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GSA TODAY

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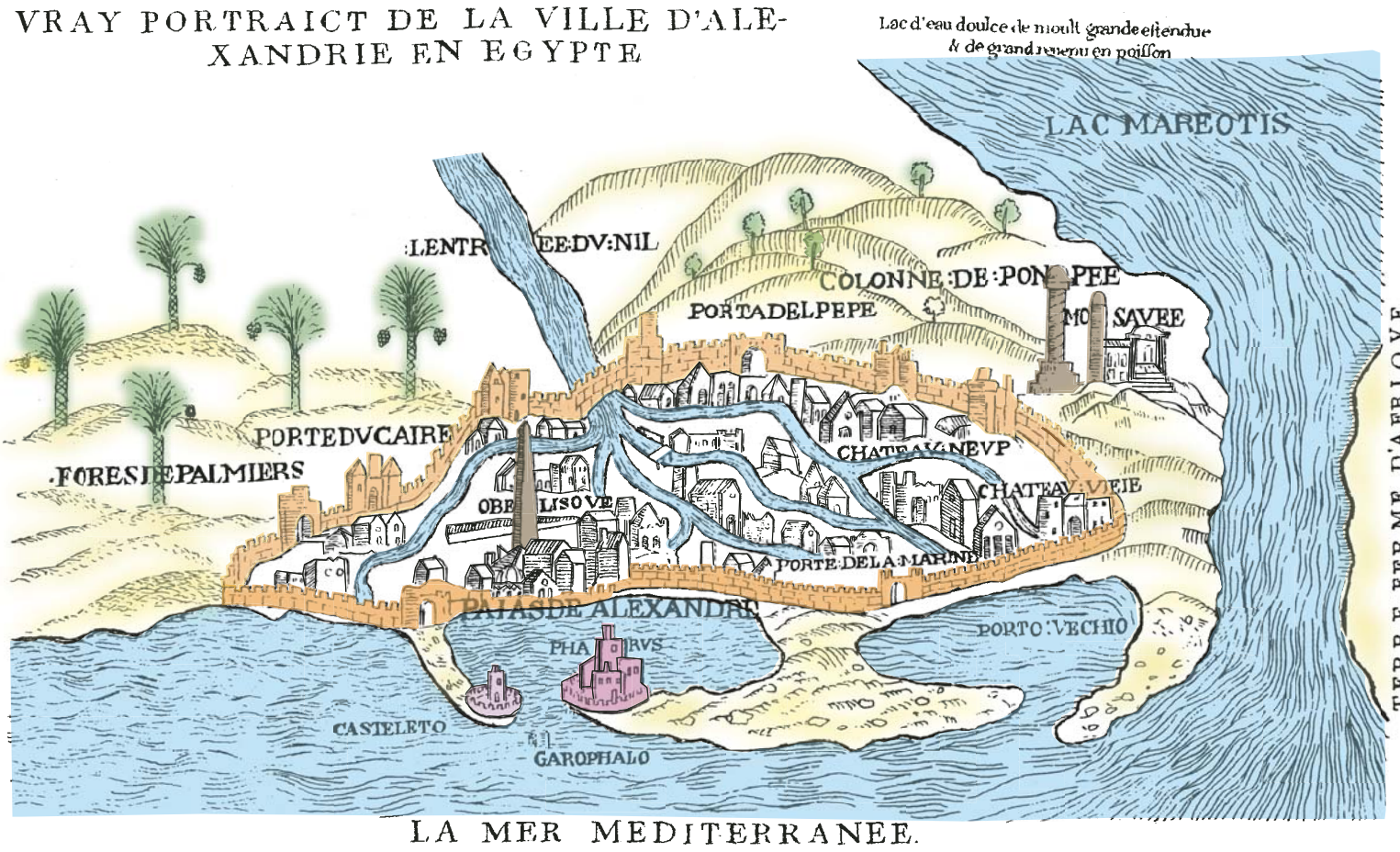
Alexandria, Egypt, before Alexander the Great: A multidisciplinary approach yields rich discoveries



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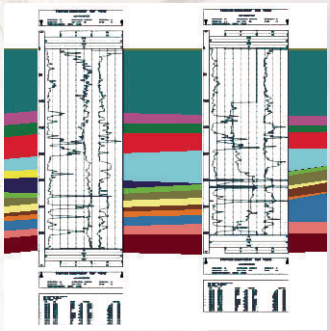

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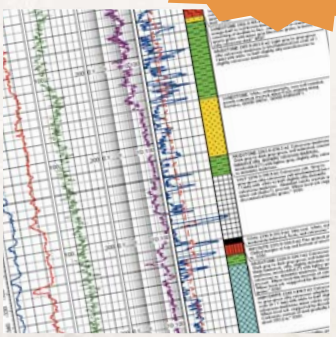

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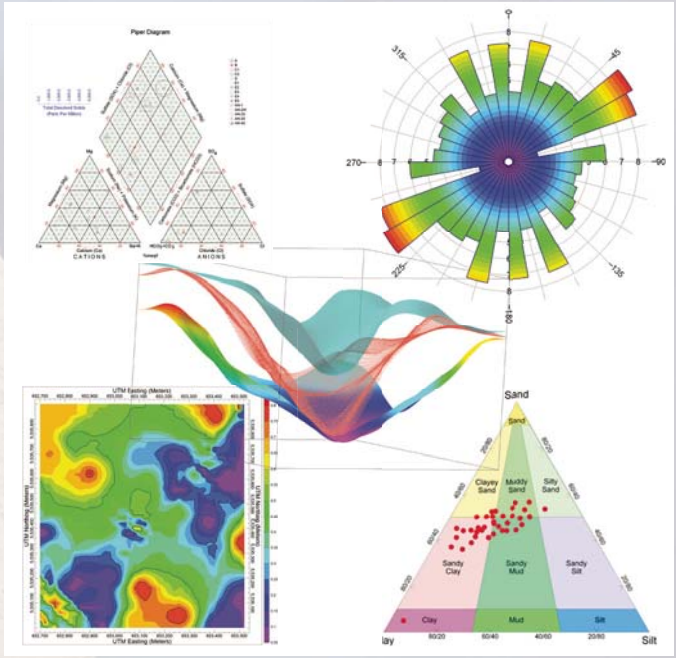

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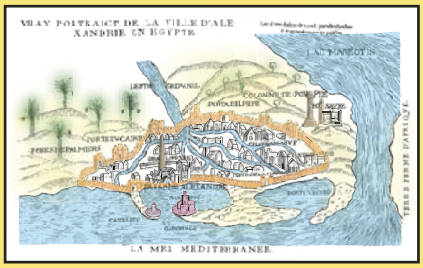

Cover: Early map of Alexandria and its harbors (*Vray Portraict de la Ville d'Alexandrie en Egypte*), created in 1548 by Pierre Belon du Mans and published in Paris in 1554 by Guillaume Cavellat, highlights the Arabic walled city with its ancient Egyptian obelisk, Pompey's column, and the famous lighthouse (Pharus) on Pharos Island. Incorrect features of note are a Nile branch rather than the Alexandria Canal flowing to the city and a large opening between Mariotis Lagoon and the Mediterranean. Two centuries of cartography would elapse before such errors were rectified. See "Alexandria, Egypt, before Alexander the Great: A multidisciplinary approach yields rich discoveries," by Stanley et al., p. 4–10.

SCIENCE ARTICLE

Erratum: Last month's issue of *GSA Today* (v. 17, no. 7, p. 12) miscommunicated the recipient of the Kirk Bryan Award for Research Excellence (Quaternary Geology and Geomorphology Division) as solely M.C. Reheis. In fact, all authors of the following paper have received the award: **Marith Cady Reheis, Andrei M. Sarna-Wojcicki, Richard L. Reynolds, Charles A. Repenning, and Martin D. Mifflin,** 2002, Pliocene to middle Pleistocene lakes in the western Great Basin: Ages and connections, *in* Hershler, R., Currey, D., and Madsen, D., eds., Great Basin Aquatic Systems History: Smithsonian Contributions to Earth Sciences no. 33, Washington, D.C., Smithsonian Institution Press, p. 53–108.

Alexandria, Egypt, before Alexander the Great: A multidisciplinary approach yields rich discoveries

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ABSTRACT

Historic records refer to Rhakotis as a settlement on Egypt's Mediterranean coast before Alexander the Great founded the famous Mediterranean port city of Alexandria in B.C. 332. Little is known of Rhakotis, however, because the site has yet to be clearly identified beneath the modern city. This problem motivated a geoarchaeological investigation of sediment cores from Alexandria's East Harbor, from which radiocarbon-dated sections of pre-Alexander age (>2300 yr B.P.) have been obtained for study. These core sections comprise a number of critical components, five of which are emphasized here: ceramics, rock fragments derived from Middle and Upper Egypt, and sediment with markedly increased contents of lead, heavy minerals, and organic matter. A multidisciplinary approach, by which archaeological, stratigraphical, petrological, and geochemical methodologies are applied to study the five distinct core components, reaffirms that a sum can be greater than its parts. Together, the diverse markers in the dated core sections enable us to confirm human activity to at least seven centuries before B.C. 332 on the mainland coast, where Alexandria would later be established. Alexander's city, it now appears, rose from a preexisting town whose inhabitants had long before recognized the favorable harbor potential of this Egyptian coastal sector. The discoveries, providing direct evidence of the settlement's early (to ca. B.C. 1000) existence, are intended to prompt new exploratory efforts on land and offshore to further delineate that center's actual position and history.

INTRODUCTION

Coastal and marine geology are now well-established earth science subfields that developed from the turn of the twentieth century to the 1950s. Study of archaeological vestiges submerged in the marine realm, on the other hand, is a more recent scholarly pursuit, having evolved primarily after World War II. Integration of geological and archaeological sciences to investigate offshore sites has emerged in close association with the improvement of diving technology and equipment for offshore exploration. These include enhanced underwater drilling, photography, and television, along with refinement of applicable high-resolution seismic methodologies and surveys by research submarine and remote operated vehicle. Coastal geoarchaeology reached a subdiscipline threshold ~25 years ago, at the time of publication of the multi-authored volume on Quaternary coastlines and marine archaeology edited by Masters and Flemming (1983). Since then, the number of studies that emphasize integration of varied geological and archaeological approaches in the marine realm has progressively risen. Of special note is the increased use of a classic geological methodology, sediment coring, to help resolve archaeological problems at sites that presently lie beneath the waves. This subbottom technology has been applied with successful results in most world oceans, especially in the Mediterranean (Morhange et al., 2005; Marriner and Morhange, 2007; Stanley, 2007).

The present investigation integrates archaeological, geological, and geochemical data obtained from sediment cores that provide evidence of early human activity in the Alexandria region of Egypt. The focus is on identifying new information dated to well before the arrival of Alexander the Great, who founded this major Mediterranean port city in B.C. 332 (Fig. 1).

BRIEF BACKGROUND

Historians generally agree that Rhakotis, or Râ-Kedet, was a settlement established before the fourth century B.C. in the area subsequently developed as Alexandria. Rhakotis has been vaguely alluded to as a modest fishing village of little significance, a more substantial walled center, or possibly a fortified settlement (Fraser, 1972; Empereur, 1998; Baines, 2003; McKenzie, 2003; Ashton, 2004). The modern city of Alexandria, with nearly four million inhabitants and an extensive cover of municipal and industrial construction, has almost entirely buried the remains of earlier habitation (Empereur, 1998). Although a city area south of the Heptastadion (Fig. 2) is called Rhacotis (Rowe, 1954), no archaeological excavation to date has revealed the presence of an early pre-Alexandrian site.

A record of early nautical activity near Pharos Island, positioned ~1 km seaward of the Alexandria mainland (Fig. 2), was initially passed down as oral history (from ca. B.C. 1200–1100) and then centuries later (B.C. 800–750) was recorded in Homer's epic *Odyssey*: "Now in the surging sea an island lies, – Pharos they call it, – By it there lies a bay with a good anchorage, from which they send the trim ships off to sea and get them drinking water." After Homer, historians and geographers intermittently refer to this Egyptian sector in their texts, such as Herodotus' *The History* (fifth century B.C.) and Strabo's *Geographia* (near the turn of the first century A.D.). Subsequently, scholars surmise that Minoan, Philistine, Phoenician, ancient Greek, and other early mariners sailing the eastern Mediterranean sought protection in the lee of Pharos Island long before Ptolemaic (B.C.

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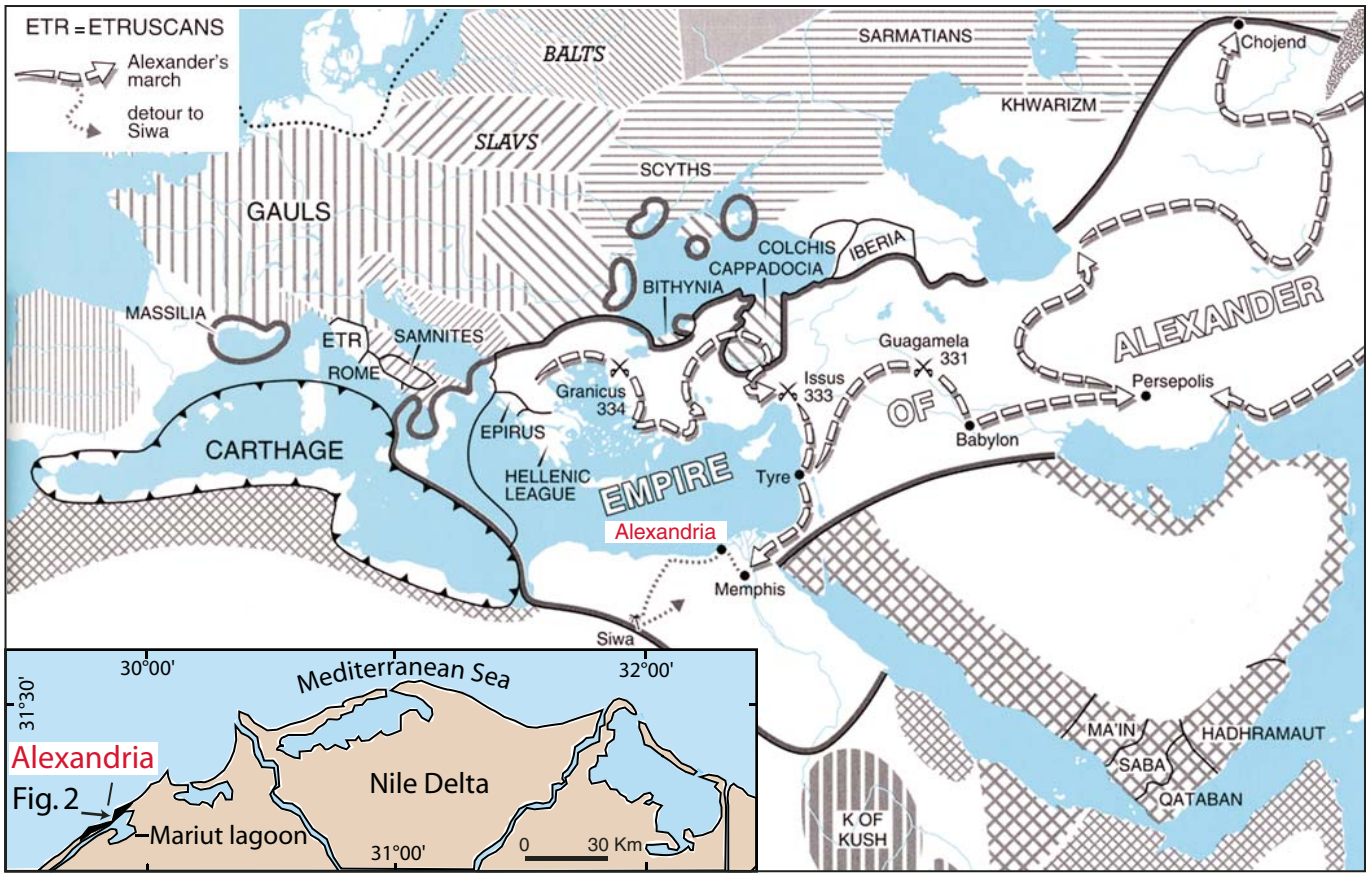

Figure 1. Map showing the geographic extent of Alexander the Great's empire and the Ptolemaic reign (post–B.C. 332) in the eastern Mediterranean (modified after McEvedy, 2002). Inset shows the Alexandria, Egypt, study area.

332–30) rule (Jondet, 1916; Weill, 1919). Additional evidence of pre-Alexander occupation in this region is provided by early archaeological sites in proximal sectors (Egypt Exploration Society, 2005), including those along the Mariut lagoon to the south (Rowe, 1954) and the Nile delta coast to the east of Alexandria (Stanley, 2005, 2007).

Recent preliminary findings record more direct evidence of settlement prior to the Ptolemies in, or proximal to, the modern city. These are based on assessments of cores collected on land adjacent to the East Harbor of Alexandria (Goiran et al., 2000; Véron et al., 2006) and in the East Harbor proper (Stanley and Landau, 2005). New findings summarized herein are obtained by a comprehensive and multidisciplinary study of dated cores recovered in the harbor.

METHODS

The present East Harbor basin covers an area of ~2.5 km^2 and is bound to the south by an arcuate coastline bordered by the city of Alexandria (Fig. 2). The region has been the focus of numerous investigations, including geography (Goddio et al., 1998), oceanography (Inman and Jenkins, 1984), geology and paleogeography (Warne and Stanley, 1993; Goiran et al., 2005), stratigraphy (Goiran et al., 2000), sedimentology (El-Wakeel and El-Sayed, 1978; Wali et al., 1994), and geochemistry (Véron et al., 2006).

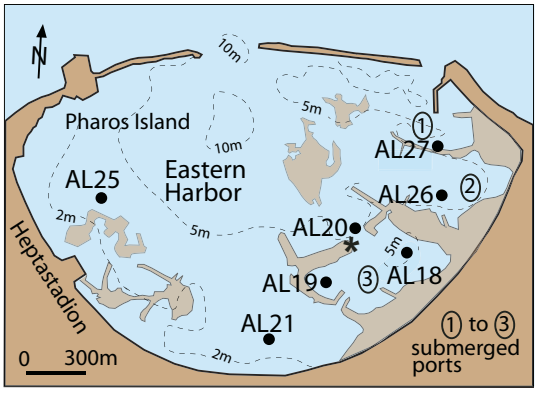

Figure 2. Configuration of the Eastern Harbor and locations of seven vibracore sites off Alexandria. Light brown features in the Eastern Harbor are shallow reefs and submerged port structures (after Goddio et al., 1998). Asterisk denotes eastern end of now-subsided Antirhodos Island, where late fifth and early fourth century B.C. wood was recovered.

New information to define this basin's early Holocene to present evolution is provided by seven vibracores (lengths ~2.0–5.5 m; Fig. 3) collected in the East Harbor (Stanley and Bernasconi, 2006). The 52 Accelerator Mass Spectrometry (AMS) dates obtained for core samples are given in uncalibrated ^{14}C

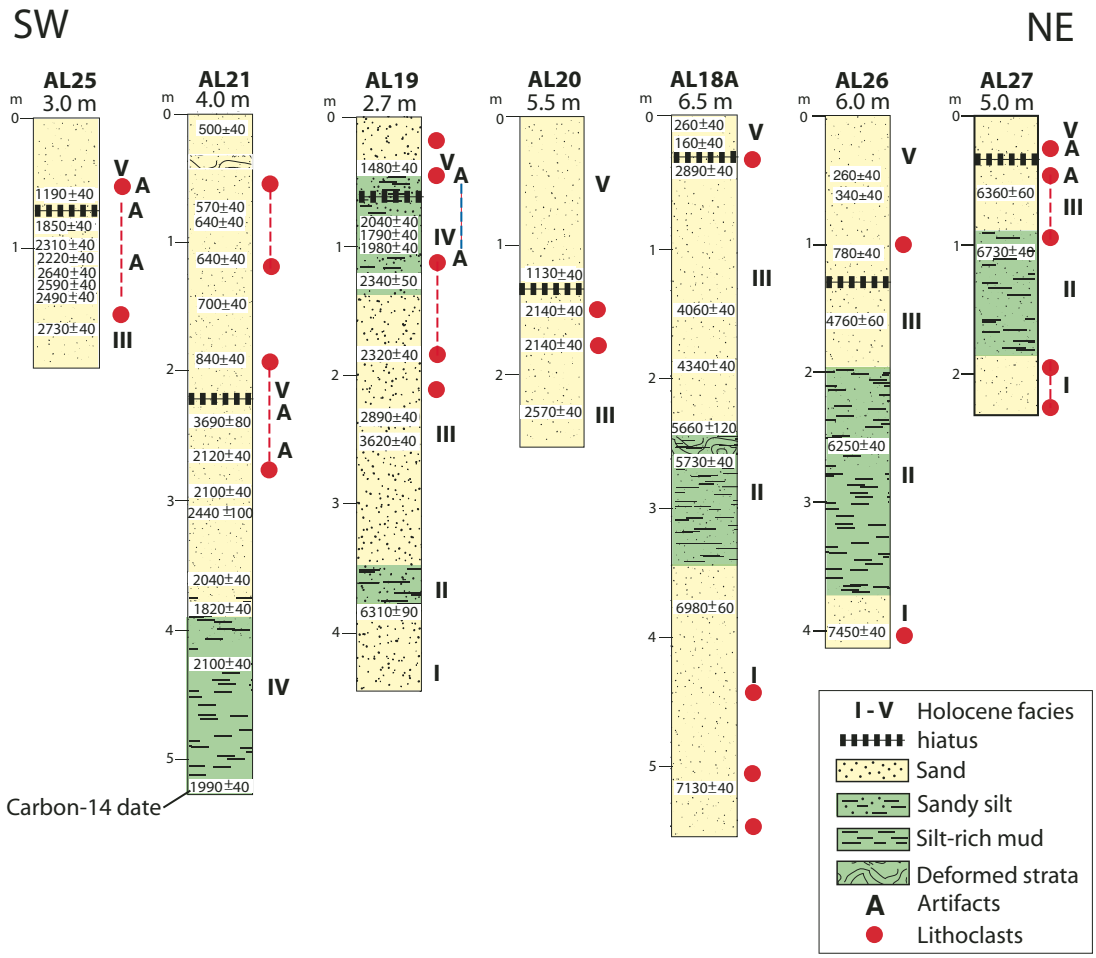

Figure 3. Stratigraphic logs of the seven vibracores collected in the East Harbor, showing five dominant lithofacies (I–V), conventional radiocarbon (uncalibrated) dates (in thousand yr B.P.), and positions of artifacts and lithoclasts. Modified after Stanley and Bernasconi (2006).

radiocarbon years (most shown in Fig. 3). Samples (n = 441) were taken throughout the sand-rich cores at <15 cm intervals for petrologic study. Lithological logs of the cores and results of different analyses are given in Stanley and Bernasconi (2006).

Lead isotopic analyses were performed at the Carnegie Institution of Washington. After addition of a ^{205}Pb spike, ~20–50 mg of coarse core material was dissolved, and the Pb was separated and analyzed using procedures described in Carlson et al. (2006). Some samples, labeled with an "L" in Table 1, were first subjected to an acetic acid leach. In most cases, >50% of the sample was dissolved in the acetic acid. After leaching, the residue was dissolved as described above, while the leach was first dried and then redissolved in HBr in preparation for Pb separation. All measured Pb isotopic compositions are corrected for mass fractionation based on these average standard values compared to the isotopic composition of NBS 981 reported by Todt et al. (1996).

OBSERVATIONS

Core Content in Greek to Recent Time

Stratigraphic analysis of dated borings identifies five mostly carbonate lithofacies (coded I to V) from base to top of East Harbor cores (Figs. 3 and 4A): Lower Sand (I) and Lower Mud (II) units of early to mid-Holocene age (>7500 to ca. 5600 yr B.P.); Middle Sand (III) facies of mid- to late Holocene age (ca. 5600–2300 yr B.P.); and Upper Mud (IV) and Upper Sand (V) of late Holocene age since Ptolemaic rule (<2300 yr B.P.). Core AL19 comprises all five stratigraphic facies, with a basal section older than 6310 ± 90 radiocarbon yr B.P., and thus serves as a representative, or type, boring to define changes through time denoted by diagnostic archaeological, geological, and geochemical criteria.

Upper Sand (V) and Upper Mud (IV) sections in this and other East Harbor cores comprise the most abundant and diverse suites of archaeological material. These upper two units contain potsherds, pebble-size rock clasts, and high concentrations of heavy minerals (Fig. 4D), lead (Fig. 5A), organic matter, quartz, and crystalline and aggregate limestone, when compared to the three older facies (I–III). Rapid municipal development during the reign of the Ptolemies and Romans gave rise to marked anthropogenic signals in the two upper lithofacies. For example, very high lead concentrations (>100 ppm) occur in post-Alexander sediment in core AL19 (Fig. 5A); this is also recorded in core sections of this age collected on land in Alexandria proper (Goiran et al., 2000; Véron et al., 2006). The

findings denote heavy lead use by Greeks and Romans during Alexandria's swift expansion.

Accelerated construction along the mainland shore and in the East Harbor proper (Fig. 2) during this time (IV–V) is amply recorded (Empereur, 1998; Goddio et al., 1998; Hesse, 1998), including the building of the Heptastadion, the large freshwater aqueduct-causeway system between the city and Pharos Island (Hesse, 1998; Goiran et al., 2000, 2005). Increased organic matter content in upper core facies IV and V includes fibers of *Phragmites* sp. and algae. Such materials were derived from the city's sewage runoff and from Alexandria Canal discharge into the harbor (Stanley and Bernasconi, 2006).

Key Markers in Pre-Greek Time

Until now, the record of human activity in Alexandria prior to the Ptolemies has been sorely limited. Underwater diver excavation at the eastern end of now-submerged Antirhodos Island (marked by an asterisk in Fig. 2) recovered posts of elm (*Ulmus* sp., a non-local wood) radiocarbon-dated (calibrated calendar years) at B.C. 410 ± 40 and planks of pine (*Pinus* sp.) at B.C. 395 ± 40 (Goddio et al., 1998).

Materials found in cores recovered in the East Harbor, however, provide more ample evidence of older pre-fourth century B.C. (>2400 yr B.P.) human activity, especially in sediment forming the upper part of the Middle Sand (III) unit in East Harbor cores (Fig. 4A). Foremost are potsherds of early age that were recovered in this part of unit III in core AL25, in the western East Harbor (Fig. 3). Ceramic fragments include coarse and poorly fired material, mostly cooking vessels, although some thinner ceramics from bowls and small jars are also observed. The pottery is wheel-made and appears to be of local production rather than imported. Archaeological analysis of ceramic fragments, including ones preserved with slip (Fig. 4B, 1–2) and others that are rimmed (Fig. 4B, 3–4), show they are most closely comparable to typical southeastern Mediterranean ware made in the ninth to seventh centuries B.C. (plates 81–83 *in* Tufnell, 1953; National Museum of Natural History collections). These potsherds and lithic fragments prevail in sediment radiocarbon dated to well before 2330 yr B.P. (calibrated dates of B.C. 940 to B.C. 420).

Most cores include carbonate pebbles derived from exposures proximal to the East Harbor that originated in the lower (older) sections of cores AL18A, AL26, and AL27. Core AL19 also contains pebble-sized rock fragments (diorite, gabbro, quartzite, marble, and dense fossiliferous limestone) in the upper half of facies III at a depth of 2.3 m from core top (Fig. 4C). These lithoclasts, with diameters of 1–5 cm, are of non-local (allochthonous) derivation and were obtained from distant quarries, mostly in Middle and Upper Egypt. This upper facies III section, positioned >50 cm beneath the base of the Upper Mud (IV) unit, is radiocarbon dated as older than ca. 2320 yr B.P. but younger than 2890 ± 40 yr B.P. (Fig. 4A). Rock reached Alexandria's East Harbor either by vessel or overland transport for use in building structures; in the case of core site AL19, located ~500 m from the present coastline (Fig. 2), this material was likely brought to localities near the southern East Harbor margin. Some clasts may also have been derived from materials recycled from statuary or other artifacts of Egyptian dynastic origin. Polished, flat, well- to very well–rounded clasts are typical of rock worn on a beach or in a shallow aqueous setting subject to strong swash action (Stanley, 2005).

Similarly, in the mid- to upper section of the Middle Sand (III) unit there is a marked increase in proportions of heavy minerals (to 1%; Fig. 4D) and organic matter content (to 1.5% by weight; Stanley and Landau, 2007). As with potsherds and rock clasts, the increased content of heavy minerals and organic matter found in carbonate-rich facies dated prior to Ptolemaic rule are associated with increased human activity. Construction activity involved use of noncarbonate rock material and sediment transported to the area, while organic matter

TABLE 1. Pb CONCENTRATION AND ISOTOPIC COMPOSITION OF ALEXANDRIA CORE SEDIMENTS AND ARTIFACTS

Sample no.	Depth (cm)	Sample	[Pb] ppm	204/206	207/206	208/206
TJ1	56	Clayey silt	171	0.05401	0.84601	2.08725
TJ2	96	Clayey silt	286	0.05409	0.84785	2.09116
TJ9	120	Shelly silt	102	0.05367	0.84034	2.07878
TJ24	123	Carbonate sand	84	0.05395	0.84481	2.08589
TJ25	126	Carbonate sand	78	0.05362	0.84187	2.08423
TJ16	129.5	Silty carbonate sand	49	0.05363	0.84263	2.08632
TJ17	139	Silty carbonate sand	48	0.05370	0.84271	2.08528
TJ18	149.5	Silty carbonate sand	65	0.05350	0.84089	2.08428
TJ3	159	Dark clay	68	0.05341	0.83923	2.08245
TJ10	183	Silt w/shell frag.	83	0.05330	0.83602	2.07573
TJ10L	183	Silt w/shell frag.	74	0.05330	0.83621	2.07632
TJ11	204.5	Fine silt	56	0.05318	0.83394	2.06831
TJ11L	204.5	Fine silt	51	0.05319	0.83388	2.06732
TJ12	226	Silt w/shell & rock frags.	52	0.05314	0.83391	2.06727
TJ12L	226	Silt w/shell & rock frags.	43	0.05315	0.83338	2.06554
TJ26	230	Silty sand	16.7	0.05318	0.83566	2.07105
TJ27	235	Silty carbonate sand	15.9	0.05339	0.83691	2.07127
TJ28	240	Silty carbonate sand	13.6	0.05335	0.83762	2.07550
TJ13	243	Silt w/shell frags.	37	0.05367	0.84127	2.08179
TJ13L	243	Silt w/shell frags.	22	0.05387	0.84342	2.08225
TJ19	245	Clayey sand	8.2	0.05376	0.84249	2.07925
TJ20	247	Clayey sand	12.1	0.05374	0.84323	2.08363
TJ21	249	Clayey sand	10.4	0.05365	0.84089	2.07847
TJ4	251	Clayey silt	1.99	0.05397	0.84348	2.07967
TJ29	273	Silty carbonate sand	0.66	0.05321	0.83064	2.05908
TJ30	326	Sandy silt carbonate	0.74	0.05312	0.83082	2.05704
TJ5	349	Silty sand	4.36	0.05323	0.83250	2.06064
TJ31	405	Silty carbonate sand	1.12	0.05314	0.82924	2.05593
Archaeological samples						
TJ6		Metal artifact, Core AL25	6.65	0.05425	0.84835	2.08671
TJ14		Ceramic glaze, Core AL25	49	0.05391	0.84389	2.08343
TJ15		Ceramic no glaze, Core AL25	17.9	0.05341	0.83703	2.07152
TJ22		Ceramic, Core AL25	17.1	0.05349	0.83855	2.07631
TJ23		Ceramic, Core AL25	128	0.05356	0.84093	2.08351
TJ32		Pb crab	30.4*	0.05325	0.83646	2.07953
TJ33		Wooden coffin lid	83	0.05341	0.83182	2.05998
TJ34		Clay cartouche	206	0.05389	0.84465	2.08873
TJ35		Terra cotta figurine	18.6	0.05366	0.83853	2.07095
TJ36		Mummy case	190	0.05767	0.87327	2.10021
TJ37		Clay vase	17.0*	0.05029	0.79379	2.00047

Note: Artifacts TJ32–TJ37 from the Smithsonian Institution's Egyptian and Nile delta materials collection. Pb concentrations determined by isotopic dilution using a ^{205}Pb spike. Uncertainties on Pb concentration: <1%. Isotopic compositions have uncertainties of $^{204/206}$Pb = 0.06%, $^{207/206}$Pb = 0.10%, and ^{208}Pb/^{206}Pb = 0.12%. Sample numbers ending in "L" are acetic acid leaches; residues of leaching are denoted by the same sample number without the "L" ending.

*wt%.

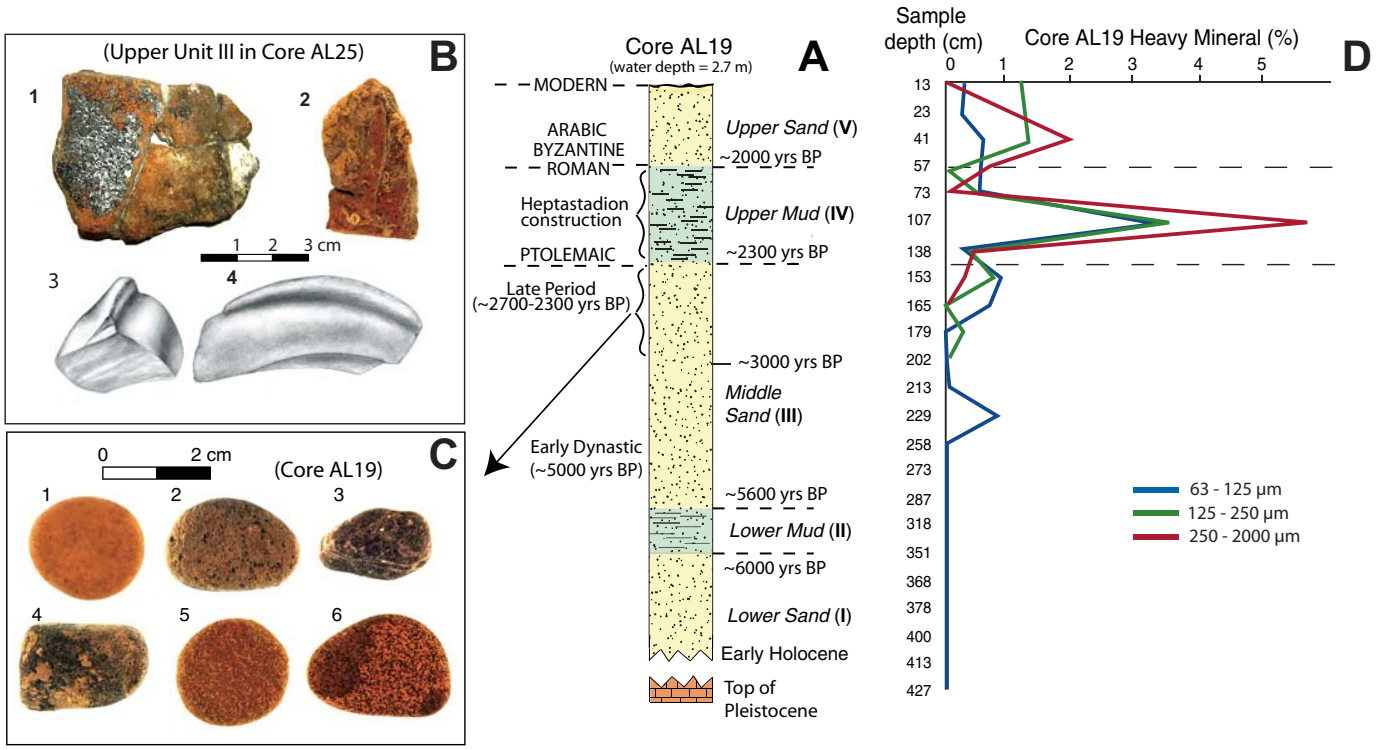

Figure 4. (A) Lithologic log of type core AL19 showing five (I–V) dated stratigraphic units. (B) Sherds of representative ware locally produced and dated from ninth and eighth centuries B.C.: slip (1, 2) and rimmed (3, 4). (C) Examples of pebbles of diverse lithologies derived from Middle and Upper Egypt, dated from ca. 3000–2300 yr B.P., recovered in upper part of unit III in core AL19. 1, 2—fossiliferous limestone; 3, 4—quartzite; 5—diorite; 6—gabbro. (D) Relative percentage of heavy mineral content in very fine, fine, and medium sand-size fractions, with marked increase in upper part of unit III before 2300 yr B.P.; major peak occurs in unit IV during Alexandria's development by Greeks and Romans.

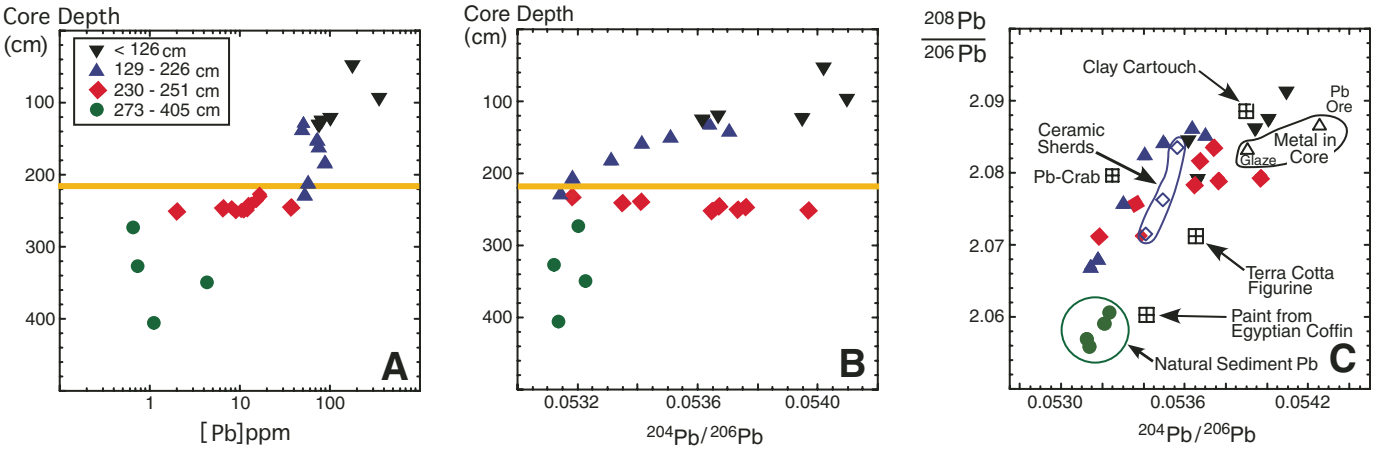

Figure 5. (A) Lead concentration, in ppm on a log-scale. (B) Isotopic ratio ($^{204}Pb/^{206}Pb$) versus depth in AL19; horizontal yellow lines denote ca. 2300 yr B.P. Alexander timeline. Major changes in both concentration and isotopic ratio occur between ca. 2900 and 2300 yr B.P. Samples color-coded by depth in core. (C) Isotopic ratios ($^{208}Pb/^{206}Pb$ versus $^{204}Pb/^{206}Pb$) of sediment in core AL19 and artifactual material, including ceramic and metal from core AL25 and pre-Alexandria artifacts in the Smithsonian Institution's Lower Egypt collections (see Table 1). Ceramic fragments in the core are identified by open blue diamonds. Artifactual materials are shown by cross-hatched boxes. Potential representatives of anthropogenically concentrated Pb are provided by samples from cores that include a metal fragment and glaze from ceramic potsherds in core AL25 (open triangles).

was discharged into the East Harbor by increasing volumes of municipal waste water.

Geochemical Markers in Pre-Greek Time

In addition to the four archaeological and petrologic parameters, lead concentration and isotopic composition in core AL19 (see Table 1) present a formidable additional line of evidence of human activity prior to B.C. 332. Lead concentrations are consistently below 10 ppm at depths >251 cm from core top (e.g., sections in the lower part of unit III that are older than ca. 4000 yr B.P.; Fig. 5A). From 251–230 cm (deposition in pre-Alexander time), Pb concentration gradually increases, reaching 50–80 ppm through depths of 123 cm (Ptolemaic time). Above 120 cm, Pb concentrations increase to >100 ppm, marking substantial Pb input into the East Harbor following accelerated growth of Alexandria by Greeks and Romans, as also documented by Véron et al. (2006).

In all samples below 251 cm, both $^{204}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$ ratios are slightly lower than values typical of average continental crust (e.g., $^{204}Pb/^{206}Pb$ = 0.0535 and $^{208}Pb/^{206}Pb$ = 2.0658; Stacey and Kramers, 1975). These values are indicative of the isotopic composition of natural Pb deposited in sediment prior to human influence. Throughout the post-Alexander portion of the core (above 226 cm depth), Pb concentrations are very high (>43 ppm) and show continually increasing $^{204}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$ ratios upsection in the core (Fig. 5B), consistent with increasing input of pollutant Pb from ore sources (Véron et al., 2006). Potential examples of this material include the metal fragment and ceramic glaze recovered from core AL25 (Fig. 5C).

Of special note, however, is that Pb concentration and isotopic composition do not correlate at the onset of anthropogenic Pb contamination in the interval between 251 cm and 183 cm from core top. Within the 251–235 cm interval, $^{204}Pb/^{206}Pb$ ratios increase to values similar to those seen in the shallowest portions of the core, yet both Pb concentrations and $^{208}Pb/^{206}Pb$ (Fig. 5C) remain below those characterizing the shallow portions of the core. Between ~230 and 183 cm from core top, Pb concentrations increase dramatically, yet $^{204}Pb/^{206}Pb$ ratios drop to values similar to those of the natural sediment Pb, but with significantly higher $^{208}Pb/^{206}Pb$. This may indicate an initial burst of anthropogenic Pb contamination into the East Harbor involving a source of Pb different from the ore-leads characteristic of the post-Alexander era.

The core component between 251 and 183 cm depth, characterized by high $^{208}Pb/^{206}Pb$ (~2.07 to ~2.084) and moderate $^{204}Pb/^{206}Pb$ (~0.0532 to ~0.0538) is similar in isotopic composition to ceramic potsherds from core AL25 that date to pre-Alexandrian times (Figs. 4B and 5C). These ceramic fragments have only moderate Pb concentrations (17–128 ppm), at least compared to weight percent concentrations in the analyzed pigments and metals (Table 1), and thus explain the relatively modest Pb concentration increase but marked Pb isotopic variation between 251 and 230 cm depth in the core. These data suggest that the first significant anthropogenic Pb contribution to East Harbor sediments did not derive from Greek and Roman metalworking, but instead reflect deposition of clay used perhaps for both building construction and manufacturing of ceramic vessels. The area surrounding the East Harbor is dominantly carbonate (Stanley and Bernasconi, 2006), so the clay signature is not likely to be locally (in situ) sourced. Only well into the post-Alexandria period did Pb pollution in the East Harbor shift to isotopic compositions expected for anthropogenically concentrated Pb; for example, as associated with metallurgy, paints, and pigments.

CONCLUSIONS

The more approaches utilized in an archaeological investigation, the greater the possibility of attaining robust new findings. Results from the application of diverse geological methodologies in this study provide consistent data on five distinct and diverse components in radiocarbon-dated East Harbor cores: ceramics, allochthonous rock fragments, lead concentration, heavy minerals, and organic matter, which all increase substantially in the same upper part of the Middle Sand (III) unit dated to ca. 3000 yr ago. Stratigraphically, this depositional phase clearly corresponds to one that began well before the arrival of Alexander in B.C. 332.

Together, the five archaeological, petrological, and geochemical markers provide compelling evidence of human activity dating to as much as seven centuries before the development of Alexandria by the Ptolemies. In particular, the ceramic sherds, lead isotopes, and associated data collected from harbor sediment cores indicate that a coastal population flourished in this area during Egypt's Intermediate (ca. B.C. 1000) and Late Dynastic (pre-Ptolemaic) periods.

In summary, evidence from East Harbor cores shows that Alexandria did not grow from a barren desert, but was built atop an active town that had for centuries exploited the safe harbor setting along this Egyptian coast. Beyond providing a preliminary insight into the early settlement's history, it is expected that the investigation findings will provide impetus for further geoarchaeological exploratory efforts in this historically rich region.

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2006–2007 Congressional Science Fellow Report

Keeping Pace with Capitol Hill

Craig Cooper, *2006–2007 GSA–U.S. Geological Survey Congressional Science Fellow*

One of the most amazing things about working on Capitol Hill is the pace: fast, relentless, and intense—jobs here definitely qualify as "extreme careers." The days are long: mine typically starts before 6:00 a.m., and it's a rare treat for me to get home in time to read a bedtime story to my daughters, who are usually fast asleep before I even leave the office. The days are hectic, filled with deadlines too numerous to count. For example, I recently had only four hours to convert over 850 pages of public responses to a 120-page Department of Energy draft into a one-page bullet-point summary, while also taking part in two hours of constituent meetings and engaging in negotiations on a mostly unrelated bill—and those tasks comprised less than 30% of my day! Congress is a tough place to work.

Yet, working with Congress is also intensely rewarding. There is something special about helping to craft legislation that impacts people's lives in meaningful ways. My greatest personal reward to date has been the opportunity to work on the lead bill to mandate increases in automobile fuel economy. This bill is part of the energy package that goes to the Senate floor next week (Tuesday, 12 June—most likely, the issue will already be decided by the time this article is published). If passed in its current form, it will increase fuel economy standards for the first time in over 30 years and ultimately save more oil than we now import from the Persian Gulf. If polls are to be believed, over 80% of Americans want improved fuel economy. Congress is spending a lot of time and effort trying to achieve this goal.

Fuel economy is one of many big issues, but big issues are only one small part of what Congress does. The smaller issues are just as important. For example, Senators Feinstein and Boxer recently introduced legislation to try to change U.S. law in order to allow an airport to help pay for the cost of installing soundproofing in an adjacent school (S.996). No large firm, national organization, or cadre of well-heeled lobbyists led this charge. This bill is the result of local government working with the federal government to help a small local school solve a large airport problem. This type of work happens every day, and I wish that more Americans understood how Congress works with local governments.

Unfortunately, most Americans don't know that Congress is working this hard to serve the public interest. Newspapers and TV news don't report the good things that Congress does. They typically report the conflict, not the cooperation. For example, on 16 May 2007, the U.S. Senate passed the Water Resources Development Act (S.1248) by a 91 to 4 vote. This bill, the culmination of many months of hard work, authorizes funding to improve our nation's water resources. It is an excellent example of how Congress can (and does) work together. Unfortunately, this news was nowhere to be seen in our nation's leading newspapers. On 17 May, the political news on the front page of the *Washington Post* consisted of stories about the net worth of presidential candidates, the U.S. attorneys scandal, and the Paul Wolfowitz scandal at the World Bank. The only news references to the water resources bill were on unrelated "test vote" amendments on funding for the Iraq war. There was no mention in the news of how Congress worked together to help people—only detailed discussions of the leading conflicts and scandals of the day. The U.S. news media do not report what our government does. They mostly report what the government argues about. No wonder Americans think that the only thing the government does is argue!

The single most important thing I can tell you is that news coverage of government is generally truthful but not entirely accurate. It's almost as if the media provide an action-packed overview of the "show" that is government. The conflicts are accurately captured, but the story is incomplete. It would be unwise to judge the "show" that is our government by the "trailer" that is carefully edited by the news media. Contact your congressional representative or senator if you want to know the complete story. This is a hard-working place, and a lot of good things happen here.

This manuscript is submitted for publication by Craig Cooper, 2006–2007 GSA–U.S. Geological Survey Congressional Science Fellow, with the understanding that the U.S. government is authorized to reproduce and distribute reprints for governmental use. The one-year fellowship is supported by GSA and by the U.S. Geological Survey, Department of the Interior, under Assistance Award No. 06HQGR0169. The views and conclusions contained in this document are those of the author and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. government. Cooper can be reached at craig_cooper@feinstein.senate.gov.

2007–2008 Congressional Science Fellow Named

Maria Honeycutt

Maria Honeycutt has been named the GSA–U.S. Geological Survey Congressional Science Fellow for 2007–2008. With a research background in coastal geologic processes and consulting experience in hazard identification and mitigation, Honeycutt is eager to get to work on policy initiatives for a broad range of earth and ocean science-related issues. "It is a tremendous honor to have been selected by GSA and the USGS for the Fellowship, and I feel fortunate to be able to serve during such an interesting and challenging time on Capitol Hill."

Honeycutt earned a B.A. in geology with high honors from Smith College in 1995, and M.S. (1997) and Ph.D. (2003) degrees in oceanography from the University of Delaware's College of Marine and Earth Studies. Honeycutt spent 1998 as a Knauss National Sea Grant Marine Policy Fellow embedded in the Mitigation Directorate at Federal Emergency Management Agency (FEMA) Headquarters in Washington, D.C. At FEMA, she was involved in diverse projects ranging from post-hurricane building damage assessments to a review of pilot mapping projects completed under FEMA's congressionally mandated Evaluation of Coastal Erosion Hazards Study. Her work on this study shaped many of the goals for her dissertation research, which focused on quantifying the impacts of the antecedent geologic framework and storms on long-term spatial and temporal patterns of shoreline change along the Atlantic coast of Delaware.

For nearly three years, Honeycutt has been employed as a principal geologist with URS Corporation in Maryland, and spent most of the preceding four years with another engineering firm, PBS&J. At URS, Honeycutt led efforts to develop advisory coastal flood recovery maps for the Gulf Coast in the wake of hurricanes Ivan, Katrina, and Rita. "In a matter of a few weeks or months after a severe storm, maps are generated to provide state and local officials with up-to-date flood-risk data to use during the recovery process. I saw first-hand the challenges and hardships created if we, as scientists and engineers, fail to issue reliable data in a timely way to support decision-making." Honeycutt is currently leading analyses of storm-induced erosion, overland surge and wave modeling, and floodplain mapping for the Mississippi coast as part of a follow-up study. Honeycutt also serves as the co-chair of the Coastal Issues Policy Committee for the Association of State Floodplain Managers and is professionally registered as a certified floodplain manager.

Hazards are likely to remain a hot topic on Capitol Hill, and Honeycutt is looking forward to immersing herself in many of the other scientific topics that have captured Congress' interest as well. "The impacts of 2004 and 2005 hurricanes on the environment, as well as on our society and economy, brought some needed attention to a wide range of natural resource management issues. Climate change has been a focus of the 110th Congress, and progress is being made on ocean governance, fisheries, and coastal habitat protection. Energy, offshore resources, water quality and quantity are also critical policy areas for the nation. The opportunities are truly endless."

Geoscience Education Division to Award Student Grants

Students in geoscience education: Are you presenting at the GSA Annual Meeting this fall? GSA's Geoscience Education Division is offering several travel grants for up to US$250 to student members who will be presenting work at the meeting. Grants will be awarded based on merit and financial need.

To be eligible for an award, you must be

- A current Student Member of GSA and the Geoscience Education Division—to join the Division now, go to http://gsaged.org/ and click on "How Do I Join?"
- Presenting a poster or talk in a geoscience education topical or discipline session at the 2007 Annual Meeting.

To apply for the award, please send as a single e-mail attachment:

- Confirmation of your standing as a Student Member of the Geoscience Education Division (include member number);
- A copy of your accepted abstract;
- A current CV, limited to two pages; and
- A brief itemized budget and statement of your financial needs, including all other sources of funding.

Send your applications to Heather Petcovic, **heather.petcovic@wmich.edu,** *no later than* **1 September 2007.** Notification of grant status will be made prior to the 24 September Annual Meeting early registration deadline, and awards will be made following confirmation of attendance at the meeting.

Faculty: please direct your students' attention to this opportunity!

GSA COMMITTEES: Progress through Service

The GSA Publications Committee

The purpose of the GSA Publications Committee is to maintain the continuity and quality of each Society publication. Historically, the Committee has played a vital operational role that, until relatively recently, did not change considerably. Today, however, the Committee is taking on some new and inspiring challenges.

The Changing Environment of Publications

GSA began publishing the *Geological Society of America Bulletin* in 1890. *Bulletin* was, until 1973, the Society's only research and news journal. Rapid expansion of the geosciences led to recognition of a need to expand the Society's publishing efforts. Thus, 1973 marked the initiation of the tremendous success story of the *Geology* journal. *GSA News and Information,* and later, *GSA Today,* followed to meet the communication needs of GSA Headquarters and Society Members.

The pace of change has since increased dramatically with the progressive and inevitable transition from a print journal world, in which many of us grew up, to one dominated by electronic publishing. In 2005, GSA commissioned its first online-only journal, *Geosphere*, to allow for publication of an array of media forms. *Geosphere* is attracting contributions at an increasing rate and will soon be publishing its first special issue.

The incorporation of the Society's journals into *GeoScience World,* an Internet resource for research and communication in the geosciences built on a core database of peer-reviewed journals, represents the Society's recognition of the need for cooperation among a diversity of geoscience organizations.

Committee Roles and Responsibilities

An essential charge of the Publications Committee is to identify and recommend to Council all publications editors. This endeavor involves solicitation by the committee of high-quality candidates for these key positions and deliberation over its recommendations.

The revenue from GSA publications is nearly 50% of the total annual revenue of the Society. This fact, joined with our high publications standards, guarantees that topics such as the transition to electronic publishing, institutional costs and subscriptions, and the impact of open access on scientific publication will remain critical components of future discussions and recommendations from the Publications Committee.

Serving on the Committee

The committee consists of two GSA Council members, science editor representatives from each publication, three Members at Large (volunteers), the Geoscience Information Society library representative, and the director of GSA Publications. A committee chair is selected from among the Councilors and at-large members. Most members serve four-year terms, while science editors remain on the committee for the duration of their editorial tenure.

Volunteers on the Committee should have a keen interest in GSA publications and, ideally, some background in the general world of science publishing, including issues related to the ongoing transition to electronic publication. Volunteers should also have a solid perspective regarding the interests and needs of current geoscience students, who are rapidly becoming the immediate future of our profession.

The time commitment on the part of volunteer participants is not huge, but does include attending two official committee meetings each year. The first takes place at GSA headquarters, typically for a full day in February. The second is convened at GSA's Annual Meeting, typically for about two hours on Sunday morning.

GSA faces several important, provocative decisions concerning publications in future years. The insight and open-mindedness of volunteers on the Publications Committee will be invaluable.

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

GEOLOGIC PAST **A Look inside Volume 1 of *Geological Society of America Bulletin,* 1890**

Volume 1 of *GSA Bulletin* begins with a review of the founding and organization of the Geological Society of America, followed by papers read at the "Semi-Annual Meeting held at Toronto, August 28–29, 1889." James Hall, the first president of GSA, gave the opening address and then presented papers on the "Revision of the genus *Orthis*" (p. 19) and "New genera and species of Dictyospongidae" (p. 22). G.K. Gilbert was next, with his paper, "The strength of the Earth's crust" (p. 23). T.C. Chamberlain presented a paper titled, "Boulder belts and boulder trains" (p. 27).

Another geology great, James Dwight Dana, presented "Areas of continental progress in North America" (p. 36). C.D. Walcott ("Study of a line of displacement in the Grand Cañon" [*sic*], p. 49) and J.W. Spencer ("High continental elevation preceding the Pleistocene," p. 65; and "Ancient shores, boulder pavements, and high-level gravels," p. 71) completed the presentations.

Other articles published in the first volume of *GSA Bulletin* include "Notes on the surface geology of Alaska," by I.C. Russell (p. 99), "Orographic movements in the Rocky Mountains," by S.F. Emmons (p. 245), "On glacial phenomena in Canada," by Robert Bell (p. 287), "The value of the term 'Hudson River Group' in geologic nomenclature," by C.D. Walcott (p. 335), and "Some additional evidences bearing on the interval between glacial epochs," by T.C. Chamberlin (p. 469). The Proceedings of the Annual Meeting held at New York 26–28 December 1889, including obituary notices, completes the volume.

The Financial Epochs of the Geological Society of America

Dave Stephenson, *President, GSA Foundation*

Three epochs mark the 118-year history of the Geological Society of America relative to its financial status and sources of income. Each of these epochs is markedly different in character, the state of geologic knowledge, size of headquarters staff, and income needs and sources. The Society was founded with 13 members during a time when there were only about 200 geologists in North America, most of whom were in academic institutions.

1888–1930: The Formative Years

This time period was characterized by gradual growth in maturity, membership, and Society prestige. Attendance at the annual meeting went from 13 in 1888 to 519 in 1930. GSA managed to be mostly self-supporting and conducted business mainly on the small income from membership dues and a few subscriptions to *GSA Bulletin*. Headquarters was a small room lent to the Society by Columbia University. The staff consisted of a secretary, treasurer, editor, and several secretarial assistants, all part-time. The secretary and treasurer received small honoraria, which they used to pay the secretarial staff.

The Society was solvent, with income and expenses balanced at about $12,000 each by 1930. There were no travel expenses for staff, officers, Council, or committees. Annual meeting costs were borne by the local host and the $1.00 registration fee. In 1930, the year before his death, R.A.F. Penrose was GSA president.

1931–1980: The Penrose Epoch

This period was initiated by GSA's inheritance from R.A.F. Penrose of about $3,900,000, which in today's economy would be over $50,000,000. The flow of income from that endowment enabled the Society's expansion into new activities and products. Peter Berkey, as the Society secretary, made arrangements with Columbia University for an indefinite loan of a house on the edge of campus, which became the Society's home for the next 30 years.

In early 1931, the Society was made up of about 600 geologists, few with business acumen. The officers and councilors were chosen mainly for their scientific stature, not their financial management abilities. Thus, decision-making regarding management of the Penrose Endowment was a challenge.

Fortunately, the Society hired expert legal and financial advisors. For many years beyond 1931, the Penrose Endowment provided the largest single source of money available to the Society. As tax laws changed, limiting the amount of total income a society can generate from endowments, and inflation continued to erode the real value of income, it became clear that additional funds needed to be actively sought.

1981–Present: The Foundation Years

Because the Penrose Endowment, while well-managed, could not keep pace with the Society's need for income, and to have a structure that could help the Society solve financial shortfalls, GSA Council established the GSA Foundation as a legally separate 501(c)(3) non-profit organization in 1980.

The first major campaign for funds was in support of the *Decade of North American Geology* (DNAG) books and maps project. Several Foundation and Society representatives (Howard Gould, Pete Palmer, and Dwight Roberts) raised $3.4 million in 18 months for the DNAG program. Following that success, the Foundation has continued to raise monies that allow

GSA to have a greater impact in the geosciences and society and create new programs and products for its membership.

The continuing search for new funds has been the responsibility of the Foundation for the past 25 years. Initially, the Foundation did its own bookkeeping, issued its own audited annual financial statement, and made its own investment decisions. Shortly after the start of the Second Century Fund drive in 1992, a process was begun to unify many of the financial elements of the Society and the Foundation, while maintaining the legal separation.

A special task force reviewed the structural relationship between the two organizations in 1993 and concluded that the Foundation should continue to operate as a separate entity. It was believed then, as now, that in order to satisfy the donors, it is necessary to have a separate fiduciary unit with its own governing board that is not beholden to the management of the spending unit. Since the late 1980s, policy has been that the Foundation be the recipient of all outside funding other than what GSA receives in dues, product sales, or government grants.

Source: Eckel, Edwin B., 1982, The Geological Society of America—Life History of a Learned Society: Geological Society of America Memoir 155, 168 p.

Most memorable early geological experience:

To illustrate the differences between rational (cause and effect) and empirical deductions in his classes, J. Hoover Mackin used to point out that if you put one foot into a bed of red-hot coals and other foot on a block of ice, the average temperature should be comfortable.

—Donald J. Easterbrook

About People

GSA Fellow **Holly Stein,** director of Applied Isotope Research for Industry and the Environment Program at Colorado State University, has received the Helmholtz-Humboldt Research Award for her work on ore deposit geology and geochemistry. The award honors internationally renowned scientists outside of Germany who have contributed fundamental discoveries, new theories, or insights that significantly impact their own research area and reach beyond it. As part of the award, Stein received a 60,000 Euro prize (about US$89,000), presented by the president of Germany in a formal reception in Berlin. The award provides for a formal affiliation with the GeoForschungsZentrum and the University of Potsdam, with an additional €25,000 to promote research cooperation between university partners if Stein accepts an invitation to undertake research in Germany. She will also be an invited speaker at other universities throughout Germany.

GSA Bulletin science editor **Brendan Murphy,** of St. Francis Xavier University, appears in the Science Channel's *Geologic Journey–Atlantic Coast* episode, shown on the cable channel this summer. The episode covers the geologic history of the Atlantic Coast, noting that it preserves evidence of all the major geologic events leading to the amalgamation and breakup of Pangea. Murphy appears early in the episode, in a segment that examines the vestiges of the ancient Iapetus Ocean, whose destruction gave rise to a major mountain-building event: the development of the Appalachian mountain belt.

GSA Awards Prizes for Intel Science Fair Excellence

During the 2007 Intel International Science and Engineering Fair in Albuquerque, New Mexico, USA, GSA awarded prizes for science and engineering projects investigating the earth sciences. The winners and their schools will receive a free subscription to *GSA Today* as well as a cash prize. Projects were judged on their demonstration of a high level of understanding of earth-science concepts and the nature of Earth as a system, as well as the use of innovative methods to explain concepts.

Hannah Louise Wolf, 16, Parkland High School, Allentown, Pennsylvania, USA. A US$2,000 Award *for* "On shaky ground: Probing proximal seismites within the epicenter of a Cretaceous earthquake in Grand Staircase–Escalante National Monument, Utah."

Terik Daly, 17, Oak Grove High School, San José, California, USA. A US$1,500 Award *for* "Chemical aspects of the impact process."

Ruslan Anvarovych Fatkullin, 16, Chernomorskoye School-Gymnasium #3, Chernomorskoye, Autonomous Republic of Crimea, Ukraine; and **Zarema Ilyasivna Umerova,** 15, Mezhvodnoe High School, Mezhvodnoe, Autonomous Republic of Crimea, Ukraine. A US$500 Award *for* "Using modified ancient technology for obtaining fresh water from the atmosphere in the arid steppe Crimea."

CONGRATULATIONS to these students!

Winners of the 2007 Intel International Science and Engineering Fair GSA Special Award, from left: Presenter and judge Brian Salem, Ruslan Anvarovych Fatkullin, Zarema Ilyasivna Umerova, Hannah Louise Wolf, and Terik Daly.

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GSA Divisions: Build on Your Interests!

GSA Members may join and participate in one or more of the Society Divisions for a nominal fee. To learn more about each of GSA's seventeen Divisions, go to www.geosociety.org and click on "Sections and Divisions."

Archaeological Geology, est. 1977. The Archaeological Geology Division was organized to provide a forum for presentation of papers on archaeological geology and discussion of related problems, to stimulate research and teaching in archaeological geology, and to promote these objectives within the framework of the Geological Society of America. Division Awards include the Ripp Rapp Archaeological Geology Award, the Richard Hay Student Paper/Poster Award, and the Claude C. Albritton, Jr., Award memorial fund.

Coal Geology, est. 1954. The Coal Geology Division's over 200 members worldwide come from all facets of the coal geology community, including state and national geological surveys, academia, and industry. The Division's purpose is to encourage coal research and to disseminate coal geology information to all interested parties. It does this by actively participating in GSA's annual and Section meetings, convening scientifically pertinent and thought-provoking symposia and technical sessions with the highest quality presentations. This Division sponsors a major award for outstanding contributions to the field of coal geology, the Gilbert H. Cady Award, and also recognizes the volunteered contributions of its members through its Distinguished Service Award. For students, this Division offers both the Antoinette Lierman Medlin Scholarship and the best student paper award.

Engineering Geology, est. 1947. GSA's oldest Division, the Engineering Geology Division promotes education, research, outreach, and application of engineering geologic knowledge toward the betterment of human society by adopting sound design of buildings, structures, and facilities that assure public safety and a healthy environment. Each year, this Division honors geologists with the E.B. Burwell, Jr., Award and, along with the Association of Environmental and Engineering Geologists, commissions the Richard H. Jahns Distinguished Lecturer. Other Division awards include the Meritorious Service Award and the Distinguished Practice Award. For students, this Division also sponsors the Roy J. Shlemon Mentor Program in Applied Geology, the Shlemon scholarship for research in engineering geology, Shlemon support for attending field trips and short courses, and a Division best student paper award.

Geobiology & Geomicrobiology, est. 2001. As of 31 December 2006, the Geobiology & Geomicrobiology Division had the greatest proportion of Student Members (at 41%) as compared to other Divisions. The Division's purpose is to bring together scientists working at the interface of biology and geology and to encompass the integration of these disciplines through time and across space by simultaneously promoting both the broad scope and detailed disciplinary work demanded of rigorous interdisciplinary research. Fields currently within this Division include biogeochemistry, biomineralogy, geochemical ecology, paleontology, micropaleontology, origins of life and co-evolution of planets and life, paleobiology and paleoecology, molecular paleontology and ecology, systems modeling and informatics, and astrobiology. As reflected in its high proportion of Student Members, this Division stays true to its goal of nurturing this spectrum of fields through active encouragement and mentoring of students.

Geoinformatics, est. 2006. The mission of GSA's newest Division, the Geoinformatics Division, is to advance "Data to Knowledge," providing GSA members with an opportunity to participate in the emerging field of cyberinfrastructure. The Division actively promotes and sponsors short courses, symposia, and GSA Special Papers that emphasize information technology–supported discovery and integration of geoscience data leading to a more comprehensive understanding of Earth and the planets as complex systems.

Geology and Health, est. 2005. The Geology and Health Division is concerned with the intersection of geological conditions, whether natural or anthropogenic in origin, with health, disease, pathology, and death in modern and fossil humans, animals, and plants. With a focus on the interdisciplinary relationship of geology to medicine, biology, chemistry, and other sciences, this Division fosters communication and collaboration among scientists and practitioners with differing professional perspectives.

Geology and Society, est. 2003. The motto of the Geology and Society Division is, "Geology Working for Society." The Division leadership believes every member of GSA should be a member of the Geology and Society Division, not for empire-building, but for the necessity of heightening knowledge of issues and improving the communication skills of the entire geologic community in order to properly communicate geologic information to society as a whole.

Geophysics, est. 1971. The Geophysics Division brings together scientists interested in geophysics to facilitate the presentation and discussion of their challenges and ideas, to stimulate communication among geophysicists and other earth scientists, and to promote research and the publication of results on geophysical studies. This Division sponsors the George P. Woollard Award for outstanding contributions to geology through the application of the principles and techniques of geophysics, the Allan V. Cox Student Research Grant Award, and the Geophysics Division Student Research Grant Award.

Geoscience Education, est. 1991. The Geoscience Education Division is driven by the purpose of fostering discussions and active participation of GSA Members in all aspects of earth science education. The Division complements and expands participation in the educational efforts of the National Earth Science Teachers Association (NESTA), the National Association of Geology Teachers (NAGT), the National Science Teachers Association (NSTA), and other similar organizations.

DIVISIONS
Archaeological Geology
Coal Geology
Engineering Geology
Geobiology & Geomicrobiology
Geoinformatics
Geology and Health
Geology and Society
Geophysics
Geoscience Education
History of Geology
Hydrogeology
International
Limnogeology
Planetary Geology
Quaternary Geology & Geomorphology
Sedimentary Geology
Structural Geology & Tectonics

To that end, this Division cosponsors the Biggs Earth Science Teaching Award with the NAGT.

History of Geology, est. 1976. The mission of the History of Geology (HoG) Division is to encourage the study and communication of the history of geology as well as discussion of challenges in the study of the development of the geological sciences. The "Rock Stars" articles in *GSA Today*, highlighting the life and work of "giants in geology," are submitted through this Division. The Division sponsors technical sessions at the GSA Annual Meeting and at Section meetings, honors geologists for their research, writing, and historical work (the Mary C. Rabbitt History of Geology Award and the History of Geology Student Award), and for service to the Division (the Gerald M. and Sue T. Friedman Distinguished Service Award). The HoG was instrumental in the generation of the GSA *Decade of North American Geology* series, and HoG members were also active in the establishment of the History of Earth Sciences Society in 1982.

Hydrogeology, est. 1959. The fastest-growing Division in GSA for 2005–2006 (11.5% membership growth), the Hydrogeology Division emphasizes and focuses on the geologic aspects of hydrogeology, the role of geology in the hydrologic cycle, and the importance of hydrogeology to society and science. The Division fosters research, communication, and presentation of the science, as well as mentoring of students interested in a career in hydrology or hydrogeology (the John Mann Mentors in Applied Hydrogeology Program). The O.E. Meinzer Award and the Birdsall-Driess Distinguished Lecturer honorees are named by this Division, along with its Distinguished Service Award and the Hydrogeology Division Student Research Grant Awards.

International, est. 1989. The International Division was established to provide a forum for meetings, symposia, and lecture tours on the geology of regions beyond North America and to provide a focal point for the exchange of views with non–North American geologists. This Division also raises funds for overseas colleagues to attend GSA Annual Meetings, aids in the distribution of books and journals to underfunded overseas institutions, and works to strengthen ties with overseas geoscientific societies. The International Division honors renowned international geologists or those studying the geology of regions beyond North America with the Distinguished Career Award.

Limnogeology, est. 2002. The Limnogeology Division encourages research on both ancient and modern lakes around the world, the collaboration of scientists from all disciplines on lake research, the communication of lake research, and the fostering of student research and careers in lake studies. This Division sponsors the Kerry Kelts Research Awards for students.

Planetary Geology, est. 1981. The mottos of the Planetary Geology Division are, "When one planet just isn't enough!" and "The GSA Division with the biggest field area!" Awards sponsored by this Division include the G.K. Gilbert Award, presented annually for outstanding contributions to the solution of fundamental problems in planetary geology in the broadest sense, which includes geochemistry, mineralogy, petrology, geophysics, geologic mapping, and remote sensing; the Eugene M. Shoemaker Impact Cratering Award; the Career Achievement Award; the Stephen E. Dwornik Student Research Paper Award; and (jointly with the Meteoritical Society) the Pellas-Ryder Award for the best student paper in Planetary Science.

Quaternary Geology and Geomorphology, est. 1955. The Quaternary Geology and Geomorphology Division facilitates communication among scientists in these fields as well as the presentation and study of their research and ideas to the wider scientific community. This Division sponsors multiple awards, including the Kirk Bryan Award for Research Excellence, the Farouk El-Baz Award for Desert Research, the Don J. Easterbrook Distinguished Scientist Award, the Distinguished Career Award, and the J. Hoover Mackin and Arthur D. Howard student research awards. The Gladys W. Cole Memorial Research Award, funded through the GSA Foundation, is also presented by this Division.

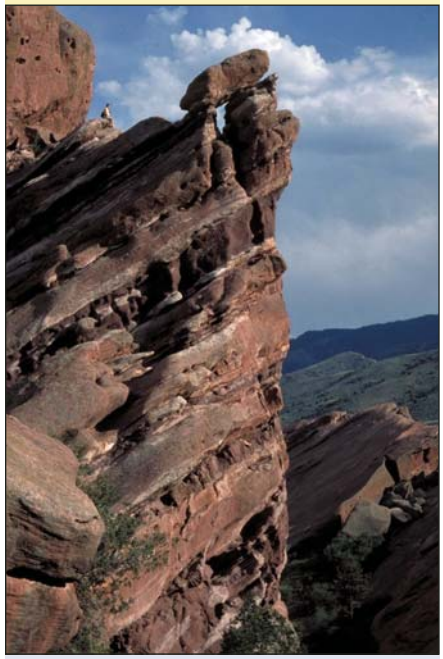
Sedimentary Geology, est. 1985. The Sedimentary Geology Division works to ensure the continued active presence of sedimentary-related topics and sessions at the GSA Annual Meeting and at Section meetings and nurtures the work of students by offering the Sedimentary Geology Division Student Research Grant Award as well as providing aid for students to attend Division-sponsored short courses and field trips. The Division also maintains an active list of Web resources for sedimentary geologists. The Laurence L. Sloss Award for outstanding accomplishments in sedimentary geology and service to GSA is sponsored by this Division.

Structural Geology and Tectonics, est. 1980. Ranked the largest GSA Division as of 31 December 2006 (1,661 members), the Structural Geology and Tectonics Division focuses on the geometry and mechanisms of natural and experimental deformation at all scales. It works to promote the research of scientists in these fields and to facilitate communication and discussion at all levels of the earth sciences. This Division offers the GSA Career Contribution Award for advancement of the science of structural geology and tectonics, a Best Paper Award, and a Division Student Research Grant Award.

Denver 2007 Short Course Program

The following GSA-sponsored professional development short courses are open to GSA Members as well as nonmembers. You may attend a short course without registering for the meeting; however, a Short Course Only registration fee of US$40 (see the registration form in the June *GSA Today* or go to www.geosociety.org/meetings/2007/) is required in addition to the cost of the course. That US$40 fee may be applied toward meeting registration if you decide to attend. *Exclusion:* GSA K–12 Teacher Members who are not registered for the meeting are not required to pay the Short Course Only fee.

These courses fill up quickly—early registration is recommended! Also, registration for the meeting after 24 September costs an additional US$30. For full short course descriptions, go to www.geosociety.org/meetings/2007/cw.htm. Questions? Contact Jennifer Nocerino, jnocerino@geosociety.org.



North "wall" of Red Rocks Amphitheatre, near Morrison, Colorado. Image courtesy Red Rocks Park and Amphitheatre, http://www.redrocksonline.com/images/media/large/pic10.jpg.

PROFESSIONAL COURSES

501. Estimating Rates of Groundwater Recharge. Sat., 27 Oct., 8 a.m.–5 p.m. CEU: 0.8. Fee: US$214; includes course materials and lunch. Rick Healy, U.S. Geological Survey; Bridget Scanlon, Bureau of Economic Geology, The University of Texas at Austin. Limit: 35.

502. Laser Ablation ICP-MS: Fundamentals and Applications to Geological, Environmental, and Biological Problems. Sun., 28 Oct., 8 a.m.–5 p.m. CEU: 0.8. Fee: US$262; includes course materials and lunch. Alan Koenig, U.S. Geological Survey; Ian Ridley, U.S. Geological Survey. Limit: 30.

FACULTY AND GRADUATE STUDENT COURSES

503. Three-Dimensional Geologic Mapping for Groundwater Applications. Sat., 27 Oct., 8 a.m.–5 p.m. CEU: 0.8. Fee: US$61; includes course materials and lunch. Cosponsored by *GSA Geology and Society Division; GSA Hydrogeology Division*. Richard C. Berg, Illinois State Geological Survey; Harvey Thorleifson, Minnesota Geological Survey; Hazen Russell, Geological Survey of Canada. Limit: 55.

504. Sequence Stratigraphy for Graduate Students. Fri.–Sat., 26–27 Oct., 8 a.m.–5 p.m. CEU: 0.8. No fee, but preregistration is required. Cosponsored by *ExxonMobil; BP*. For information and to register, please contact Kirt Campion, ExxonMobil Upstream Research Company, kirt.m.campion@exxonmobil.com; Art Donovan, BP Upstream Technology Directorate. Limit: 55.

505. Introduction to the "Learning with Data Workshop." Sun., 28 Oct., 8 a.m.–noon. CEU: 0.4. Fee: US$30; includes course materials and refreshments. William A. Prothero, Jr., University of California at Santa Barbara; Sabina Thomas, Baldwin Wallace College; for more information, see http://lwd.earthednet.org/. Limit: 25.

506. New Tools for Quantitative Geomorphology: Extraction and Interpretation of Stream Profiles from Digital Topographic Data. Sun., 28 Oct., 9 a.m.–5 p.m. CEU: 0.7. Fee: US$30; includes course materials and lunch. Cosponsored by *NSF Geomorphology and Land Use Dynamics; GSA Quaternary Geology and Geomorphology Division*. Kelin Whipple, Arizona State University; Cameron Wobus, University of Colorado; Eric Kirby, Pennsylvania State University; Benjamin Crosby, Idaho Sate University. Limit: 20.

507. Processing and Analysis of GeoEarthscope and Other Community LiDAR Topography Datasets. Sat., 27 Oct., 9 a.m.–5 p.m. CEU: 0.7. Fee: US$180; includes course materials and lunch. Ramon Arrowsmith, Arizona State University; Chris Crosby, Arizona State University; David Phillips, UNAVCO. Limit: 20.

508. Starting out in Undergraduate Research and Education: A Professional Development Workshop for Young Faculty. Sat., 27 Oct., 8 a.m.–5 p.m. CEU: 0.8. Fee: US$50; includes course materials and refreshments. Cosponsored by *Council on Undergraduate Research; National Association of Geoscience Teachers; GSA Geoscience Education Division*. Jeffrey G. Ryan, University of South Florida; Lydia K. Fox, University of the Pacific; Jill Singer, Buffalo State College. Limit: 30.

509. Seismic Data Usage for Undergraduates: Options for Both Majors and Non-Majors. Sat., 27 Oct., 8 a.m.–5 p.m. CEU: 0.8. Fee: US$15; includes course materials and lunch. Cosponsored by *GSA Geoscience Education Division*. Michael Hubenthal, Incorporated Research Institutions for Seismology (IRIS) Consortium; Michael Wysession, Washington University; John Taber, IRIS Consortium; Jeff Barker, Binghamton University. Limit: 25.

510. Teaching Field Methods in Hydrogeology. Sat., 27 Oct., 8 a.m.–5 p.m. CEU: 0.8. Fee: US$147; includes course materials and lunch. Cosponsored by *GSA Hydrogeology Division*. Todd Halihan, Oklahoma State University; Shemin Ge, University of Colorado; Ed Harvey, University of Nebraska–Lincoln. Limit: 80.

511. Education Research: An In-Depth Look at Qualitative Methods. Sat., 27 Oct., 1–5 p.m. CEU: 0.4. Fee: US$100; includes course materials. Julie Sexton, Colorado State University. Limit: 55.

512. Strategies for Successful Recruitment of Geoscience Majors: Conceptual Framework and Practical Suggestions. Sat., 27

Oct., 9 a.m.–5 p.m. CEU: 0.7. Fee: US$50; includes course materials and refreshments. Cosponsored by *GSA Geoscience Education Division; National Association of Geoscience Teachers*. Randall M. Richardson, University of Arizona; Carolyn Eyles, McMaster University. Limit: 35.

K–12 TEACHER COURSES

513. Teaching College-Level Earth Science to High-School Students. Sat., 27 Oct., 8 a.m.–noon. CEU: 0.4. Fee: US$5; includes course materials and refreshments. Cosponsored by *National Science Foundation*. Wendy Van Norden, Harvard-Westlake School; Raymond V. Ingersoll, University of California at Los Angeles. Limit: 25.

514. Using GPS Data to Learn about Tectonic Plate Movement, Earthquakes, Volcanoes, and Other Applications: A Workshop for Educators in Secondary Education. Sun., 28 Oct., 1–5 p.m. CEU: 0.4. Fee: US$41; includes course materials and refreshments. Susan C. Eriksson, UNAVCO; Shelley E. Olds, UNAVCO. Materials will be available prior to the course at www.unavco.org/cws/2007GSA_course/. Limit: 20.

Continuing Education Units (CEUs)

All professional development courses and workshops sponsored by GSA offer CEUs. One CEU is earned for every 10 contact hours of participation in an organized continuing education experience under responsible sponsorship, capable direction, and qualified instruction. One contact hour is defined as a typical 60-minute classroom session or its equivalent.

Cancellation Deadline:
1 October 2007

Field Trips 2007 GSA Annual Meeting in Denver

Register online: www.geosociety.org/meetings/2007/reg.htm

Early Registration Deadline: 24 September 2007
Cancellation Deadline: 9 October 2007

GSA invites you to join your colleagues on these annual meeting field trips. Most of the trips are new this year; a few are classics you might have missed in previous years. If you're not attending the meeting but still want to go on a field trip, you may register just for the trip and pay only the nonregistrant fee (US$40) in addition to the field trip fee. That nonregistrant fee may be applied toward meeting registration if you decide to attend. Trip fees include transportation during the trip as well as a trip guide. Other services, such as meals and lodging, are noted by the following: B—breakfast, L—lunch, R—refreshments, D—dinner, ON—overnight lodging.

Questions? Contact the trip leaders or Eric Nocerino, +1-303-357-1060, enocerino@geosociety.org. Complete trip descriptions and registration details are in the June *GSA Today* and are posted at www.geosociety.org/meetings/2007fieldtrips.htm. All trips begin and end in Denver at the Colorado Convention Center unless otherwise indicated.

PREMEETING

401. **Track of the Yellowstone Hot Spot: Young and On-Going Geologic Processes from the Snake River Plain to Yellowstone.** Tues.–Sat., 23–27 Oct. Cost: US$420 (4ON, B, R); min: 20/max: 44. Lisa A. Morgan, U.S. Geological Survey (USGS), Federal Center, P.O. Box 25046, MS 966, Denver, CO 80225, USA, +1-303-273-8646, lmorgan@usgs.gov; Kenneth L. Pierce.

402. **River Incision Histories of the Black Canyon of the Gunnison and Unaweep Canyon: Interplay between Late Cenozoic Tectonism, Climate Change, and Drainage Integration in the Western Rocky Mountains.** Wed.–Fri., 24–26 Oct. Cost: US$255 (3ON, L, R); min: 12/max: 40. Cosponsored by *GSA Quaternary Geology and Geomorphology Division*. Andres Aslan, Dept. of Physical and Environmental Sciences, Mesa State College, 1100 North Ave., Grand Junction, CO 81501, USA, +1-970-248-1614, aaslan@mesastate.edu; Karl Karlstrom.

403. **Cornucopia of Coal and Coalbed Gas in the Powder River Basin: From Mining and Utilization to Methane and Methanogens.** Thurs.–Fri., 25–26 Oct. Cost: US$290 (1ON, L, D); min: 10/max: 25. Cosponsored by *GSA Coal Geology Division; GSA Geobiology and Geomicrobiology Division; GSA Hydrology Division*. Romeo M. Flores, USGS, Box 25046, MS 939, Denver Federal Center, Denver, CO 80225, USA, +1-303-236-7774, rflores@usgs.gov; Jason D. Putnam; Margaret S. Ellis; Michael E. Brownfield; Edward L. Heffern; Gary D. Stricker.

404. **Clastic Sedimentology, Sedimentary Architecture, and Sequence Stratigraphy of Fluvio-Deltaic, Shoreface, and Shelf Deposits, Book Cliffs, Eastern Utah and Western Colorado.** Thurs.–Sat., 25–27 Oct. Cost: US$240 (2ON, L, R); min: 5/max: 30. Cosponsored by *GSA Sedimentary Geology Division; Society for Sedimentary Geology (SEPM)*. Simon A.J. Pattison, Dept. of Geology, Brandon University, 270 18th St., Brandon, Manitoba R7A 6A9, +1-204-727-7468, pattison@brandonu.ca; Paul Davies; Huw Williams.

405. **Stratigraphy and Sedimentology of the Green River Formation in the Piceance Basin—The Richest Oil Shale Deposits in the World.** Thurs.–Sat., 25–27, Oct. Cost: US$310 (2ON, B, L, R); min: 10/max: 30. Yuval Bartov, Colorado Energy Research Institute, Colorado School of Mines, 1500 Illinois St., Golden, CO 80401, USA, +1-303-273-3841, ybartov@mines.edu; Rick Sarg.

406. **Proterozoic Geology and Phanerozoic Reactivation of the Newly Recognized Grizzly Creek Shear Zone, Glenwood Canyon, Colorado.** Fri.–Sat., 26–27 Oct. Cost: US$245 (1ON, L, R); min: 10/max: 20. Cosponsored by *GSA Structural Geology and Tectonics Division*. Joseph L. Allen, Geology and Physical Sciences, Concord University, Campus Box 19, Athens, WV 24712, USA, +1-304-384-5238, allenj@concord.edu; Colin A. Shaw.

407. **Coal Geology in the Mesaverde Group along the Eastern Edge of the Greater Green River Basin in Northwestern Colorado and South-Central Wyoming.** Fri.–Sat., 26–27 Oct. Cost: US$205 (1ON, L, R); min: 5/max: 30. Cosponsored by *GSA Coal Geology Division*. Nick Jones, Wyoming State Geological Survey, P.O. Box 1347, Laramie, WY 82073, USA, +1-307-766-2286 ext. 243, njones@uwyo.edu.

408. **Geoarchaeology of the Clary Ranch Paleoindian Sites, Western Nebraska.** Fri., 26 Oct. Cost: US$105 (L, R); min: 22/max: 40. David W. May, Dept. of Geography, University of Northern Iowa, 205 Innovative Teaching and Technology Center, Cedar Falls, IA 50614, USA, +1-319-273-6059, dave.may@uni.edu; Dave Rapson; Matthew G. Hill.

409. **From Buttes to Bowls: Repeated Inversions in the Landscape of the Colorado Piedmont.** Fri., 26 Oct. Cost: US$110 (L, R); min: 5/max: 20. Cosponsored by *Colorado Geological Survey; Colorado Scientific Society*. Matthew Morgan, Colorado Geological Survey, 1313 Sherman St., Suite 715, Denver, CO 80203, USA, +1-303-866-2066, matt.morgan@state.co.us; Vincent Matthews III.

410. **The Beautiful Vail Valley: A Classroom in Geologic Hazards and Mitigation.** Sat., 27 Oct. Cost: US$75 (L, R); min: 12/max: 45. Cosponsored by *Colorado Geological Survey*. Vincent Matthews III, Colorado Geological Survey, 1313 Sherman Street, Room 715, Denver, CO 80203, USA +1-303-866-3028, vince.matthews@state.co.us; Jonathan White; Mark A. Gorman II, University of Colorado, 1300 30th St. D5-12, Boulder, CO 80303, USA, +1-303-786-0999, mark.gorman@colorado.edu; Jason Pardo; Bryan Small; Ian Miller.

411. **Geology of the Cripple Creek Gold–Telluride Deposit, Colorado.** Sat., 27 Oct. Cost: US$85 (L, R); min: 10/max: 30. Cosponsored by *Society of Economic Geologists; International Geological Correlations Program*. Paul G. Spry, Geological and Atmospheric Sciences, Iowa State University, 253 Science I, Ames, IA 50011-3212, USA, +1-515-294-9637, pgspry@iastate.edu; Eric P. Jensen.

Powder River stops 1 and 2 (trip 403), Wyodak Coal Mine and Wyodak Power Plant. Photo courtesy Romeo Flores and Margaret Ellis.

412. **Geoarchaeological Context of Paleoindian Sites in Middle Park, Colorado.** Sat., 27 Oct. Cost: US$79 (L, R); min: 10/max: 40. Cosponsored by *GSA Archaeological Geology Division*. James H. Mayer, Dept. of Geosciences, University of Arizona, Gould-Simpson Building #77, 1040 E. Fourth Street, Tucson, AZ 85721, USA, +1-520-400-6470, jhmayer@email.arizona.edu; Todd A. Surovell.

413. **Fish, Turtles, Plants, and Insects within the Morrison Formation: A Walk through a Late Jurassic Ecosystem.** Sat., 27 Oct. Cost: US$110 (L, R); min: 5/max: 20. Mark A. Gorman II, University of Colorado, 1300 30th St., D5-12, Boulder, CO 80303, USA, +1-303-786-0999, mark.gorman@colorado.edu; Jason Pardo; Bryan Small; Ian Miller.

414. **Hydrology and Geochemistry of the Boulder Creek Watershed.** Sat., 27 Oct. Cost: US$66 with bike rental, US$45 with own bike (L, R); min: 12/max: 30. Cosponsored by *U.S. Geological Survey; GSA Quaternary Geology and Geomorphology Division*. Philip L. Verplanck, USGS, Denver Federal Center, P.O. Box 25046, MS 973, Denver, CO 80225, USA, +1-303-236-1902, plv@usgs.gov; John Pitlick; Peter W. Birkeland; Sheila F. Murphy; Larry B. Barber; Travis Schmidt.

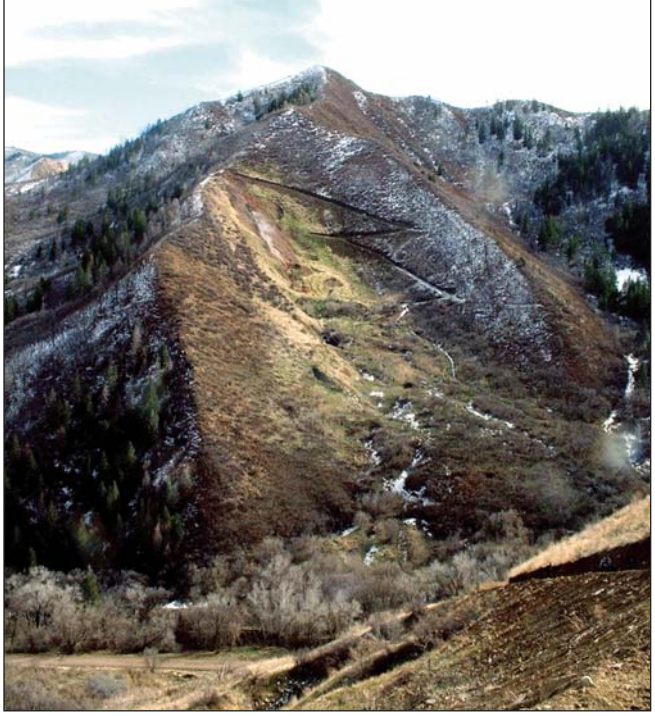
415. **From the Crest of the Front Range to the Depths of the Denver Basin.** Sat., 27 Oct. Cost: US$89 (L, R); min: 8/max: 22. Shari Kelley, Dept. of Earth and Environmental Science, New Mexico Institute of Mining and Technology, 801 Leroy Place, Socorro, NM 87801, USA, +1-505-661-6171, sakelley@ix.netcom.com; Robert Raynolds.

416. **The K-T Boundary and Associated Volcanic Tuffs at West Bijou Creek, Denver Basin.** Sat., 27 Oct. Cost: US$70 (L, R); min: 15/max: 47. Cosponsored by *EARTHTIME*. Kirk R. Johnson, Denver Museum of Nature & Science, 2001 Colorado Blvd., Denver, CO 80205, USA, +1-303-370-6448, kirk.johnson@dmns.org; Samuel Bowring.

DURING THE MEETING

417. **Revisiting the South Cañon Number 1 Coal Mine Fire.** Sun., 28 Oct. Cost: US$75 (L, R); min: 12/max: 45. Cosponsored by *GSA Coal Geology Division*. Glenn B. Stracher, Div. of Science and Mathematics, East Georgia College, 131 College Circle, Swainsboro, GA 30401, USA, +1-478-289-2073, stracher@ega.edu; Nancy Lindsley-Griffin; Steven Renner; Janet Lynn Stracher.

418. **Old and New Geologic Studies along the Front Range between Golden and Morrison, Including Structural, Volcanic, and Economic Geology and Paleontology (1).** Sun., 28 Oct. Cost: US$85 (L); min: 12/max: 45. Cosponsored by *Friends of Dinosaur Ridge; GSA Geoscience Education Division; GSA Sedimentary Geology Division*. Chris Carroll, Friends of Dinosaur Ridge, 16831 W. Alameda Pkwy., Morrison, CO 80465, USA, +1-303-697-3466, carroll_chris@msn.com; T. Caneer; Tim Connors; Norbert Cygan; Harald Drewes.



East side of South Canyon, west of Glenwood Springs, Colorado (see trip 417), where abandoned workings of the South Cañon Number 1 Coal Mine have been burning beneath the slopes since 1910. Photo by Glenn B. Stracher, 2004.

Poudre River (see trip 419). Photo courtesy John Pitlick and Ellen Wohl.

419. **Kirk Bryan Field Trip: Fluvial-Hydraulic Processes in the Colorado Front Range.** Tues., 30 Oct. Cost: US$70 (L, R); min: 20/max: 50. Cosponsored by *GSA Quaternary Geology and Geomorphology Division*. John Pitlick, Geography Dept., Box 260, University of Colorado, Boulder, CO 80309-0260, USA, +1-303-492-5906, pitlick@colorado.edu; Ellen Wohl.

420. **Denver's Building Stones.** Tues., 30 Oct. Cost: US$39 (R); min: 15/max: 30. Jack Murphy, Denver Museum of Nature & Science, 2001 Colorado Blvd., Denver, CO 80205, USA, denverbasin@dmns.org; Robert G. Raynolds.

"Castles" of Oligocene Brule, White River Badlands (see trip 421). Photo courtesy Patrick Burkhart.

POSTMEETING

421. **Late Quaternary through Holocene Landscape Evolution of the White River Badlands, South Dakota.** Weds.–Sat., 31 Oct.–3 Nov. Cost: US$410 (3ON, L, R); min: 12/max: 30. Patrick Burkhart, Geography, Geology, and Environment, Slippery Rock University, 335 ATS, Slippery Rock, PA 16057, USA, +1-724-738-2502, patrick.burkhart@sru.edu; Rachel Benton; Michael Jahn; J. Elmo Rawling III; Jack Livingston.

422. **A GeoMystery Field Trip to the Anton Escarpment.** Thurs., 1 Nov. Cost: US$85 (L, R); min: 6/max: 36. Cosponsored by *GSA Engineering Geology Division; GSA Quaternary Geology and Geomorphology Division.* David C. Noe, Colorado Geological Survey, 1313 Sherman St., Rm. 715, Denver, CO 80203, USA, +1-303-866-2432, dave.noe@state.co.us.

423. **Integrated Analysis of Laramide to Holocene Deformation of the Northeastern Front Range Using 3-D Balancing and Comparative Fracture Analysis of Pre- and Post-Laramide Strata.** Thurs., 1 Nov. Cost: US$79 (L, R); min: 12/max: 36. Eric A. Erslev, Dept. of Geosciences, Colorado State University, Fort Collins, CO 80523, USA, +1-970-491-6375, erslev@warnercnr.colostate.edu; Scott M. Larson.

424. **Stratal Architecture and Sequence Stratigraphy of the Mount Garfield Formation, Grand Junction Area, Colorado.** Sat.–Thurs., 1–3 Nov. Cost: US$270 (2ON, L, R); min: 24/max: 36. Diane L. Kamola, Geology, University of Kansas, 1475 Jayhawk Blvd., Lawrence, KS 66045, USA, +1-785-864-2724, kamola@ku.edu; Andrew S. Madof; Mustapha Zater.

425. **Laramide Paleoseismites of the Bighorn Basin.** Thurs.–Sun., 1–4 Nov. Cost: US$420 (3ON, L, R); min: 10/max: 30. Mervin J. Bartholomew, Earth Sciences, University of Memphis, Memphis, TN 38152, USA, +1-901-678-1613, jbrthlm1@memphis.edu; Kevin G. Stewart.

426. **Walking with Dinosaurs along Colorado's Front Range.** Thurs., 1 Nov. Cost: US$70 (L, R); min: 12/max: 45. Joanna Wright, Geography & Environmental Sciences, University of Colorado–Denver, Campus Box 172, P.O. Box 173364, Denver, CO 80217, USA, +1-303-556-6007, jwright@carbon.cudenver.edu.

Death Valley National Park and surrounding area (see trip 429). NASA image by Laura Rocchio, Landsat Project Science Office, using data provided courtesy of the Earth Satellite Corporation and compiled from observations by the Enhanced Thematic Mapper Plus sensor on the Landsat 7 satellite on 11 June and 20 July 2000 (http://visibleearth.nasa.gov/view_rec.php?id=17518; accessed 8 May 2007). Green—vegetation; brown, beige, and rust—bare ground, where the different colors result from varying mineral compositions; bright blue-green—salt pans.

427. **Geomorphic Effects of a Catastrophic Forest Fire.** Thurs., 1 Nov. Cost: US$69 (L, R); min: 12/max: 45. Lee McDonald, U.S. Forest Service, Denver, CO, USA, leemac@cnr.colostate.edu; Robert G. Raynolds.

428. **Old and New Geologic Studies along the Front Range between Golden and Morrison, Including Structural, Volcanic, and Economic Geology and Paleontology (2).** Thurs., 1 Nov. Cost: US$85 (L); min: 12/max: 45. Cosponsored by *Friends of Dinosaur Ridge; GSA Geoscience Education Division; GSA Sedimentary Geology Division*. Chris Carroll, Friends of Dinosaur Ridge, 16831 W. Alameda Pkwy., Morrison, CO 80465, USA, +1-303 697-3466, carroll_chris@msn.com; Tim Connors; Harald Drewes; T. Caneer; Norb Cygan.

429. **Coeval Miocene Magmatism and Crustal Extension in the Colorado River and Death Valley Extensional Terrains.** Thurs.–Sun., 1–4 Nov. Cost: US$430 (3ON, L, R); min: 10/max: 20. J.P. Calzia, USGS, 345 Middlefield Road, Menlo Park, CA 94025, USA, +1-650-329-5538, jcalzia@usgs.gov; O. Tapani Rämö; C.F. Miller.

430. **Aquifer Stratigraphy in the Denver Basin.** Fri., 2 Nov. Cost: US$90 (L, R); min: 8/max: 22. Robert G. Raynolds, Denver Museum of Nature & Science, 2001 Colorado Blvd., Denver, CO 80205-5798, USA, +1-303-370-6047, denverbasin@dmns.org; John Moore; Marieke Dechesne; Steven A. Boand.

431. **New Perspectives and an Update on Continental Accretion—Colorado Style: Island Arcs and Backarcs of the Central Front Range.** Fri., 2 Nov. Cost: US$85 (L, R); min: 10/max: 40. Thomas R. Fisher, Dept. of Geology and Geological Engineering, Colorado School of Mines, Golden, CO 80401, USA, +1-303-715-0480, thom.fisher@escalantemines.com; Lisa Rae Fisher.

Classified Rates—2007

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Positions Open

HYDROGEOLOGY
(TENURE-TRACK, ASSISTANT PROFESSOR)

The Department of Geology at Central Michigan University invites applications for a tenure-track Assistant Professor position in Hydrogeology beginning August 2008 or earlier. A state-supported university with an on-campus enrollment of more than 20,000 students, CMU is a Doctoral Research University recognized for strong undergraduate education and a range of focused graduate programs and research. The Geology Department (www.gel.cmich.edu) consists of nine full-time faculty and 30-40 undergraduate majors. The department has a very strong record of incorporating research into the undergraduate curriculum and has a variety of well-equipped teaching and research facilities.

The successful candidate will be appointed at the Assistant Professor level and will be expected to (1) enthusiastically and effectively teach service courses, as well as courses for majors and minors, including hydrogeology; (2) develop an active research program that merits external funding and that will involve undergraduate students; (3) consistent with one's background, develop and teach new courses as needed by the department; (4) develop collaborations with colleagues in geology and related departments; and (5) contribute to CMU's interdisciplinary environmental studies and earth science education programs.

Required qualifications include a Ph.D. in Geology or related field, excellent written and oral communication skills, demonstrated potential for teaching excellence, a demonstrated commitment to innovative field-based research involving students, and an ability to link their research program to their teaching agenda. Applicants must have demonstrated research expertise in hydrogeology. The department is particularly interested in applicants who demonstrate expertise in the area of groundwater-surface water-atmosphere interactions; groundwater-rock interactions; environmental geochemistry, geochemical cycling, biogeochemistry or geomicrobiology; environmental geophysics, or fluid flow modeling.

Preferred qualifications include: postdoctoral experience, grant-writing experience, a record of teaching courses in hydrogeology or related areas, demonstrated ability to teach introductory geology courses as well as upper-level courses in geophysics, low temperature/environmental geochemistry, biogeochemistry, glacial geology, or geomorphology, and/or an ability to develop a research program focusing on relevant problems related to the Great Lakes.

Interested persons must submit a letter of application, curriculum vita, copies of transcripts, a statement of proposed research agenda, a statement of prior teaching experience and philosophy, and three letters of reference to: Hydrogeology Search Committee Department of Geology Central Michigan University Mount Pleasant, MI 48859.

DISASTER SUPPORT CADRE POSITIONS

Dewberry is augmenting it's cadre of part-time and intermittent staff to perform disaster work for FEMA. Dewberry has supported the Federal Emergency Management Agency (FEMA) Department of Homeland Security (DHS) for over 20 years on disaster response and recovery assignments.

Our support contracts call for a variety of skills and technical capabilities. All positions are intermittent (part-time), on-call (travel and field work required). Must be

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able to commit for a minimum 90-day assignment and pass an FBI Background Clearance check. Conditions in the areas affected can be very challenging. While the work is arduous, it is also very satisfying.

Dewberry is seeking qualified applicants with five or more years of experience in the following fields:

- Geotechnical Specialists
- Geologists
- Engineers: Civil/Structural/Mechanical/Electrical/Coastal/Environmental/Water Resource/Wind/Industrial).

Interested individuals should submit detailed resume to rsaddler@dewberry.com; Fax: +1-703-849-0185; or apply online at www.recruitingcenter.net/clients/dewberry/publicjobs/controller.cfm?jbaction=JobProfile&Job_Id=10433&esid=az.

Dewberry, www.Dewberry.com, EOE/M/F/D/V.

ASSISTANT PROFESSOR
QUATERNARY GEOLOGIST/SURFICIAL PROCESSES
WISCONSIN GEOLOGICAL AND
NATURAL HISTORY SURVEY (WGNHS)

Qualified candidates are encouraged to apply for a full-time, tenure-track faculty position available January 1, 2008. Duties entail conducting fundamental and applied research in Quaternary geology/surficial processes through field-based investigations, including geologic mapping. The successful candidate will focus on the Quaternary deposits of Wisconsin, conducting research in glacial geology, sedimentology, geochemistry, geochronology, geomorphology, or engineering geology. Work is performed in cooperation with other WGNHS staff, university personnel and collaborating governmental agencies whose interests include geology, geophysics, hydrogeology, and mineral/energy resources. Office is located in Madison. Application review begins 8/15/2007. For a complete position description and application instructions, please visit our website at www.uwex.edu/ces/hr.

AA/EEO employer.

INDIANA UNIVERSITY–PURDUE UNIVERSITY
FORT WAYNE (IPFW), STRUCTURAL GEOLOGY/
NEOTECTONICS/APPLIED GEOPHYSICS

IPFW seeks to fill a full-time, tenure-track position at the Assistant Professor level in structural geology/neotectonics/applied geophysics. The successful applicant for the position will have a Ph.D. and be expected to share with other faculty responsibilities for teaching introductory geology, introductory planetary geology, introductory climatology, and regional field geology. Over a multi-year cycle, the successful applicant will teach additional courses in his/her specialty, including structural geology and geomorphology. Familiarity and experience with GIS will be a plus. Geosciences faculty are expected to maintain an active research program and to involve undergraduate students in research. IPFWs geology research program is well-supported in both equipment (e.g. thin section lab, SEM, XRD) and opportunities for new faculty.

There are four other full-time faculty in the department. IPFW is a comprehensive university. Send a letter of application, statement of teaching and research interests, curriculum vitae, copies of transcripts, and the names and contact information for three references to Prof. J. Farlow, Search Committee Chair, Department of Geosciences, Indiana University–Purdue University Fort Wayne, 2101 East Coliseum Boulevard, Fort Wayne, IN 46805. Review of applications will begin November 1, 2007. IPFW is an equal opportunity, equal access, Affirmative Action University.

DEPARTMENT OF ENVIRONMENTAL SCIENCES
THE UNIVERSITY OF TOLEDO

The Department of Environmental Sciences at The University of Toledo invites applications for a tenure track position at the **Assistant Professor** level in **Earth Surface Processes** to complement existing university and departmental strengths in ecology, hydrology, geology, geography and environmental engineering. Competitive candidates must have a Ph.D. in the geosciences or a closely related field; postdoctoral experience is desirable. The successful candidate will be expected to provide instruction at the introductory level for nonmajors as well as for the undergraduate and graduate programs in geology and environmental science.

Our department is a rapidly growing, multidisciplinary, research-oriented academic unit with 23 tenured/tenure-track full-time faculty. The primary research focus envisioned for the candidate is on physical interactions at the land-lake-air interfaces, with application to the Lake Erie Basin. Applicants should have expertise in the application and utilization of remote sensing and computerized geospatial analysis in their research. Research opportunities are particularly promising in the western Lake Erie basin, where the confluence of an intensively used agro-urban watershed and an economically and ecologically critical water body produce an ideal natural laboratory for environmental research. This person will be expected to develop an externally funded research program as well as collaborate with colleagues in ongoing large scale, multidisciplinary research projects including watershed investigations, remediation and wetlands restoration.

It is anticipated that this position will begin in mid-August 2008. Review of applications will begin October 5, 2007 and continue until the position is filled. Salary, fringe benefits and start-up funds are competitive. Applicants should submit curriculum vitae, descriptions of teaching and research interests, and the names and addresses of three references to: Alison Spongberg, Chair, Search Committee, Earth Surface Processes, Department of Environmental Sciences, Mail Stop #604, University of Toledo, Toledo, OH 43606-3390. The University of Toledo is an equal opportunity, equal access, affirmative action employer and educator. M/F/V/D are encouraged to apply. For more information visit the Departmental Web site at www.eeescience.utoledo.edu.

GEOPHYSICS
SOUTHERN ILLINOIS UNIVERSITY–CARBONDALE

The Department of Geology at Southern Illinois University–Carbondale invites applications for a tenure-track position in Geophysics at the rank of assistant professor with a start date of Aug. 16, 2008. Preference will be given to candidates with post-doctoral experience. The applicant should demonstrate the existence of, or potential for developing, an internationally recognized, externally funded research program. The candidate's research interest is open, but we prefer a Geophysicist who will complement our existing strengths. The successful applicant is expected to teach courses in introductory geology and undergraduate and graduate courses in their area of expertise. Normal teaching load is one to two courses per semester. Applicants must hold a Ph.D. in geology or a related field or show that they will complete all degree requirements by the time of appointment.

Review of applications will begin October 1, 2007 and continue until the position is filled. Applicants should submit a curriculum vitae, a statement of teaching and research interests, and the names and addresses of at least three referees to: Dr. John Sexton, Search Committee Chair, Department of Geology, Mail Code 4324, Southern Illinois University Carbondale, 1259 Lincoln Drive, Carbondale, IL 62901; fax: +1-618-453-7393; e-mail: sexton@geo.siu.edu.

Southern Illinois University Carbondale is a large, research-oriented institution situated in a pleasant small-town setting southeast of St. Louis. SIUC is seeking to enhance interdisciplinary research as it strives to be a top 75 public research university (http://news.siu.edu/s150/). The Geology Department has a full-time faculty of 10 with about 40 undergraduate and 30 graduate students and offers Bachelor and Master degree programs in geology and participates in the interdisciplinary Environmental Resources and Policy Ph.D. program. SIUC has programs and facilities involved with energy and mineral resources research that provide opportunities for interdisciplinary studies including the Coal Research Center and the Mining and Mineral Resources Program.

For further information, please visit our comprehensive Web site www.science.siu.edu/geology. SIUC is an affirmative action/equal opportunity employer that strives to enhance its ability to develop a diverse faculty and staff and to increase its potential to serve a diverse student population. All applications are welcomed and encouraged and will receive consideration.

USTAR POSTDOCTORAL FELLOWS,
UNIVERSITY OF UTAH

The University of Utah invites applications for two postdoctoral fellowships jointly appointed between the Energy & Geoscience Institute (EGI) and the Department of Civil and Environmental Engineering. We seek highly qualified individuals with research experience and interest in the science and engineering of CO_2 sequestration related to climate change mitigation. The appointments are jointly funded by the Utah Science, Technology and Research initiative (http://ustar.utah.gov) and the Energy & Geoscience Institute (http://egi.utah.edu). The Utah Science, Technology and Research (USTAR) Economic Development Initiative is a prestigious program initiated by the state of Utah and designed to spur job growth and economic development. These USTAR Postdoctoral Fellows will help design, deploy and lead the science and engineering of six major field projects of underground geological CO_2 injection and storage, with sites in Utah, Wyoming, Colorado, New Mexico and Texas. Within this aggressive carbon sequestration field program, the minimum size deployment is injection of 75,000 tons/year, with others approaching 1,000,000 tons/year.

A Ph.D. at the time of appointment in civil and environmental engineering, hydrology, earth and environmental science, or a closely related field is required, as well as a significant record of research productivity. We seek individuals who complement existing strengths at EGI, the Department of Civil and Environmental Engineering, and who can work collaboratively in the Carbon Engineering group (http://egi.utah.edu/CO2) at the university. We especially seek candidates with experience in numerical modeling, including coupled multiphase simulation modeling and/or reactive transport modeling and/or coupled hydrogeomechanical modeling at multiple spatial scales. We also seek individuals with significant experience in laboratory experimental work related to high pressure, high temperature multiphase flow. Field-experience is a plus. Our research program offers competitive salaries and opportunities for career advancement. To apply, please send a CV, relevant publications and the contact information of three references to Energy & Geoscience Institute, Attn: USTAR at 423 Wakara Way #300, Salt Lake City, UT 84108 Applications will be accepted until the positions are filled. No e-mail applications accepted. For detailed inquiries, contact Prof. Brian J. McPherson, b.j.mcpherson@utah.edu.

GEOCHEMISTRY/PETROLOGY
UNIVERSITY OF CALIFORNIA AT BERKELEY

The Department of Earth and Planetary Science at UC Berkeley invites applications for a tenure-track position in geochemistry/petrology at the Assistant Professor level. We seek an individual with research interests and/or approaches that will complement or add to our existing strengths (see http://eps.berkeley.edu/) and who will contribute to our core teaching in geology, geochemistry and petrology. We especially encourage applications from scientists whose research involves field or laboratory studies of earth materials and processes, including qualified women and underrepresented minorities.

Please self-register and upload PDFs of, or email PDFs of, or mail a curriculum vitae, bibliography, statement of teaching and research interests, and the names and addresses (email and postal) of at least three references to the self-registration URL: http://gold.ls.berkeley.edu:80/candidate/selRegister.php?i=14. After you self-register and upload your material, you should see a URL you may provide to your letters of reference writers where they may upload PDFs of those letters. Please request that referees read the University's confidentiality statement, http://apo.chance.berkeley.edu/evalltr.html prior to uploading letters.

Email address: geosrch@eps.berkeley.edu.

Mailing address: Geochemistry-Petrology Search Committee, University of California, Berkeley, 307 McCone Hall MC 4767, Berkeley, CA 94720-4767.

Applications should be postmarked by December 5, 2007; late applications mailed or posted to the URL after December 5, 2007, will not be considered. Fax applications will not be accepted. The University of California, Berkeley is an Affirmative Action Employer/Equal Opportunity Employer.

COLLECTION MANAGER, FOSSIL INVERTEBRATES
FIELD MUSEUM, CHICAGO

The Department of Geology of the Field Museum of Natural History has an immediate opening for a Collection Manager of Fossil Invertebrates. This collection encompasses all major phyla of metazoans and is ranked among the top paleontology collections in the world. We seek candidates at the Masters level (Bachelors in exceptional cases) in invertebrate paleontology who are also taxonomically oriented, familiar with database systems, adept in communicating with scientists and the public and eager to participate in fundraising initiatives and public learning programs. Screening will begin Sept. 1, 2007. To apply send CV and contact information for 3 references to: Dr. Scott Lidgard, Collection Manager Search Committee, Dept. of Geology, The Field Museum, Roosevelt Rd. at Lake Shore Dr., Chicago, IL 60605. E-mail: slidgard@fieldmuseum.org.

FACULTY POSITIONS IN CLIMATE DYNAMICS,
LITHOSPHERIC DYNAMICS, MARINE ORGANIC–
BIOGEOCHEMISTRY AND SCIENCE EDUCATION

The Department of Marine, Earth, and Atmospheric Sciences at North Carolina State University is seeking applications to fill four tenure-track faculty positions.

Global Climate Dynamics

The Department is seeking to fill a tenure-track faculty position at the assistant professor level, except for exceptional candidates, with an emphasis in global climate dynamics. Candidates with expertise in any of the following areas will be favorably considered: coupled

global climate models, climate variability and climate change, as well as climate prediction. Applicants must hold a Ph.D. degree in the atmospheric or related physical sciences.

Marine Organic Chemistry-Biogeochemistry

The Department is seeking to fill a tenure-track faculty position in the field of Marine Organic Geochemistry at the assistant professor level. Candidates with backgrounds in all areas of marine organic geochemistry will be considered, however, expertise in stable isotope biogeochemistry (an IRMS was recently purchased by our department) is of particular interest, along with microbiology, carbon cycling, and diagenesis. Applicants must hold a Ph.D. degree in marine chemistry or related field.

Lithospheric Dynamics–Earth Surface Interactions

The Department is seeking to fill a tenure-track, faculty position in Earth Science with an emphasis in lithospheric dynamics and earth surface interactions at the assistant professor level. Examples of interests include, but are not restricted to, geomorphology, geodynamics, geohazards, neotectonics, and paleoclimate, utilizing applications such as cosmogenic isotopes, GPS geodesy, and InSAR. Applicants must hold a Ph.D. degree in the geosciences or related physical sciences.

Geoscience Education

The Department is seeking to fill a tenure-track faculty position in the field of Geoscience Education at the assistant professor level. We are particularly interested in candidates who focus on improving learning of science by non-science majors. The successful candidate will design and teach large introductory geoscience classes. A record and/or strong promise of creativity in teaching methods is desired, with the goal of adapting cutting-edge pedagogy for undergraduate science courses. North Carolina State University has begun a focused STEM (Science, Technology, Education and Mathematics) Education Initiative. Applicants must hold a Ph.D. degree in the geosciences or in Science Education with a strong emphasis in the geosciences.

Information on Application

The successful candidate for each position must demonstrate high potential for outstanding accomplishments in research, including development of a sponsored research program, graduate student mentoring, and teaching courses that range from introductory survey courses for non-majors to advanced courses.

Opportunities exist for the successful candidate for disciplinary and interdisciplinary interactions with more than 30 other faculty in the Marine, Earth, and Atmospheric Sciences. Additional information about the department and its facilities can be found on our Web page: www.meas.ncsu.edu.

Further details on each position and instructions for application are provided on our Web site at www.meas.ncsu.edu/Jobs/05-faculty_searches.html. We welcome the opportunity to work with candidates to identify suitable employment opportunities for spouses or partners. Review of applications will begin September 15th, 2007; the position will remain open until filled.

NC State University is an equal opportunity and affirmative action employer. All qualified applicants will receive consideration for employment without regard to race, color, national origin, religion, sex, age, veteran status, or disability. In addition, NC State University welcomes all persons without regard to sexual orientation. Applications from women, minorities, and persons with disabilities are encouraged. Individuals with disabilities desiring accommodations in the application process should contact Tami Talmadge via e-mail at tami_talmadge@ncsu.edu, phone +1-919-515-7773 or fax +1-919-515-7802.

QUATERNARY PALEOCLIMATE SCIENTIST
SCIENTIST/SENIOR SCIENTIST

We are seeking an experienced paleoclimate scientist to contribute to, and ultimately lead, multidisciplinary team based research into the causes and consequences of climate change in the New Zealand region over the last one million years.

This research will be a key component of a well established long term research programme that is closely integrated with New Zealand university research and international programmes, such as ANDRILL and INTIMATE. The successful applicant will have:

- Specialist skills in biological or geochemical environmental proxies
- Proven track record in carrying out, completing and publishing research
- Proven ability in integration and interpretation of multidisciplinary datasets
- Established networks and collaborations
- Knowledge of Southwest Pacific and Southern Ocean climate systems

Further information can be obtained from our website www.gns.cri.nz or by phoning Andrea McLiver on 04 570 4759. Please send a covering letter, CV and completed application form to Human Resources or email us at careers@gns.cri.nz.

Applications close on 31 July 2007.

U.S. GEOLOGICAL SURVEY
CENTRAL REGION
EARTH SURFACE PROCESSES TEAM
TEAM CHIEF SCIENTIST
SUPERVISORY PHYSICAL SCIENTIST (GS-1301-15)
OR
SUPERVISORY GEOPHYSICIST (GS-1313-15)
OR
SUPERVISORY GEOLOGIST (GS-1350-15)

The U.S. Geological Survey (USGS), Central Region invites applications for the position of Team Chief Scientist, Earth Surface Processes Team, in Lakewood, Colorado. The Team Chief Scientist supervises a staff of approximately seventy (70) research and operational personnel. Strong scientific leadership and managerial skills are essential. Also required is a comprehensive knowledge of the scientific principles, concepts, and practices that apply to the Team's principal areas of investigation, which include the geologic mapping, regional geologic and tectonic synthesis, geochronology and isotope studies, geomorphology, paleoclimate research, hydrogeology, ecosystem studies, pedology, paleoseismic analysis, and materials properties characterization. Strong written and oral communication skills are required in order to effectively convey the USGS results to other Federal and State agencies, universities, and other institutions, and to engender their support and participation of USGS programs.

This is an interdisciplinary position that can be filled as either Supervisory Physical Scientist or Supervisory Geophysicist or Supervisory Geologist. The vacancy announcement numbers for this position are: CR-2007-0516, CR-2007-0518, CR-2007-0520, CR-2007-0522, CR-2007-0524, and CR-2007-0526. Applications will be accepted beginning July 16, 2007, through August 31, 2007. For qualification and application details visit **http://www.usajobs.opm.gov/. You must apply online in order to be considered for this position.**

The annual salary range is $111,694 to $145,201. The position is located in Lakewood, Colorado, a suburb of Denver. For more information contact Georgia Lahr at 303-236-*9572* or glahr@usgs.gov.

You must be a U.S. citizen. The U.S. Geological Survey is an equal opportunity employer.

U.S. GEOLOGICAL SURVEY
MENDENHALL POSTDOCTORAL RESEARCH
FELLOWSHIP PROGRAM

The U.S. Geological Survey (USGS) invites applications for the Mendenhall Postdoctoral Research Fellowship Program for Fiscal Year 2009. The Mendenhall Program provides opportunities to conduct research in association with selected members of the USGS professional staff. Through this Program the USGS will acquire current expertise in science to assist in implementation of the science strategy of its programs. Fiscal Year 2009 begins in October 2008.

Opportunities for research are available in a wide range of topics. The postdoctoral fellowships are 2-year appointments. The closing date for applications is November 9, 2007. Appointments will start October 2008 or later, depending on availability of funds. A description of the program, research opportunities, and the application process are available at http://geology.usgs.gov/postdoc. The U.S. Geological Survey is an equal opportunity employer.

Opportunities for Students

Ph.D. Student Opportunities in the area of Quaternary Paleoclimatology at **Geology Department of Baylor University** (Waco, Texas): An 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 steve_dworkin@baylor.edu.

MULTIPLE HIRES IN CRUST, MANTLE, AND CORE DYNAMICS

The Jackson School is building a premier education and research program in Crust, Mantle, and Core Dynamics. We seek scientists at the forefront of their disciplines attracted to challenging areas of scholarship that require collaboration across disciplines and programs. We particularly seek individuals eager to address the questions encompassing the broad theme of determining how the core, mantle, crust, and surface interact to shape the physical, chemical, and biological evolution of the Earth across a wide range of spatial and temporal scales. These questions include, but are not limited to:

- What controls the style, vigor and time dependence of mantle and core convection?
- How are chemical and physical processes acting in the Earth's interior manifested at the surface and how do surface processes affect Earth's interior?
- What controlling influence do fluids have on geological processes in the Earth's crust and mantle?
- How can knowledge of active tectonic processes and present-day plate motions be utilized to better decipher Earth's history?

Over the next three years, we will hire six or more faculty and scientists who complement our existing strengths. We are interested in a wide variety of research areas ranging from geodynamics, seismology, mineral physics, GPS/remote sensing of active and surface deformation, fluid dynamics, geochronology, geochemistry, rock physics, and computational geosciences focusing on modeling and simulation. We also encourage innovative scientists in other areas related to crust/mantle/core dynamics to apply. Successful applicants will join a strong and diverse group of 125 Ph.D. faculty and scientists, with the facilities and partnerships that will help ensure their success.

MULTIPLE HIRES IN EARTH SURFACE AND HYDROLOGIC PROCESSES

The Jackson School is building a premier education and research program in Earth Surface and Hydrologic Processes. We seek outstanding scientists at the forefront of their disciplines who are attracted to challenging areas of scholarship that require collaboration across disciplines and programs. We seek to address compelling questions in surface and hydrologic processes within the broad theme of determining how surface and hydrologic processes are influenced by their dynamic setting at the interface of the lithosphere, atmosphere, hydrosphere, and biosphere. These questions include:

- How do climate, ice sheets, and tectonics interact to define the distribution and character of sea level change?
- How do coastal zone geology, biology, biogeochemistry, and hydrology respond to surficial processes, particularly to sea level change?
- What are the impacts of climate variability/change and land use change on water, nutrient, and sediment cycles?
- What is the integrated result of the interplay between tectonic deformation, climate change, and biota on the Earth's surface and on the supply, distribution, and storage of sediments?
- What are the physical, chemical, ecological processes and social forces that will determine the sustainability of our water resources?

Over the next three years, we will hire six or more faculty and scientists who complement our existing strengths. We are interested in a range of research areas from quantitative geomorphology to hydrologic-biologic interactions to societal impacts and resource sustainability, and capabilities ranging from modeling landscape dynamics to remote sensing, shallow environmental geophysics, aerogeophysics, and monitoring groundwater and coastal systems. We also encourage innovative scientists in other areas related to surface and hydrologic processes to apply.

Opportunities exist at any level, can include cluster hires, and can be within or in combination with any Jackson School Unit—the Department of Geological Sciences, the Bureau of Economic Geology, or the Institute for Geophysics. The schedule of appointment is also negotiable.
For more information on the school and its hiring program visit us online at www.jsg.utexas.edu/hiring.

Ph.D. is minimum requirement for application. Send inquiries and applications (cover letter, CV, list of publications, list of references, statements of teaching and/or research interests) to: Randal Okumura, Office of the Dean / Jackson School of Geosciences, The University of Texas at Austin / PO Box B, University Station / Austin, TX 78713 or jobs@jsg.utexas.edu.

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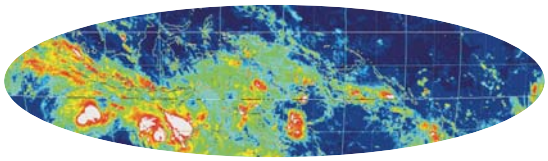

MULTIPLE HIRES IN CLIMATE SYSTEMS SCIENCE

The Jackson School is building a premier education and research program in Climate System Science. We seek scientists at the forefront of their disciplines attracted to challenging areas of scholarship that require collaboration across disciplines and programs. We seek the expertise required to address fundamental questions associated with a changing Earth system, including:

- What processes control the rates of change and variability of the climate system, including the atmosphere, ocean, cryosphere, land surface, and biosphere?
- Can we improve our ability to anticipate these changes and determine the potential impacts on society?

Over the next three years, we will hire six or more faculty and scientists who complement our growing strengths. We will hire individuals who will enable us to build a comprehensive climate program and who will make fundamental advances in our understanding of the climate system. These areas include, but are not limited to:

- Improved modeling of the Earth system, specifically including ice sheets, the global carbon cycle, and interaction between the components of the Earth system.
- Enhanced observation of the Earth system, including remote sensing of Earth-surface processes and components.
- Greater capability to utilize geologic archives to understand climate change, including paleoclimatology, paleoceanography, and paleobiology.
- Improved ability to link climate and hydrology, particularly at the basin-to-continent scale.
- Increased strengths in atmospheric dynamics and physical oceanography.
- Increased ability to understand variability and quantify uncertainties, including statistical climatology.
- Greater capability to address societal impacts and vulnerability, including adaptation and mitigation.

We encourage applications from innovative scientists in other areas that are related to climate system science.

MULTIPLE HIRES IN ENERGY—SCIENCE, ENVIRONMENT, AND POLICY RESEARCH

The Jackson School is building a premier education and research program in Energy—Science, Environment and Policy Research. We seek scientists at the forefront of their disciplines attracted to challenging areas of scholarship that require collaboration across disciplines and programs. We seek to address compelling questions within the broad theme of determining how we can create an energy future that is sustainable and environmentally and economically robust. These questions include, but are not limited to:

- How can we integrate classically separated disciplines (geomechanics, geochemistry, tectonics, stratigraphy, petrophysics, geophysical imaging, regional/basin scale studies) to advance interrelationships at the forefront of energy and environmental science?
- How do fluid-rock interactions and the interplay between mechanical and chemical processes influence fluid flow and storage in the subsurface?
- How can we improve identification and recovery of energy resources by comprehensive integration of information at all scales, integrated numerical modeling, and innovative automated and continuous monitoring?
- Can we solve the compelling environmental issues associated with the extraction and use of fossil fuel energy sources, including water and land use, and carbon sequestration?
- Can we develop energy policies founded on solid scientific and engineering information and innovative approaches that will simultaneously promote environmental stewardship and energy security?

Over the next three years we will hire six or more faculty and scientists who complement our existing strengths. We are interested in a wide variety of research areas ranging from rock/fluid systems, subsurface sensing, tectono-stratigraphy, carbon management, energy economics and policy, basin-scale analysis and modeling, and resource and reserve geoinformatics. We also encourage applications from innovative scientists in other areas related to energy—science, environment and policy.

Opportunities exist at any level, can include cluster hires, and can be within or in combination with any Jackson School Unit—the Department of Geological Sciences, the Bureau of Economic Geology, or the Institute for Geophysics. The schedule of appointment is also negotiable. For more information on the school and its hiring program visit us online at www.jsg.utexas.edu/hiring.

Ph.D. is minimum requirement for application. Send inquiries and applications (cover letter, CV, list of publications, list of references, statements of teaching and/or research interests) to: Randal Okumura, Office of the Dean / Jackson School of Geosciences, The University of Texas at Austin / PO Box B, University Station / Austin, TX 78713 or jobs@jsg.utexas.edu.

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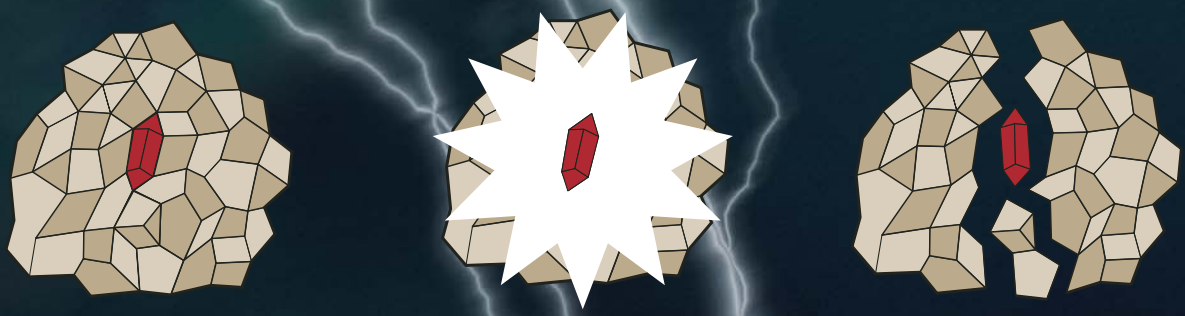
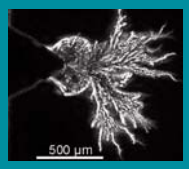
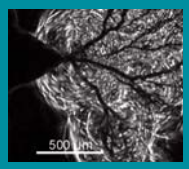
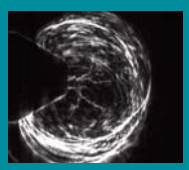


Selective fragmentation using an electric pulsed power process







Ref.: Coutesy of Research Centre of Karlsruhe, Germany

selFrag Lab offers a state-of-the-art laboratory equipment using a high voltage pulsed power process for selective fragmentation. Under a worldwide license from the Research Center of Karlsruhe in Germany, selFrag AG (Div. of Ammann-Group) has developed and commercialized the technology.

Our Technology
Selective fragmentation is based on controlled variable HV-discharges of very short duration applied to solids under water. Very fine plasma channels and the resulting shock waves propagating through the solids cause the material to disaggregate along grain boundaries, inclusions or inhomogeneities.

Your Advantages
- Higher speed and quality of overall analytical processes
- High degree of selectivity
- Morphological intact minerals or micro-fossils
- mono-mineral fragments
- High yield of available target specimens
- Very low production of fines
- No (cross-) contamination of samples

The selFrag Lab is a user friendly and compact piece of equipment designed for the use in a wide range of laboratory environments in the mining and oil & gas industry, the geoscience, planetology, as well in material analysis or process development. More details are available at www.selfrag.com