliar, invent new approaches to understanding, and connect their work and lives to the world at large. We thus welcome applicants who would add to the college's diversity of ideas, beliefs, experiences, and cultural backgrounds. EOE.

FOREST HYDROLOGY (TENURE TRACK)
THE PENNSYLVANIA STATE UNIVERSITY

Assistant/Associate Professor with the School of Forest Resources at The Pennsylvania State University beginning August 2007. Responsibilities include research (75%) and resident instruction (25%) in forest hydrology with an emphasis on environmental problems related to water quality and quantity on forested and mixed land-use watersheds in the Appalachian hardwood forest region and atmospheric deposition. Research interests related to hydrologic processes and watershed biogeochemistry with a focus on impacts of forest management, land-use change, atmospheric deposition, and climate change are encouraged. The individual could assume responsibilities for a regional atmospheric deposition research program and allied efforts investigating the influence of forest management practices on the Penn State University Experimental Watersheds (www.sfr.cas.psu.edu/Faculty/lynch.htm).

The successful candidate is expected to develop and teach a senior-level course in water quality/watershed management and a graduate course in their area of specialization. Candidates must have a Ph. D. in forest hydrology or an allied field, such as water science and management, geoscience, atmospheric chemistry, soils, geography, and aquatic ecology. A more complete position description can be found at www.sfr.cas.psu.edu/. Applicants should submit a letter of application, resume', academic transcripts, a 1–2 page statement of teaching and research interests, and the names and contact information for three professional references to Dr. David R. DeWalle, School of Forest Resources, 107 Land and Water Research Building, The Pennsylvania State University, University Park, PA 16802, +1-814-863-3532, Fax +1-814-865-3378, e-mail drdewalle@psu.edu. Electronic submission preferred.

Review of applications will begin on March 26, 2007. Applications are welcome until the position is filled. Penn State is committed to affirmative action, equal opportunity, and the diversity of its workforce.

Opportunities for Students

Graduate Opportunities in Boreal Watershed Biogeochemistry. Graduate assistantships are available at Memorial University in St. John's, Newfoundland, Canada to study the effects of environmental change on boreal watersheds. The impact of environmental change on dissolved organic matter (DOM) cycling within the continuum from streams to coastal ecosystems is the focus of a Canada Research Chair funded program. DOM is a critical component of the global carbon cycle and represents the largest active reservoir of organic matter in the aquatic environment. Our research group is focused on understanding the impact of nutrient enrichment, elevated temperature, and land use activities on watershed dissolved organic carbon and nitrogen cycling. Students joining the group will have the opportunity to use stable isotope tracers and the isotopic composition of biomarkers to study the flow of carbon and nitrogen in aquatic ecosystems. Those interested please contact: Dr. Susan Ziegler, CRC in Environmental Science, Department of Earth Sciences, Memorial University of Newfoundland, St. John's, NL A1B3X5 Canada. +1-709-737-2669, sziegler@esd.mun.ca, www.mun.ca/earthsciences/Ziegler/Main.php.

Ph.D. Student Opportunities in the area of Quaternary Paleoclimatology at Geology Department of Baylor University (Waco, Texas): A NSF grant-supported GRA (graduate research assistant) position is available to support a Ph.D. student to work on: "Climatic Reconstruction of the Past 50,000 Years from the Eolian Sequences in the Westerlies-dominated Central Asia." GTA (graduate teaching assistant) positions are also available to support students to pursue their degrees in the area of Quaternary Paleoclimatology (who may be working on planned projects: "Holocene Climatic Variations Recorded in Lacustrine Sequences in the Westerlies-dominated Central Asia" and "Holocene Environmental Changes and Their Cultural Responses in the Middle and Lower Reaches of the Yellow River Basin in China". If interested, please contact Dr. Jordan Feng at +1-254-710-2194 (office phone) or zhaodong_feng@baylor.edu or contact our graduate program director, Dr. Stacy Atchley at +1-254-710-2196 (office phone) or stacy_atchley@baylor.edu

Graduate Assistantships in Geology at California State University, Bakersfield. Several graduate assistantships available for students wishing to pursue a M.S. in Geology beginning fall term of 2007 are available. Appointments include health benefits and a salary of approximately $17,000 per year. Department strengths are in the areas of sedimentary geology, petroleum geology, geophysics, hydrogeology, geochemistry, structural geology, and environmental geology. Bakersfield is located in the heart of California's petroleum and agricultural areas and abundant opportunities exist for internships and industry-supported thesis projects.

Review of application will begin April 1, 2007 and continue until positions are filled. For more information visit www.csub.edu/Geology/.

Opportunity for Graduate Studies in Economic Geology at the Nevada Bureau of Mines and Geology. The Nevada Bureau of Mines and Geology is offering a graduate research assistantship through the Department of Geological Sciences and Engineering at the University of Nevada–Reno (UNR) that will be part of a NSF-funded study of the Getchell gold-mining district in Nevada. The position carries a ten-month stipend of initially $14,000 as well as health insurance and a tuition waiver. The assistantship would begin in the fall semester of 2007. Opportunities exist to collaborate with geoscience faculties at UNR and the University of Nevada, Las Vegas as well as other institutions. For more information, please contact Dr. John Muntean at munteanj@unr.edu or +1-775-682-8747 and visit www.nbmg.unr.edu and www.unr.edu/mackay/. EEO/AA.

M.S. or Ph.D. opportunity in Hydrogeology—UMass-Amherst. Applications are invited for an outstanding student interested in pursuing a M.S. or Ph.D. in Hydrogeology at the University of Massachusetts–Amherst. An opening beginning in August of 2007 is available on a funded project investigating the role of subsurface fluids on the coupled hydro-mechanical behavior of rocks and sediments. The proposed work combines hydrogeologic and geomechanical characterization of rock samples as well as coupled numerical modeling of the resulting behavior. Opportunities for fieldwork/travel are also possible. Research assistantships include tuition and fee waivers, health benefits, and a $21,000 per year salary. Interested students are encouraged to contact Dr. David Boutt at dboutt@geo.umass.edu for more information.

Graduate Student Opportunity in Quaternary Geology/Geochronology. A graduate research assistantship will be available beginning in May of 2007 for a motivated student to study the geochronology of Glacial Lake Agassiz beaches utilizing OSL dating. The ideal candidate will exhibit enthusiasm for Quaternary geology, coastal geomorphology, and sedimentology, have a strong background in general physics with aptitude for experimental science, and be willing to pursue a multidisciplinary degree path. Stipend support and a tuition waiver are available for a student seeking a M.S. degree. Please direct inquiries to Dr. Ken Lepper, Department of Geosciences, North Dakota State University (Ken.Lepper@ndsu.edu).

Visiting Fellowships—Institute for Rock Magnetism. Applications are invited for visiting fellowships (regular and student) lasting for up to 10 days during the period from July 1 through December 31, 2007. Topics for research are open to any field of study involving fine particle magnetism, but preference will be given to projects relating magnetism to geological or environmental studies, or to fundamental physical studies relevant to the magnetism of Earth materials.

A limited number of travel grants of up to $750 are available to cover actual travel costs. No funds are available for per diem expenses. Application forms and information necessary for proposal preparation may be obtained from IRM manager Mike Jackson at the address below, or online at www.irm.umn.edu.

Short proposals (two pages, single-spaced text plus two forms and necessary figures and tables) are due by April 30, 2007, for consideration by the IRM's Review and Advisory Committee. Successful applicants will be notified in June, 2007. Proposals should be sent by e-mail to irm@umn.edu, or by post to: Facilities Manager, Institute for Rock Magnetism, University of Minnesota, 291 Shepherd Laboratories, 100 Union St. SE, Minneapolis, MN 55455-0128.

Scientific uncertainty and public policy: Moving on without all the answers

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INTRODUCTION

Science is the foundation of modern society: telecommunications, the Internet, transportation, medicine, public health, agriculture, and much more. As representatives of this cornerstone of modern society, scientists are called upon to inform and advise the elected and appointed officials who formulate public policy. Recent examples of difficult scientific topics and contentious public debate include embryonic stem cells, genetically modified agricultural products, animal and human cloning, radioactive waste disposal, missile defense systems, and anthropogenic climate change. Our National Academies of science and engineering and the Institute of Medicine are responding ever more frequently to requests from Congress to provide up-to-date summaries of the state of the science on a wide array of topics. Repeatedly, the underlying science indicates that all these topics are burdened with uncertainties.

Frequently, "scientific uncertainty" is offered as an excuse to avoid making important policy decisions. We must recognize, however, that delaying decisions because of uncertainty is an implicit endorsement of the status quo and often a thinly veiled excuse for maintaining it. It is a bulwark of the take-no-action policy popularly known as "business as usual."

Discussion of scientific uncertainty in the media and elsewhere should be welcomed by scientists, who are trained to couch their results in terms of the attendant uncertainty. Scientists are encouraged to display data with "error bars" and to frame conclusions in terms of probabilities. While developing public awareness about the nature of scientific uncertainty should in principle be a good thing, in reality it has led to confusion because uncertainty has been both misunderstood and distorted.

UNCERTAINTY AND CLIMATE CHANGE

Probably no other scientific topic in recent decades has in the eyes of the public been more shrouded in uncertainty than that of global climate change. There are many sources of this puzzlement: some real, some manufactured.

One barrier to understanding is that humans find it difficult to appreciate that we are major players in the natural arena. Face to face with earthquakes, volcanic eruptions, tsunamis, hurricanes, and tornadoes, the typical human reaction is one of awe and a feeling of personal insignificance. Although an individual may feel helpless when compared to these titanic forces of nature, collectively Earth's human population is staggeringly powerful. Humans are currently the most important geological agents at work on the planet, but many people have a hard time believing it.

Another barrier is the fact that the general public is not well trained in science—too often, the power of many independent lines of evidence goes unappreciated. Confidence in an answer should grow if the same conclusion is reached through independent avenues of research, even if the individual results have greater uncertainties or are on occasion simply wrong. There is a tendency to focus on the weakness of the parts rather than the strength of the whole[1], supposing that if a single piece of evidence can be discredited, the entire construct will fall like a house of cards. In fact, discrediting a single line of evidence is more like snipping a strand in a net hammock—the hammock continues to be supported by the many strands that remain intact. The scientific evidence for climate change in the natural world is compelling in its totality although individual pieces of the story may indeed be open to some question.

With little skill in understanding science, it should come as no surprise that many Americans are fertile ground in which opinion-shapers may plant seeds of uncertainty, confusion, and doubt. I call these opinion-shapers the "manufacturers and marketers of uncertainty." Their ideological and/or economic interests lie in maintaining the status quo, and they work actively to sow confusion. They tarnish scientific results they don't like with phrases like "unsound science," "junk science," or "uncertain science."

We have seen these manufacturers and marketers of uncertainty in many settings over the years: the agro-chemical industry's obfuscation of the environmental consequences of widespread pesticide use, the tobacco industry's decades-long denial of smoking-related health problems, the electric utility industry's rejection of the role of high sulfur coal in producing acid rain, the leaded gasoline industry's foot-dragging when faced with the deleterious health consequences of environmental lead, the synthetic chemical industry's reaction to the role of CFCs in ozone depletion, and, of course, the fossil fuel industry's long denial of the role of anthropogenic greenhouse gases in climate change.

[1] I am grateful to Robert W. Buddemeier, who emphasized these concepts in his review of my book *Uncertain Science… Uncertain World*, which appeared in *Palaios*, v. 19, no. 2, p. 188–189, 2004.

doi: 10.1130/GSAT01703GW.1.

Why Not Wait for More Research to Clarify Uncertainty Before Forging Ahead with Policy Decisions?

This is a legitimate question, but upon analysis and reflection, waiting cannot easily be defended as a course of action. A frequent outcome of conducting more research on complex systems such as planetary climate or terrestrial ecosystems or the human body is that uncertainty, rather than being diminished, actually grows as research reveals an even greater complexity than previously supposed. Additionally, there is an element of wishful thinking (some would say hubris) in imagining that with just a little more research we will find "the right answer" or a "silver bullet" solution.

One must also recognize that much of the uncertainty about how climate will evolve over the twenty-first century will not yield to more research. This irreducible uncertainty is related to demographic, economic, and political developments. The range of unfolding climate pathways that appears in reports from the Intergovernmental Panel on Climate Change is wide indeed, not only because of uncertainties in the climate modeling but also because of uncertainties in world population projections, the economics of alternative non–carbon-based energy development, the degree of integration of the global economy, and the vagaries of international conflicts that impact the production and distribution of carbon-based fuels. These are uncertainties outside the realm of the natural sciences.

Calling for more research must also be seen as a double-edged sword. Because causes and consequences of environmental problems are typically nonlinear, a decade of delay can have a century of consequence. Moreover, the benefit/cost ratio of remediation is generally greatest when a problem is first recognized. The climate system may also have "tipping points" that, when reached, would have truly catastrophic consequences. Just a few years ago, conventional scientific wisdom held that ice loss from Greenland and West Antarctica was proceeding on a millennial time scale. Recent observations, however, have shown that ice loss is occurring at a much faster pace, as meltwater lubricates the base of ice sheets, and floating ice shelves, which impede the flow of ice from the interior, are rapidly disintegrating. Greenland and West Antarctica each have an ice volume equal to about a seven-meter rise in sea level—waiting for more definitive research results to guide policy formulation is risky business indeed.

FRAMEWORK FOR POLICY FORMULATION IN THE FACE OF AN UNCERTAIN FUTURE

Policy making must take place in an environment of perpetual uncertainty and cannot wait for clarification that may never come, at least not in a helpful time frame. Therefore, policies adopted in the face of uncertainty should be thought of as provisional, not final. Accurate prediction of the future is difficult, in part because the future is a moving target. That last year's flu shot recipe is not likely to work well this year or next, or that anti-malarial prophylactics of the 1970s are virtually ineffective today, are simple reminders that the future never stands still. Because the future unfolds in unexpected ways, we must be prepared to take small steps, evaluate them continuously, and make mid-course corrections if necessary to get back on track.

As we come to recognize a problem such as acid rain or ozone depletion or global warming, our scientific understanding grows, albeit always remaining incomplete. Clearly, we don't know everything about these phenomena, but that does not mean that we don't know anything. We must not let incomplete knowledge lead to policy paralysis—we must move on without all the answers.

Three simple principles provide a framework for formulating policy under conditions of deep uncertainty. The first is a straightforward acknowledgment that there is a problem to be addressed, that we have incomplete knowledge about the problem, and that as we shape policy on the basis of incomplete knowledge we are likely to make mistakes. This is somewhat akin to the introductory confessions at Alcoholics Anonymous meetings: "My name is John Doe and I am an alcoholic"; if we don't acknowledge a problem, we will never solve it.

The second principle follows directly: because the chances for going astray are relatively high, we need to have many balls in the air at once—we need to think of a multiplicity of pathways forward in order to find one or several that prove helpful. As geologists, we have all had our exposure to T.C. Chamberlin's[2] exhortation to embrace "multiple working hypotheses" so as not to fall into the rut of confinement that a single hypothesis frequently becomes. In the context of mitigating climate change, we need many horses pulling us toward a greenhouse-stabilized future; e.g., energy conservation, renewable energy sources, and carbon sequestration. That a single "silver bullet" solution will emerge is nothing but wishful thinking.

Third: monitor the future as it unfolds, and make mid-course corrections as necessary. This principle derives from our acknowledgment that we are likely to make some mistakes along the way and policy adjustments may be necessary. We should anticipate the need for and be prepared to make mid-course corrections. This strategy, known as "adaptive management," is one of action coupled with continual evaluation and adaptation to changing circumstances or misguided decisions. Adaptive management is premised on optimism but grounded in skepticism. In the assessment and reevaluation of policy, we must not have unrealistic expectations. A multifaceted policy that does a pretty good job of moving us forward under a range of possible futures is a safer bet than a fantastic solution appropriate only to a very particular future world.

CONCLUSIONS

We can ill-afford to allow uncertainty to lead to policy paralysis or to be invoked as a reason to maintain the status quo. Scientists should not let science or policy be hijacked by those who, parading beneath a banner of uncertainty, don't like what science is telling them. More research may lead to some better understanding, but uncertainty will never be eliminated—it simply will take on new forms. Long-term solutions will emerge from policies that encourage many incremental and diverse steps and a continuous evaluation of their efficacies. Uncertainty should be recognized not as a barrier to policy formulation and implementation, but rather as a stimulus for creative solutions as it promotes a competition of ideas.

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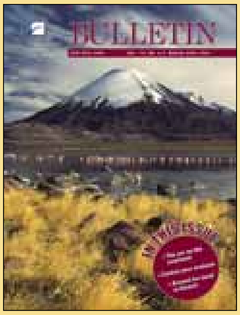
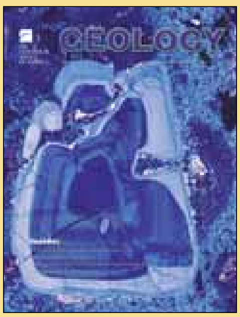
[2]Chamberlin, T.C., 1890, The Method of Multiple Working Hypotheses: *Science,* v. 15; reprinted in 1965 in *Science,* v. 148, p. 754–759.

Journal Highlights





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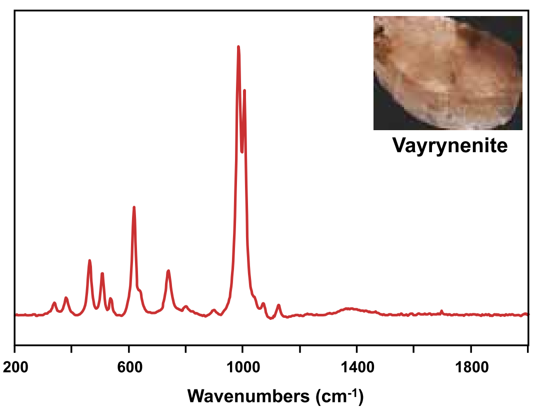

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