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What do you think this is? “Conceptual uncertainty” in geoscience interpretation

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ABSTRACT
Interpretations of seismic images are used to analyze subsurface geology and form the basis for many exploration and extraction decisions, but the uncertainty that arises from human bias in seismic data interpretation has not previously been quantified. All geological data sets are spatially limited and have limited resolution. Geoscientists who interpret such data sets must, therefore, rely upon their previous experience and apply a limited set of geological concepts. We have documented the range of interpretations to a single data set, and in doing so have quantified the “conceptual uncertainty” inherent in seismic interpretation. In this experiment, 412 interpretations of a synthetic seismic image were analyzed. Only 21% of the participants interpreted the “correct” tectonic setting of the original model, and only 23% highlighted the three main fault strands in the image. These results illustrate that conceptual uncertainty exists, which in turn explains the large range of interpretations that can result from a single data set. We consider the role of prior knowledge in biasing individuals in their interpretation of the synthetic seismic section, and our results demonstrate that conceptual uncertainty has a critical influence on resource exploration and other areas of geoscience. Practices should be developed to minimize the effects of conceptual uncertainty, and it should be accounted for in risk analysis.

INTRODUCTION
Geoscientists are required to make predictions from geological data that are often sparsely distributed or incomplete. For example, boreholes and seismic surveys sample limited volumes and have a limited resolution. Geoscientists use these data to produce geological framework models (3-D representations of stratigraphic horizons and fault planes) and to determine properties such as lithology and permeability. Components of these framework models will always be characterized by some uncertainty due to the inherent incompleteness of geological data sets. Quantifying this uncertainty is important because geological framework models are often used as the basis for assessments and decisions that have important social and commercial implications (e.g., resource extraction, ground-water supply, CO₂, and nuclear waste storage, solute transport, and earthquake and other geological hazard predictions).

Quantification of uncertainty in geological framework models in petroleum geoscience has concentrated on such parameters as the petrophysical properties of reservoirs (e.g., Egermann and Lenormand, 2005) and the resolution and processing of seismic data (e.g., Jones et al., 2007). In petrophysical models, predictions of reservoir permeability are based on water saturation data (Aguilera, 2004), pressure measurements, log data, well cores (Yan et al., 2006), and the like. These data are used to predict heterogeneities in reservoir properties and to calculate uncertainty parameters for flow simulations. Geostatistics, particularly in reservoir modeling, is widely used to aid in reservoir forecasting, uncertainty calculations, and risk analysis for decision making. Understanding the limitations in geostatistics is critical if it is to be used as a decision-making tool (Deutsch, 2006). Defining the limitations of geostatistics and uncertainty in interpretation is important for (1) acknowledging and assessing possible alternatives to a single interpretation; (2) highlighting areas within an interpretation that are less well constrained; (3) propagating uncertainties into further modeling or risk assessments; (4) combining and rationalizing different, seemingly inconsistent data sets and/or types; and (5) educating management, politicians, and the general public about scientific uncertainty.

We have called the range of concepts that geoscientists could apply to a single data set conceptual uncertainty. Geoscientists use their training and experience (i.e., their prior knowledge) to apply a concept (or rarely, to generate a new one) to data to construct an interpretation and, ultimately, to produce a framework model. We suggest that the initial geological framework model is a fundamental source of uncertainty because it is dependent on the tectonic paradigm or concept used in its construction. We argue that conceptual uncertainty can be more important than the uncertainty inherent in the positioning of horizons or fault planes in a framework model or in the subsequent populating of these features with petrophysical properties.

In this study, we have attempted to quantify conceptual uncertainty from 412 interpretations of a single synthetic seismic data set. In collating the interpretations of a large number of geoscientists with different backgrounds and experience, we have effectively constrained the range of concepts that could be applied to the synthetic seismic. In effect, we have defined the “conceptual uncertainty space” of that data set. We have examined the role of prior knowledge in seismic data interpretation and have highlighted examples in which the prior knowledge of individual geoscientists appears to have affected their interpretational choices and final outcome. In particular, we looked at examples of how expertise in particular tectonic settings, length of experience, and type of training and interpretational techniques used may have affected interpretational...
behavior. We also considered the influence of the broader contextual information a geoscientist uses in his or her interpretation. In the Discussion section of this paper, we make suggestions for more rigorous studies of conceptual uncertainty and discuss the significance for interpretation and prediction in geoscience.

Use of prior knowledge is the main method by which scientific disciplines progress and evolve (e.g., Levi-Strauss, 1966; Kuhn, 1962), and commonly described human biases form part of the way we use prior knowledge to interpret data (e.g., Frodeman, 1995). Cognitive bias commonly results from using heuristics or rules of thumb based on experience (prior knowledge). In cases of interpretational uncertainty, bias from prior knowledge is well documented in other disciplines, such as economics. In these disciplines, theories, such as elicitation theory, are used to mitigate against bias from prior knowledge. Baddeley et al. (2004) noted that heuristics are often used when making quick decisions or in instances when data are difficult to process or are limited in extent. Curtis and Wood (2004 and references therein) have provided examples and discussions of the use of prior knowledge in geoscience. However, few actual studies of the effects of prior knowledge in geoscience have been undertaken, with the exception of a study by Rankey and Mitchell (2003), who undertook an experiment to document the variation in interpretation of a data set by six seismic interpreters.

EXPERIMENT DESIGN AND PROCEDURE

To document the range of potential interpretations from a single data set and to test whether prior knowledge is important for interpretational outcomes, we asked geoscientists to produce a single interpretation of a seismic section. Rather than ask geoscientists to interpret a real section for which the "answer" is unknown, we created a synthetic seismic section from a 2-D geological model. Forward modeling enabled us to produce a geological model from an initial layer-cake stratigraphy so we could define the model input parameters and evolution, allowing us to compare interpretations against a "correct" answer. The synthetic seismic section (in two-way time) was printed as an A4 color plate (Fig. 1) with a series of questions on the reverse. In 2005 and 2006, we asked 412 geoscientists (participants) to make interpretations (answers) at conferences, workshops, and universities. These events took place in Europe, North America, and the Middle East. We questioned participants on factors we thought might have influenced their interpretations, including the participant's educational level, length of experience, background expertise, and perception of his or her ability in structural geology and seismic interpretation. If you would like to try the interpretation experiment for yourself, bear in mind that Figure 2 and the next paragraph contain the "answer" to the synthetic seismic section.

We forward modeled an inverted growth fault (i.e., extension followed by thrusting on a single structure; Figs. 2A–2D). The model was designed so that a number of realistic interpretations could be made from the single synthetic seismic data set (Fig. 2E). Details of the model and synthetic seismic generation can be found in the GSA Data Repository (see footnote 1).

In the experiment, participants were deliberately given little information about the seismic section and its generation. However, if the participants had taken the time to carefully read the information on the reverse of the seismic image, they would have learned that the seismic section they were being asked to interpret was synthetic. The introduction to the questionnaire included the sentence, "The section overleaf has been created by forward modeling using known assumptions." However, few of the participants who engaged in conversation about the exercise appeared to appreciate this fact.

We wanted to test the range of concepts that would come out of a simple interpretation exercise. We therefore did not ask the participants how they would have tested their interpretations. In a real geological situation, once a preliminary model or hypothesis has been generated, it is generally tested by collecting further data or by checking the validity, for instance, by restoring the section. In our study, the participants were only asked to produce a single interpretation and were given no further information than that on the questionnaire. This precluded...
participants from forming multiple models that could then be compared and rejected based on such testing.

RESULTS
We sorted the returned interpretations into the following tectonic setting categories: extension, thrust (shortening), inversion, strike-slip, diapirism (salt or mud), other (geological setting identified but not included in the list), and unclear (tectonic setting could not be identified). Many answers contained more than one of these tectonic setting elements; in these cases, the dominant or main tectonic setting was chosen. Strict selection criteria (horizon offsets, arrows or labels to define fault motion, and/or written annotations) were used to categorize the answers to reduce our own bias in the sorting procedure. Because of these strict sorting criteria, 32% of participants’ answers had to be classified as unclear. One reason for the small number (2%) of strike-slip answers returned is that out-of-plane displacement cannot be seen in a vertical seismic section. None of the participants annotated in- or out-of-plane movements, even those who explicitly stated they had a strike-slip interpretation. For the “apparently” strike-slip answers, we considered the geometric arrangement of faults, but only classified the answer as strike-slip in cases where there was no ambiguity. The 5% of answers in the “other” category fell outside the range of the common tectonic settings categories we had chosen.

The range of tectonic settings implied by the interpretations is summarized in Figure 3. The answers span all five tectonic concept categories (inversion, strike-slip, extension, shortening...
[thrust], and diapirism). Participants also applied nontectonic concepts to their interpretation, such as carbonate reefs and sequence stratigraphy concepts (5%), further extending the conceptual uncertainty for the data set. Only 10% of answers showed the “correct” inversion model, as produced in the forward model. This increases to 21% if we include participants who showed both extension and thrusting in their interpretation. In the rest of this article, inversion is classified as extension and thrusting anywhere in the section, for instance, extension on one fault and shortening on another. Across all the tectonic setting expertise groups the most common interpretational answer (26%) was a thrust (shortening) tectonic setting. The results show that 79% of the participants applied the wrong concept in their interpretation and that the most common answer was not the “correct” scenario created in the forward model.

The features most commonly singled out in the seismic image were areas of high- or low-intensity signals. High-intensity features would normally indicate an acoustic impedance contrast and therefore a geological feature or change in rock property (e.g., Brown, 1986). The two main fault segments, areas of high-intensity signals on the image, were highlighted by 69% and 68% of participants, respectively. The next most common feature interpreted, highlighted by 62% of participants, is an area of almost no data (Fig. 4).

In the original model, this area of no data is a small fault splay in the hanging wall to one of the main faults. Many participants annotated diapirism or a gas chimney in this area.

In the following sections, we look at examples in which the prior knowledge of individual geoscientists appears to have directly influenced the concepts they applied in their interpretations of the seismic image. We show examples of how expertise, experience, and training influenced the concepts applied and hence the final interpretation. Finally, we consider the reliance of interpreters on a breadth of geological and geographical information to support their interpretations of a data set.

**Expertise (Tectonic Setting)**

Participants were provided with a list of tectonic settings (extension, inversion, thrust, salt, strike-slip, and other) and asked to indicate their dominant field of expertise. Some participants indicated more than one expertise category; the following analyses do not include these participants. Twenty-nine percent of the participants who indicated thrust tectonics as their dominant field of expertise interpreted the section as thrust faults, while 27% of participants with some other expertise also produced a thrust fault answer. Of the participants with dominant expertise in inversion, 25% produced an inversion interpretation, whereas of those without inversion expertise 20% produced an inversion interpretation. Participants with dominant expertise in extension and diapirism were more likely to produce an answer that matched their expertise than participants with some other dominant expertise (extension expertise 10% as compared to 3% other expertise; diapirism expertise 13% as compared to 7% other expertise). The only group in which the dominant expertise negatively correlated with interpretational outcome, when compared to other geoscientists, was strike-slip (strike-slip expertise 0% as compared to 3% other).

Examples can be found for all settings where those with a specific expertise appear to have allowed this to dominate their interpretations. Figure 5 shows two examples from students who described their expertise as salt tectonics and sequence stratigraphy, respectively, and who produced interpretations that appear to be based directly on their expertise. In Figure 5B, a master's student in sequence stratigraphy has used classic sequence stratigraphy interpretation techniques: maximum flooding surfaces, onlaps and truncations to interpret a reef build-up. In Figure 5A, a Ph.D. student in salt tectonics shows doming associated with salt mobilization. Although these participants have honored the data, they have chosen to interpret it in a way that fits with their dominant expertise and knowledge. By applying these dominant concepts to the data set, they have produced an “incorrect” interpretation. In other examples, interpreters have not honored the data, perhaps due to inexperience in seismic interpretation.

Tectonic setting expertise seems to have influenced the concepts some participants brought to their interpretation.
However, the percentage differences between the expertise categories are not all statistically significant, and the examples of interpretations that match dominant expertise are not seen across the group as a whole. The results suggest that one or more other factors also influenced the concepts applied to a data set by an individual. It is important to note that we asked for the participants’ dominant expertise rather than their breadth of expertise, and, additionally, we did not take into consideration how proficient each participant may have been in seismic interpretation.

**Experience (Length)**

To evaluate how length of experience affects conceptual uncertainty, interpreters were asked to choose the length of time that they had technical experience, from none, student, 0–5 years, 5–10 years, 10–15 years, and 15+ years. In the study group, students were just as likely to produce an “incorrect” answer (76%) as participants with 15+ years experience (76%). Like the student examples in Figures 5A and 5B, two professionals with the same level of experience (15+ years) interpreted the seismic image at a petroleum industry conference and produced answers that matched their dominant tectonic setting expertise (Figs. 5C and 5D). Both marked the same features in the top part of the section as faults. The first interpreter, with dominant expertise in thrust tectonics, interpreted the features as thrust faults. The second interpreter, with extensional expertise, marked the features as extensional faults. Neither of these features are faults in the original model (Fig. 2D). These results indicate that participants with a greater number of years of experience did not necessarily produce more “right” answers.

**Interpretational Techniques**

We classified the answers according to the interpretational techniques applied to analyze and interpret the data. We defined five technique classifications from the interpretations: (1) identification of features, in which the participants had highlighted features such as faults, gas chimneys, unconformities, etc., by drawing along them; (2) identification of horizons, where participants had drawn along horizon reflectors and/or identified sediment packages; (3) drawing “sticks”—participants simply drew straight lines on the seismic section; (4) annotation, where participants used arrows and writing to annotate features and horizons; and (5) sketches and/or writing, where participants wrote a description of their interpretation of the seismic section or drew sketches to show the evolution of their interpretation through time. Examples of the different classifications can be seen in Figure 6. The different styles have an effect on the identification of specific features.
(e.g., participants whose interpretational style included feature identification were ~30% more likely to identify the main fault strands than participants who just identified horizons). Table 1 groups the participants by the number of techniques they used to complete their answer. The participants who used the most techniques were most likely to get the “correct” interpretational answer. Both of the two participants who used 4 out of the possible 5 techniques produced the “correct” answer.

**DISCUSSION**

We have documented the breadth in conceptual uncertainty for a single data set. The interpretation produced most often was a thrust-based interpretation rather than the “correct” forward modeled scenario of inversion. There are several non-unique and geologically sound solutions to the data set (Fig. 1E); therefore the small percentage (21%) of correct interpretational answers that matched the forward model and the range of concepts applied to the data set is perhaps not surprising.

Observations of participants’ interpretations suggest that they used a range of prior knowledge to undertake the interpretation exercise. In some cases, but significantly not all, prior knowledge based on dominant tectonic setting expertise appears to have biased the concepts participants applied to the data set (Fig. 5). These observations contrast with those of Rankey and Mitchell (2003) who concluded that interpretations are likely to be based on previous experience and preconceived notions. Our results suggest that other factors, such as an individual’s training and the techniques used to interpret the section, may have more influence on interpretational outcome than tectonic expertise. How we define prior knowledge is important when comparing our results to those of other workers.

It is interesting to note that participants with more experience (measured as number of years of experience) did not necessarily produce more “correct” answers. This suggests that type of experience is more significant than length of experience alone. How participants defined their own length of experience was not constrained (i.e., did participants who were two years into a Ph.D. count themselves as students or as having two years post-degree experience?). Similarly, we asked participants for their dominant tectonic expertise rather than their breadth of expertise, and it is likely that a participant with expertise in more than one tectonic setting may be better able to distinguish between likely interpretations. These initial results suggest that more than one controlling factor influences conceptual uncertainty; therefore, a full multivariate statistical analysis is required to establish significant relationships.

Participants used a range of interpretational techniques that led to different styles of answers. Our results show that the greater the number of techniques used by individual participants, the greater their chances of producing a “correct” interpretation. We believe that the number of techniques used serves as a proxy for the intensity with which each participant queried the data. Those who used the most techniques may have scrutinized the data more thoroughly than participants who used fewer techniques. However, some techniques, such as feature identification, also appear to be more effective than others at identifying key elements within the seismic section.

The effect of the techniques employed and interpretational style applied to the interpretation of the data set have implications for training and education.

Interpretations of the synthetic seismic image focused on areas of high- and low-intensity signals. Areas of low-intensity responses in seismic images are often caused by dispersion of layering due to diapirism or gas percolation through the overlying strata (e.g., Bouriaik and Akhemtjanov, 1998; Veerayya et al., 1998), and many participants marked such features in an area of poor data quality, even though this part of the section was not crucial to the overall tectonic interpretation. Sixty-two percent of participants focused their interpretations on an area of no data (i.e., an area of high uncertainty). Annotating gas or diapirism in this area, a direct hydrocarbon indicator, could be critical in a commercial situation. The need to interpret the part of the synthetic seismic image with the least data perhaps says something about human nature, but it also suggests that participants were drawn to anomalous areas with the highest and lowest intensity data.

In the following, we consider the influences of different types of prior knowledge and bias for our study in the context of definitions from psychology. In cognitive psychology, biases are commonly divided into types. The most relevant bias types for this study are described here, but see Krueger and Funder (2004) for a full discussion of bias types and their origins. **Availability bias** occurs when interpreters use the model or interpretation that is most dominant in their minds. For example, a geoscientist interpreting a new data set having just spent six months looking at fold and thrust belts will have the concepts for fold and thrust terrains most readily available in his or her mind. **Anchoring bias** is the failure to adjust from experts’ beliefs, dominant approaches, or initial ideas. In this case, interpreters may know that a seismic section is from, for example, the Gulf of Mexico, and will therefore have the concept of salt tectonics in their minds because this is the accepted interpretational concept for the Gulf of Mexico area. Interpreters will not consider other concepts in their interpretations. **Confirmation bias** involves actively seeking out opinions and facts that support one’s own beliefs or hypotheses. For example, when a geoscientist believes that the seismic section is from an extensional terrain, he or she will identify features that support this belief and ignore information that does not corroborate or correspond to an extensional interpretation.

Examples of bias based on dominant tectonic setting expertise can be found at all levels of experience. Individual participants with 15+ years experience anecdotally show evidence of **availability** and **anchoring** bias in the same way students do. Participants do, however, require some experience to undertake the exercise because an interpreter has to be able to apply relevant knowledge and concepts to the data to produce a realistic

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**TABLE 1. NUMBER OF TECHNIQUES PARTICIPANTS USED IN INTERPRETATIONS AND PERCENTAGE OF PARTICIPANTS IN THESE SUBGROUPS WHO MADE A "CORRECT" INTERPRETATION**

<table>
<thead>
<tr>
<th>Number of techniques used</th>
<th>Number of participants using each technique</th>
<th>Percent who produced a &quot;correct&quot; answer (inversion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>31</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
<td>202</td>
<td>25</td>
</tr>
<tr>
<td>1</td>
<td>176</td>
<td>13</td>
</tr>
</tbody>
</table>

*Note: Out of five possible techniques (features, annotations, sticks, sketches and writing, and horizons), the maximum number of techniques used was four. The more interpretational techniques used, the more likely the participant was to interpret the seismic image correctly, with those using four or more techniques achieving 100% success at the "correct" interpretational answer.*
interpretation. Many participants asked "where in the world?" the seismic section was from. Participants were effectively asking for confirmation, provided by such context, for their interpretations. Alternatively, they may have been seeking a starting point on which to base their interpretations. Typically, when interpreting geological data, the geographical location and, hence, broad tectonic setting of the data is known and interpreters use this prior information to aid their interpretations. Therefore an anchoring bias may operate because interpreters expect to see a particular type of structure in a given setting.

We suggest that the synthetic seismic image may have been effectively biased toward a thrust tectonic setting interpretation because this setting received the highest number (26%) of answers. Conversely, the 2-D seismic section was negatively biased toward a strike-slip interpretation, the tectonic setting category with the lowest number (2%) of interpretational answers. As discussed earlier, many answers that we classified as strike-slip may have fallen into the unclear category due to the selection criteria used to categorize the results. This suggests that we may be seeing elements of both confirmation bias and disconfirmation bias (the use of features as evidence against a particular hypothesis or model) within the participant group: participants confirming thrust features, but disconfirming strike-slip features.

Interpreting geological data is generally an under-constrained problem, requiring knowledge of geological analogues and an ability to apply these to new problems and areas. Frodeman (1995) set geology apart from classical sciences, such as physics, because of the scientific reasoning required in geological science. Frodeman argued that such scientific reasoning skills will become increasingly crucial for issues like global warming, assessing uncertainty and risks in hazard prediction, solute transport, and resource management. In earth and environmental science, scientific uncertainty has an important impact on public policy formation. Pollack (2007) argued that scientific uncertainty should not be seen as a barrier to public policy development but as an opportunity for creative and competitive solutions that can be continuously developed. Assessing uncertainty and risk requires accurate geological framework models from which predictions can be made. Therefore, as geoscientists, acknowledging and evaluating conceptual uncertainty must be a critical factor in maximizing the effectiveness of the geological reasoning process and hence for informing public policy. Understanding more about the factors affecting the concepts that geoscientists apply to information-limited data sets will improve our predictions and the assessment of risk associated with those predictions.

CONCLUSIONS

Conceptual uncertainty is likely to be a major risk factor for sciences in which decision making is based on the interpretation of data sets containing limited information. Our experiment has quantified the range in conceptual uncertainty for a single data set and shown that conceptual uncertainty can have a large effect on interpretational outcome. The interpretational answers of participants in our study show evidence for bias due to their prior knowledge. A range of factors affects how an individual's prior knowledge and hence concepts are applied to data sets. These factors include an interpreter's tectonic expertise and/or breadth of expertise, the length of his or her experience, and the type of techniques an interpreter uses to interpret a section. Distinguishing between these different factors and putting practices in place to elicit intelligent information while mitigating against the unconscious negative use of prior knowledge is a key challenge. Conceptual uncertainty, once quantified, can be used in combination with petrophysical models and other uncertainty calculations to increase the predictability of petroleum and other geological systems and their properties. How an individual geoscientist's prior knowledge may influence his or her interpretation and hence affect the collective conceptual uncertainty for the data set has important implications for training, team building, risk analysis, and decision making. Our results emphasize that a geological interpretation is a model that needs testing.

ACKNOWLEDGMENTS

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Nominations due 1 February 2008

This award is given to a woman who has made a major impact on the field of the geosciences, based on her Ph.D. research. For details on the award and nomination procedures, see the October 2007 GSA Today. For the new online nomination form, go to www.geosociety.org/aboutus/awards/ or call +1-303-357-1028. Send nominations and supporting material to Grants, Awards, and Recognition, GSA, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA.

JOHN C. FRYE ENVIRONMENTAL GEOLOGY AWARD

Nominations due 31 March 2008

In cooperation with the Association of American State Geologists, GSA gives an annual award for the best paper on environmental geology published either by GSA or by one of the state geological surveys. For details, see the October 2007 GSA Today, visit www.geosociety.org, or call +1-303-357-1028. Nominations must be sent to Grants, Awards, and Recognition, GSA, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA.

NATIONAL AWARDS

Nominations due 30 April 2008

Candidate nominations are needed for the following national awards: William T. Pecora Award, National Medal of Science, Vannevar Bush Award, and Alan T. Waterman Award. For details, see the October 2007 GSA Today, visit www.geosociety.org/grants/gradgrants.htm, call +1-303-357-1028, or e-mail awards@geosociety.org.

RESEARCH AWARDS IN GEOMORPHOLOGY AND MICROPALAEONTOLOGY

Application deadline: 1 February 2008

Two of GSA’s most prestigious awards supporting research are made possible by the generosity of the late W. Storrs Cole. Qualified GSA Members and Fellows are encouraged to apply. Online application forms are now accepted at www.geosociety.org/grants/postdoc.htm. Supplemental information must be e-mailed to awards@geosociety.org or mailed to Grants, Awards and Recognition, GSA, 3300 Penrose Place, P.O. Box 9140, Boulder, CO 80301-9140, USA.

Geomorphology

The Gladys W. Cole Memorial Research Award provides support for the investigation of the geomorphology of semiarid and arid terrains in the United States and Mexico. GSA Members and Fellows between the ages of 30 and 65 who have published one or more significant papers on geomorphology are eligible for the award. While the funds may not be used for work that is already finished, recipients of previous awards may reapply if they need additional support to complete their work. The 2008 award is US$9300.

Micropaleontology

The W. Storrs Cole Memorial Research Award supports research in invertebrate micropalaeontology. This award carries a stipend of US$8200 in 2008 and will go to a GSA Member or Fellow between the ages of 30 and 65 who has published one or more significant papers on micropaleontology.

The Gladys W. and W. Storrs Cole Award funds are managed by the GSA Foundation.
IGC Travel Grant Program
33rd International Geological Congress
Oslo, Norway • 6–14 August 2008

Application deadline: 1 March 2008

The Geological Society of America is accepting applications for the 33rd International Geological Congress (IGC) Travel Grant Program. This program was established as a final act of the organizing committee for the U.S.-hosted 28th IGC held in Washington, D.C., in July 1989. Surplus funds available at the conclusion of the 28th IGC were transferred to the GSA Foundation with the stipulation that income from the fund be used to support the attendance of young geoscientists at future IGC meetings until such time that the United States again hosts an IGC. Travel grants will consist of economy airfare to Norway.

To be eligible, an applicant must be a resident or citizen of the United States, must have a birth date after 31 August 1968, and must have proof of abstract submission to the meeting.

Applications are on the Web at www.geosociety.org/grants/travel.htm. In addition to the online form and proof of abstract submission, all applicants must provide two letters of reference from current or recent supervisors. All supplemental information must be sent as e-mail attachments directly to awards@geosociety.org. Online applications and supplemental material must be received electronically no later than 1 March 2008. Applicants will be notified of results no later than June 2008.

The Geological Society of America
and the U.S. Geological Survey present

GEOHEALTH I:
BUILDING BRIDGES ACROSS
THE GEOLOGICAL
AND HEALTH SCIENCES
4–6 March 2008
U.S. Geological Survey Headquarters
Reston, Virginia, USA

Go to www.geosociety.org/meetings/08geohealthI/ for details.

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Opportunities to work as a Congressional Science Fellow are rare, and selection for this unique position will be based on applications from top competitors in the geoscience community. Prospective candidates should be GSA Members with a broad geoscience background and excellent written and oral communication skills. Minimum requirements are a master’s degree with at least five years of professional experience or a Ph.D. at time of appointment. The fellowship is open only to U.S. citizens or permanent U.S. residents. The next Geological Society of America–U.S. Geological Survey Congressional Science Fellow will be selected in early 2008.

Put your academic and professional background, experience applying scientific knowledge to societal challenges, and passion for shaping the future of the geoscience profession to work in this coveted arena: Apply today! Find application information at www.geosociety.org/csf/ or contact Ginger Williams, +1-303-357-1040, gwilliams@geosociety.org. Deadline for application: 1 February 2008.

The Geological Society of America
and the U.S. Geological Survey present

GEOHEALTH I:
BUILDING BRIDGES ACROSS
THE GEOLOGICAL
AND HEALTH SCIENCES
4–6 March 2008
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Go to www.geosociety.org/meetings/08geohealthI/ for details.

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Put your academic and professional background, experience applying scientific knowledge to societal challenges, and passion for shaping the future of the geoscience profession to work in this coveted arena: Apply today! Find application information at www.geosociety.org/csf/ or contact Ginger Williams, +1-303-357-1040, gwilliams@geosociety.org. Deadline for application: 1 February 2008.

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THE GEOLOGICAL
AND HEALTH SCIENCES
4–6 March 2008
U.S. Geological Survey Headquarters
Reston, Virginia, USA

Go to www.geosociety.org/meetings/08geohealthI/ for details.
2008 Section Meeting Mentor Program Calendar

The following Mentor Programs are sponsored by the GSA Foundation.

CORDILLERAN–ROCKY MOUNTAIN JOINT MEETING

Shlemon Mentor Program Luncheons: Thurs.–Fri., 20–21 March, 11:30 a.m.–1:00 p.m.
Mann Mentors in Applied Hydrogeology Program:
Thurs., 20 March, 5–6:30 p.m.

NORTHEASTERN

Shlemon Mentor Program Luncheons: Thurs.–Fri., 27–28 March, 11:30 a.m.–1:00 p.m.
Mann Mentors in Applied Hydrogeology Program:
Thurs., 27 March, 5–6:30 p.m.

SOUTH-CENTRAL

Shlemon Mentor Program Luncheons: Mon.–Tues., 31 March–1 April, 11:30 a.m.–1:00 p.m.
Mann Mentors in Applied Hydrogeology Program:
Mon., 31 March, 5–6:30 p.m.

SOUTHEASTERN

Shlemon Mentor Program Luncheons: Thurs.–Fri., 10–11 April, 11:30 a.m.–1:00 p.m.
Mann Mentors in Applied Hydrogeology Program:
Thurs., 10 April, 5–6:30 p.m.

NORTH-CENTRAL

Shlemon Mentor Program Luncheons: Thurs.–Fri., 24–25 April, 11:30 a.m.–1:00 p.m.
Mann Mentors in Applied Hydrogeology Program:
Thurs., 24 April, 5–6:30 p.m.

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The Pension Protection Act of 2006 offers tax-free charitable giving for those who qualify.

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The Charitable IRA brochure outlines the details for the enhanced tax incentives; however, you must check with your financial advisor for the best way to take advantage of this new opportunity.

Remember, time is short as this option will expire on 31 December 2007. Request your free booklet today. Simply e-mail drussell@geosociety.org or call Donna Russell at +1-303-357-1054.

Bequests To The Foundation

If you are planning your will, please don’t forget to add a provision for the GSA Foundation. Here is the language you’ll need.

“I hereby give, devise, and bequeath to the Geological Society of America Foundation Inc. the sum of $[name your sum here]. It is my desire that this bequest to the Geological Society of America Foundation Inc. be used for the following purposes: [please specify a Foundation Fund].”

The Foundation’s Federal Tax ID Number is 74-2156871. If you have any questions, please call the Foundation office at +1-303-357-1054.

Planned Giving Information Available

The GSA Foundation has a variety of free planned giving pamphlets available. Titles include:

- A Legacy in Trust
- Year-End Planning
- Trusts for Tomorrow
- Update Your Will
- Planning for Women
- Remarkable Unitrusts
- Your Living Will
- Year-End Tax Check List
- Your Personal 2007 Planning Guide
- Charitable Gift Planning Guidelines

To request your FREE copy of any or all of these brochures, simply e-mail drussell@geosociety.org or call Donna Russell at +1-303-357-1054. Your requested copies will be sent promptly.

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—Frederick Klinger

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drussell@geosociety.org

www.gsfafweb.org
If you click on “About GSA” on the Geological Society of America Web site, you’ll find both a mission and vision statement describing the focus for our Society. Points from these statements note that GSA is “promoting the geosciences in the service of humankind” and “supporting the application of geoscience knowledge and insight to human needs, aspirations, and stewardship of the Earth.”

This acknowledges that many geologists are not teaching or conducting research in geology; rather, they are applying it as staff for environmental, engineering, hydrogeology, mineral development, and energy exploration firms. Many are also involved with policy and planning organizations or as specialists for national, state, or local governmental agencies.

About four years ago, GSA Council recognized that we could do a better job ensuring that geologists working in applied areas would perceive the Society as meeting their professional needs. The Academic and Applied Geoscience Relations (AAGR) Committee was formed and charged with making this happen.

The AAGR Committee is striving to take advantage of GSA’s premier role in understanding our geological world in a way that improves and supports the work of those applying geology to everyday needs in society. Communication is a key component and includes conveying new knowledge and understanding as well as different scientific ways of thinking. It is also a chance for exploration of still unresolved questions and the need to make the application of geology more effective in addressing societal issues. On a practical level, it involves better integration of applied and academic science in our meetings, publications, short courses, field trips, and education and outreach programs.

The on-going work of the AAGR Committee will lead to changes that will ultimately help GSA move closer to achieving its mission and vision. The AAGR Committee encourages members with an interest in this area to consider applying to serve on the committee. Any member with ideas on how to better carry out our charge to “strengthen and expand the relations between GSA Members in the academic and applied geosciences” is encouraged to share them with us!

Jerome V. DeGraff, USDA Forest Service, 45nyutca@sbcglobal.net
Chair, AAGR Committee (through October 2007)
**GSA Today** seeks articles that lay the groundwork for furthering the influence of earth science on education, policy, planning, and funding. Articles can include in-depth geoscience commentary, short observations and analyses of hot topics, and discussion of policy news and issues.

**CHARACTERISTICS OF A “GROUNDWORK” ARTICLE:**

1. The printed article should be a complete, stand-alone article. (Ongoing or serial commentary or meetings summaries are not appropriate for this series.)
2. Supplemental information may be included as a GSA Data Repository item.
3. Length: No longer than 1400 words with two small figures or 1600 words with one figure. The philosophy behind this is twofold: (1) keeping an article short can increase the clarity and quality of the writing; and (2) a short article encourages readers to engage and seek more information.
4. Color figures may be included at no cost to authors.
5. **GSA Today** science editors will be responsible for review and acceptance of the articles.
6. Frequency: Accepted articles will be published on a space-available basis.

To submit a “Groundwork” article, send your manuscript and figures via e-mail to **GSA Today** Science Editors Stephen Johnston, stj@uvic.ca, and David Fastovsky, defastov@uri.edu.

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Final Announcement and Call for Papers

JOINT MEETING

104th Annual Meeting, GSA Cordilleran Section
60th Annual Meeting, GSA Rocky Mountain Section
Las Vegas, Nevada, USA

19–21 March 2008

REGISTRATION

Early Registration Deadline: 18 February 2008
Cancellation Deadline: 25 February 2008
Register online: www.geosociety.org/meetings

REGISTRATION FEES

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<td>US$50</td>
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<tr>
<td>Field Trip or Workshop only</td>
<td>US$30</td>
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CALL FOR PAPERS

Abstract Deadline: 11 December 2007
Submit abstracts online: www.geosociety.org/meetings
Abstract submission fee: US$10
Contact Nancy Wright at GSA, +1-303-357-1061, nwright@geosociety.org, if you have any problems with the electronic submission of abstracts.

FIELD TRIPS

This meeting offers 13 field trips ranging in length from one to three days. Field trip descriptions are posted at www.geosociety.org/sectdiv/cord/08mtg/, or can be obtained by contacting the field trip leaders or field-trip committee members Eugene Smith, gene.smith@unlv.edu, and Ernie Duebendorfer, ErnieD@nau.edu.

STUDENT MENTOR PROGRAMS

These mentor programs are sponsored by GSA Foundation. Questions? Contact Jennifer Nocerino, jnocerino@geosociety.org, +1-303-357-1036.

Roy J. Shlemon Mentor Program in Applied Geoscience: Thurs.–Fri., 20–21 March, 11:30 a.m.–1 p.m. Free meal included.

The John Mann Mentors in Applied Hydrogeology Program: Thurs., 20 March, 5–6:30 p.m. Free meal included.
Call for Nominations
2008 Biggs Award

Nomination Deadline: 1 February 2008
(new date)

Beginning in 2008, the Biggs Award for Excellence in Earth Science Teaching will become a Geoscience Education Division named award. Division-named awards are among the most prominent awards given by GSA.

The Biggs Award recognizes innovative and effective teaching in college-level earth science. Earth-science instructors and faculty members from any academic institution engaged in undergraduate education who have been teaching full-time for 10 years or fewer are eligible. (Part-time teaching is not counted in the 10-years-or-fewer requirement.) Both peer- and self-nominations are accepted for this award.

The US$750 award is made possible as a result of support from the Donald and Carolyn Biggs Fund, the GSA Geoscience Education Division, and GSA’s Education and Outreach Program. An additional travel reimbursement of up to US$500 is available to the recipient to enable him or her to attend the award presentation at the GSA Annual Meeting.

To access the nomination form and additional information, please go to www.geosociety.org.awards/biggs.htm. All nomination material should be sent to Eric J. Pyle, James Madison University, Dept. of Geology & Environmental Science, MSC 7703, Harrisonburg, VA 22807-0001, USA, pyleej@jmu.edu, by 1 February 2008.

2007 Biggs Awardee Named

Congratulations to Joe T. Elkins, assistant professor in the geology department at Bowling Green State University, who has been named the 2007 Biggs Award recipient.

The Biggs Award encourages and rewards excellence in teaching among college-level earth-science faculty who are at the early stages of their careers. The award of US$750 is made possible through support from the Donald and Carolyn Biggs Fund, the GSA Geoscience Education Division, and GSA’s Education and Outreach Program. These funds are managed by the GSA Foundation.

Joe T. Elkins
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This Special Paper includes 29 papers presented at several meetings of the International Geoscience Programme (IGCP) Project 497: “The Rheic Ocean: Its origin, evolution and correlatives.” The Rheic Ocean was one of the dominant oceans of the Paleozoic. Its origin can be traced to the Avalonian-Cadomian orogenies in the Latest Neoproterozoic. Closure of the Rheic Ocean began in the Lower Devonian and ended with the assembly of the supercontinent Pangaea. Its history involves North and South America, Africa, Baltica, and a number of peri-Gondwanan terranes. Papers mirror the history of the Rheic Ocean and document a chain of global events and produced orogenic belts that extend discontinuously from México to easternmost Europe. The ocean’s evolution was responsible for the formation of a wide variety of sedimentary basins; it significantly impacted the history of life, and it profoundly influenced contemporary paleoclimate and global environmental conditions. Fields of research involved in its study range widely and, as this book illustrates, include stratigraphy, sedimentology, paleontology, paleogeography, paleooceanography, igneous and metamorphic petrology, tectonics, structural geology, provenance analysis, geochemistry, geochronology, and paleomagnetism. Despite decades of research, aspects of the evolution of the Rheic Ocean remain controversial. With this book, the authors hope to answer a number of important questions and to encourage further research.
Honoring Our 2007 GeoCorps Participants

GSA recognizes the following outstanding GSA Members for their contributions to the GeoCorps America™ program this year. Their dedication facilitated the completion of crucial geoscience projects to reach the management goals of the National Park Service, the U.S. Forest Service, and the Bureau of Land Management (BLM). GeoCorps America places GSA Members in summer jobs within these agencies in locations known for beauty and outstanding geology across the United States. This year, the program offered 43 summer positions.

2007 GSA GeoCorps Participants

Amy Edwards
Antietam National Battlefield, Maryland

Cory Redman
Bryce Canyon National Park, Utah

Joel Allen
Bryce Canyon National Park, Utah

Christine Dektor
Capulin Volcano National Monument, New Mexico

Tiffany Rivera
Craters of the Moon National Monument, Idaho

Laurel Stratton
Denali National Park, Alaska

Lisa Fay
Denali National Park, Alaska

Eva Lyon
Florissant Fossil Beds National Monument, Colorado

Kathryn Dick
Fossil Butte National Monument, Wyoming

Leif Anderson
Grand Canyon National Park (North Rim), Arizona

Michael Smith
Grand Canyon Parashant National Monument, Utah

Drew Ditmar
Gulf Islands National Seashore, Florida

Rachel Landman
Mount Rainier National Park, Washington

Christina Gooch
Mount Rainier National Park, Washington

Kathryn Barnard
Oregon Caves National Monument, Oregon

Emory Nellie
Oregon Caves National Monument, Oregon

Raul Ochoa
Petrified Forest National Park, Arizona

Johanna Lanter
Rocky Mountain National Park, Colorado

Diane Escobedo
Rocky Mountain National Park, Colorado

Sarah Stosick
White Sands National Monument, New Mexico

Kevin Donegan
Huron-Manistee National Forest, Michigan

Carisa Bombberger
Kaalbah National Forest, Arizona

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Sierra National Forest, California

Jacob Vossenkemper
Sierra National Forest, California

Tyler Ladinsky
Sierra National Forest, California

Sean Hullburt
White River National Forest, Colorado

James Martin
White River National Forest, Colorado

Andrew Neal
BLM, Butte Falls Resource Area, Oregon

Charles Shaw
BLM, California Coastal National Monument, California

Laura Bondelon
BLM, Grand Staircase–Escalante National Monument, Utah

Michael Knell
BLM, Grand Staircase–Escalante National Monument, Utah

Tonia Rucker
BLM, Gunnison Gorge National Conservation Area, Colorado

Chas Fricke
BLM, Nevada, Winnemucca District, Nevada

Andrew Olivi
BLM, Nevada, Winnemucca District, Nevada

Derek Roy
BLM, Public Lands Center & Canyons of the Ancients National Monument, Colorado

Angela Bondy
BLM, Royal Gorge, Colorado

Matthew Dawson
BLM, Upper Missouri River Breaks National Monument, Montana

Katelyn Huffman

For more information about GSA’s GeoCorps program, go to www.geosociety.org/geocorps. Jobs for 2008 will be posted on the Web in early December 2007.
New electronic publishing services from the Geological Society of London

To mark its 200th Anniversary in 2007, the Geological Society of London is pleased to announce a major digital initiative. The Geological Society’s new online Lyell Collection features the full content of its wholly-owned journals, Special Publications and key book series. This completely new service is available in its entirety to the Earth science community worldwide.

The Lyell Collection features 14,000 original research articles and over 230,000 full-text pages, with abstracts and extracts being freely available to all. It brings together key Earth science literature in a seamless service for the first time and allows detailed searching of both current research and historical material.

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Geological Society Fellows subscribing to JGS receive electronic access back to 1845; those subscribing to QJEGH receive access back to 1967. Fellows also have free online access to all Special Publications, Engineering Geology Special Publications and Memoirs published prior to the current or previous three calendar years. During the Fellowship renewal process for 2008 options to access all newer titles will be offered.

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GEOSCIENCE EDUCATION
CALIFORNIA STATE UNIVERSITY-NORTHBRIDGE

The Department of Geological Sciences invites applications for a tenure-track appointment at the assistant professor level in Geoscience Education. We are particularly interested in candidates who focus on improving learning of science by non-science majors. We seek an outstanding teacher and researcher to lead instruction of our large introductory science classes and our general-division courses in physical science and earth sciences and upper-division science experience capstone course, and to engage in ongoing improvements in their design, implementation, and assessment. 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. The appointee also will be encouraged to design and teach an upper-division elective course in his/her area of earth science expertise. Preference will be given to applicants with a demonstrated history of research, evidence of student learning, and evidence of successful application of new teaching methods and technologies. This is a tenure-track appointment to begin Fall 2008 in the area of Geoscience Education. The position will be supported by the Learning Resources Division at the university and will work closely with the Instructional Designers in developing innovative educational materials for the course. The appointee also will be encouraged to interact with undergraduate students and contribute to ongoing improvements in their design, implementation, and assessment. A Ph.D. or equivalent degree in geological science is required at the time of appointment. To ensure full consideration, all applications must be received before January 31, 2008.

WESTERN KENTUCKY UNIVERSITY
DEPARTMENT OF GEOGRAPHY AND GEOLOGY

The Department of Geography and Geology, University of Kentucky, is seeking applications for a tenure-track assistant professor position beginning August 2008. We seek candidates who have demonstrated interest and ability to teach introductory courses in: Physical Geography (internal and external processes), Physical Geography and Environmental Geoscience. This is a tenure-track appointment to begin Fall 2008 in the area of Geoscience Education. The position will be supported by the Learning Resources Division at the university and will work closely with the Instructional Designers in developing innovative educational materials for the course. The appointee also will be encouraged to interact with undergraduate students and contribute to ongoing improvements in their design, implementation, and assessment. A Ph.D. or equivalent degree in geological science is required at the time of appointment. To ensure full consideration, all applications must be received before January 31, 2008.
OPEN RANK POSITION IN COAL GEOLOGY
SOUTHERN ILLINOIS UNIVERSITY–CARBONDALE

The Department of Geology at Southern Illinois University Carbondale invites applications for a tenure-track position in coal geology, starting Aug. 16, 2008. Research emphasis is on coal beds, the coalification process, basin analysis, coal bed methane and carbon sequestration, and other coal-related fields. Rank is open and will depend on the qualifications of the successful candidate. Requirements: Ph.D. in Geology or closely related field or show that they will complete all degree requirements by the time of appointment. Assistant Professor rank: Postdoctoral experience is preferred. The applicant should demonstrate the existence of, or potential for developing, an innovative externally funded research program and the ability to obtain external funding. The applicant should have a superior publication record and be familiar with coal basin analysis, coal bed methane and carbon sequestration, or other coal-related fields. The successful candidate will be expected to develop new courses in the geology of coal, coal bed methane, and carbon sequestration. Candidates are expected to be actively involved in graduate and undergraduate teaching. Candidates should be a strong candidate for a tenure-track faculty position and to increase its potential to serve as an advisor to graduate students. Women and minorities are encouraged to apply. For applications, submit a letter of application, curriculum vitae, three letters of recommendation, and teaching statement to: Search Committee Chair Dr. Johan Liebenths, Department of Geology, Mail Code 4324, Southern Illinois University, Carbondale, IL 62901. Fax: +1-618-453-474-2065, fax +1-850-857-6036, or e-mail liebens@uwf.edu.

Review of applications will begin December 14, 2007, and will continue until the position is filled.

The University of West Florida is an Equal Opportunity/Access/Affirmative Action Employer. Minorities and women are encouraged to apply.

UNIVERSITY OF KENTUCKY, GEOPHYSICS

The Department of Earth and Environmental Sciences at the University of Kentucky invites applications for a tenure-track faculty position in Geophysics, beginning August 15, 2008. The successful candidate will be expected to develop and maintain an innovative externally funded research program, teach courses in geophysics, and serve on university-level committees.

Requirements: Ph.D. in geophysics or closely related field or show that they will complete all degree requirements by the time of appointment. Assistant Professor rank: Postdoctoral experience is preferred. The applicant should demonstrate the existence of, or potential for developing, an innovative externally funded research program and the ability to obtain external funding. The applicant should have a superior publication record and be familiar with geophysical imaging, exploration, or environmental geophysics. The applicant should have a superior publication record and be familiar with geophysical imaging, exploration, or environmental geophysics.

The University of Kentucky is an Affirmative Action employer, and applications from minorities and women are encouraged to apply. For applications, submit a letter of application, curriculum vitae, teaching statement, three letters of recommendation, and a research statement to: Chair, Geophysics Search Committee, Department of Earth and Environmental Sciences, University of Kentucky, Lexington, KY 40506-0535. E-mail: woolery@uky.edu.

Interested applicants should submit their curriculum vitae, a brief statement of research and teaching interests, copies of relevant research publications, and at least three letters of recommendation to: Dr. Edward W. Woolery, Search Committee Chair, Department of Earth and Environmental Sciences, 101 Stone Research Building University of Kentucky, Lexington, KY 40506-0535. E-mail: woolery@uky.edu.

The University of Kentucky is an Equal Opportunity/Affirmative Action employer and is committed to building a culturally diverse and representative workforce. Applications will continue to be accepted until the position is filled. Women, minorities, and individuals with disabilities are encouraged to apply.

DIVISION DIRECTOR, DIVISION FOR EARTH SCIENCES
NATIONAL SCIENCE FOUNDATION, ARLINGTON VA
NSF's Directorate for Geosciences (GEO) seeks candidates for the position of Division Director in the Division of Earth Sciences (EAR). This position will be filled as a career appointment, a one-to-three year Limited Term Appointment, or on an Intergovernmental Personnel Act (IPA) assignment basis.

The Division Director's primary responsibilities include providing leadership and direction for research and education in the earth sciences, which include geology and environmental geosciences, oceanic geosciences, space science, sedimentary geology and paleobiology, geomorphology and land use dynamics, geophysics, petrology and geochemistry, and instrumentation and facilities, continental dynamics and EarthScope. The Division Director allocates resources and oversees the evaluation of proposals, awardee performance, and awards and declinations, and represents the NSF to relevant external groups. Information about EAR and its programs may be found at www.gsc.tu. Edu, and NSF's programs are available at www.nsf.gov. Applications must be received by November 16, 2007, to receive full consideration, though the search will remain open until a suitable candidate is selected.

Clemson University is an AA/EEO employer and does not discriminate against any person or group on the basis of race, color, national origin, sex, age, disability, or veteran status.
the basis of age, color, disability, gender, national origin, race, religion, sexual orientation or veteran status.

**TENURE-TRACK FACULTY POSITION**

**PHYSICAL GEOGRAPHY, UNIVERSITY OF KANSAS DEPARTMENT OF GEOGRAPHY**

The Department of Geography (www.geog.ku.edu) at the University of Kansas invites applications for a tenure-track, Assistant Professor position in Physical Geography, expected to begin August 18, 2008. Specific teaching and research interests are to focus on soils and geomorphology. Applicants are expected to hold a Ph.D. in physical geography (or a closely related discipline) by the start date of appointment. Applicants must have a proven record of independent research expertise in soils and geomorphology; the ability to develop and sustain a high-quality, externally-funded research program; and teaching and communication skills. Specific duties for the position include: (1) engaging in scholarly activity/research, (2) teaching at the undergraduate and graduate levels, (3) service and advising responsibilities normally expected of university faculty. The successful candidate will be expected to support existing curricula in the Geographic Sciences (GIS), and other programs within the Geography Department and at the University of Kansas. Salary is competitive with those at other research universities.

For a copy of the full position announcement, see http://www2.ku.edu/~clas/employment/. A letter of interest, teaching and current research interests, vita, graduate transcripts, selected publications/papers, teaching portfolio if available (with evaluations or summaries), and three letters of reference should be sent to: William C. Johnson, Chair, Physical Geography Search Committee, Department of Geography, University of Kansas, 1475 Jayhawk Blvd., Rm. 213, Lawrence, KS 66045-7613, +1-785-864-5143. Initial review of applications begins November 15, 2007, and will continue until the position is filled. Women and minority candidates are specifically invited and encouraged to apply. EO/AA Employer.

**NORTH DAKOTA STATE UNIVERSITY**

The Department of Geosciences at North Dakota State University invites applicants for a tenure-track appointment to begin August 2008. We seek a colleague with research expertise in Quaternary sedimentology, Quaternary geology, and/or surface process geology to expand and complement our existing strengths in Quaternary science. Research at NDSU is considered a vital component of both undergraduate and graduate education. The successful candidate will contribute to this research-enriching effort by developing a vigorous, externally funded, research program, and by supervising students in an Environmentally Dedicated Graduate Program. Applicants must possess strong English oral and written communication skills, and will demonstrate the qualifications and/or ability to teach courses in sedimentological-stratigraphic, structural geology, and introductory geology. A Ph.D. is required at the time of appointment, and postdoctoral experience is preferred. Applicants should submit a CV, a description of research goals, a statement of teaching interests/qualifications, academic and/or postdoctoral experience is preferred. Applicants should be strongly committed to excellence in teaching and advising, and to working in an environmentally dedicated Department and at the University of Kansas. Salary is competitive with those at other research universities.

For a copy of the full position announcement, see http://www2.ku.edu/~clas/employment/. A letter of interest, teaching and current research interests, vita, graduate transcripts, selected publications/papers, teaching portfolio if available (with evaluations or summaries), and three letters of reference should be sent to: William C. Johnson, Chair, Physical Geography Search Committee, Department of Geography, University of Kansas, 1475 Jayhawk Blvd., Rm. 213, Lawrence, KS 66045-7613, +1-785-864-5143. Initial review of applications begins November 15, 2007, and will continue until the position is filled. Women and minority candidates are specifically invited and encouraged to apply. EO/AA Employer.
but not restricted to hydrostratigraphy, hydrogeocology, freshwater sciences, climate dynamics, hillslope and fluvial geomorphology, geochemistry and biogeochemistry, and geodynamics. Opportunities for tenure-track positions may exist with the UNM-administered Long-Term Ecological Research site and the UNM Water Resources Program, which cover a large stretch of the state’s desert.

For more information about our program, please see our Web site at http://www.unm.edu/eps or contact our Search Committee Chair, Dr. Mary L. Bunch, an expert on thermodynamics, biogeochemistry, and human stress. We encourage applications from individuals with diverse backgrounds.

For further information, please contact the Search Committee Chair, Prof. Dork D. Mohanty, Department of Geology, University of Nebraska-Lincoln, Nebraska 68828-0902, USA, telephone +1-402-472-6986, fax +1-402-472-1056, E-mail: dork.mohanty@unl.edu.

We are an Affirmative Action/Equal Opportunity Employer and do not discriminate on the basis of sex, race, color, national origin, religion, age, disability, or sexual orientation.

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**UNIVERSITY OF CALIFORNIA, SANTA CRUZ TENURE-TRACK POSITION IN GEOLOGY**

The Department of Earth and Planetary Sciences (EPS) seeks applicants for a tenure-track position in Geology. The position will begin Fall 2008 or Spring 2009, and the starting date is negotiable. EPS has a strong core of faculty and post-docs with research interests in geomicrobiology, biogeochemistry, and paleoecology. EPS also maintains active research programs in geomicrobiology, biogeochemistry, paleoecology, paleobiogeochemistry, or paleoclimatology, which should complement current program strengths and help us develop a vigorous externally funded research program. We especially welcome candidates who can contribute significantly to both the undergraduate and graduate research programs at UCSC, and who can contribute, through their research, teaching, and service, to the diversity and excellence of the academic community.

*Required Qualifications*:

- Ph.D. in Geology or related field.
- Post-doctoral experience.
- Strong research program in the field of paleoclimatology, and to carry out a vigorous research program that involves both undergraduate and graduate students.

*Desired Qualifications*:

- Evidence of commitment to excellence in teaching at the undergraduate and graduate levels.
- Evidence of commitment to diversity, ideally with observations and model directed toward understanding the processes that control the behavior of the global environment and its response to natural and anthropogenic forcing at geo-logic to modern time scales. Fields of interest include, but are not limited to biogeochemistry, climatology, oceanography, glaciology, geobiology, and ecosystem ecology. We expect the successful candidate to develop a vigorous externally funded research program, teach a course in their field of expertise, contribute to our undergraduate and graduate curricula, and mentor Ph.D. M.S., and undergraduate students.

*Additional Information*:

- Electronic applications are encouraged. Applicants should submit a letter of application, curriculum vitae, statement of research and teaching interests, up to 3 reprints, and the names of three references to Prof. Dork D. Mohanty, Department of Geology, University of California, Santa Cruz, CA 95064.

- The University of California is an Affirmative Action/Equal Opportunity Employer. Women and minorities are encouraged to apply.

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**CLASIFIED ADVERTISING**

The Department of Geology at Baylor University invites applications for a tenure-track open-rank (Assistant to Full Professor) faculty position in the general area of geobiology, to begin Fall 2008. The Department currently consists of 13 full-time faculty members that are currently engaged in studies in the Earth & Planetary Sciences Dept. MSC 03-2040, 1 University Station, Waco, Texas 76798-2040. For further information, please see the website at http://epswww.unm.edu.

The Department of Geology at Baylor University invites applications for a tenure-track open-rank (Assistant to Full Professor) faculty position in the general area of paleoclimatology, and to carry out a vigorous research program that involves both undergraduate and graduate students. Additionally, the successful candidate will contribute to the diversity and excellence of the academic community.

*Required Qualifications*:

- Ph.D. in Geology or related field.
- Post-doctoral experience.
- Strong research program in the field of paleoclimatology, and to carry out a vigorous research program that involves both undergraduate and graduate students.

*Desired Qualifications*:

- Evidence of commitment to excellence in teaching at the undergraduate and graduate levels.
- Evidence of commitment to diversity, ideally with observations and model directed toward understanding the processes that control the behavior of the global environment and its response to natural and anthropogenic forcing at geo-logic to modern time scales. Fields of interest include, but are not limited to biogeochemistry, climatology, oceanography, glaciology, geobiology, and ecosystem ecology. We expect the successful candidate to develop a vigorous externally funded research program, teach a course in their field of expertise, contribute to our undergraduate and graduate curricula, and mentor Ph.D. M.S., and undergraduate students.

*Additional Information*:

- Electronic applications are encouraged. Applicants should submit a letter of application, curriculum vitae, statement of research and teaching interests, up to 3 reprints, and the names of three references to Prof. Dork D. Mohanty, Department of Geology, University of California, Santa Cruz, CA 95064.

- The University of California is an Affirmative Action/Equal Opportunity Employer. Women and minorities are encouraged to apply.

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**BLOOMSBURG UNIVERSITY OF PENNSYLVANIA DEPARTMENT OF GEOGRAPHY AAND ENVIRONMENT TENURE TRACK FACULTY POSITION**

Bloomington University of Pennsylvania (BU) invites applications for a full-time, tenure-track position at the Assistant Professor level to teach introductory and upper level courses in Water Resources Engineering, Geology, and Geography. The successful candidate will be expected to develop and maintain an externally funded research program, teach a course in their field of expertise, and contribute to our undergraduate and graduate curricula, and mentor Ph.D. M.S., and undergraduate students.

*Required Qualifications*:

- Ph.D. in a related field. All Ph.D.s must be completed prior to 09/08/08.
- Candidates for either position must have a Ph.D. in a related field. All Ph.D.s must be completed prior to 09/08/08.
- Candidates must communicate well and successfully complete an interview process, as judged by the department faculty. The University expects candidates to teach a minimum of 24 credits in both the regular, full-time faculty position. The successful candidate must prove evidence of potential for high quality teaching, research, and service. The University expects candidates to develop and maintain an externally funded research program, and to contribute to our undergraduate and graduate curricula, and mentor Ph.D. M.S., and undergraduate students.

*Additional Information*:

- Electronic applications are encouraged. Applications should include a letter of application, curriculum vitae, statement of research and teaching interests, up to 3 reprints, and the names of three references to Prof. Dork D. Mohanty, Department of Geology, University of California, Santa Cruz, CA 95064.

- The University of California is an Affirmative Action/Equal Opportunity Employer. Women and minorities are encouraged to apply.

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**BLOOMSBURG UNIVERSITY OF PENNSYLVANIA DEPARTMENT OF GEOGRAPHY AND ENVIRONMENT TENURE TRACK FACULTY POSITION**

The Department of Geography and Environment at Bloomsburg University invites applications for a full-time, tenure-track position at the Assistant Professor level to teach introductory and upper level courses in Water Resources Engineering, Geology, and Geography. The successful candidate will be expected to develop and maintain an externally funded research program, teach a course in their field of expertise, and contribute to our undergraduate and graduate curricula, and mentor Ph.D. M.S., and undergraduate students.

*Required Qualifications*:

- Ph.D. in a related field. All Ph.D.s must be completed prior to 09/08/08.
- Candidates for either position must have a Ph.D. in a related field. All Ph.D.s must be completed prior to 09/08/08.
- Candidates must communicate well and successfully complete an interview process, as judged by the department faculty. The University expects candidates to teach a minimum of 24 credits in both the regular, full-time faculty position. The successful candidate must prove evidence of potential for high quality teaching, research, and service. The University expects candidates to develop and maintain an externally funded research program, and to contribute to our undergraduate and graduate curricula, and mentor Ph.D. M.S., and undergraduate students.

*Additional Information*:

- Electronic applications are encouraged. Applications should include a letter of application, curriculum vitae, statement of research and teaching interests, up to 3 reprints, and the names of three references to Prof. Dork D. Mohanty, Department of Geology, University of California, Santa Cruz, CA 95064.

- The University of California is an Affirmative Action/Equal Opportunity Employer. Women and minorities are encouraged to apply.
Applications received after this date may not be considered. Positions are open until the posting is filled. Please see on-line posting for instructions for mailing three letters of recommendation. On-campus interviews with finalists are expected to commence in mid-January 2008. For information about the Physics Department please see www.calpoly.edu/~phys. For questions please contact the Physics Dept. at +1-805-756-1752, or physics@calpoly.edu. Cal Poly is strongly committed to achieving excellence through cultural diversity. The university actively encourages applications and nominations of all qualified individuals. EEO.

HYDROLOGIST/HYDROGEOLOGIST FACULTY POSITION, UTAH VALLEY STATE COLLEGE

The Department of Earth Science at Utah Valley State College (to become Utah Valley University in July 2008) seeks to hire a hydrologist/hydrogeologist in to a tenure-track position to begin in August 2008. The successful candidate will teach courses in hydrology and environmental geology, and other courses of the candidate’s choice as agreed upon with the Department Chair (possibly including courses in introductory geology, introductory meteorology, GIS, environmental law, and natural resources management). The successful candidate will also be expected to stay active and up to date in the field of hydrology/hydrogeology through some combination of supervision, research of undergraduate research, professional work, activity in professional organizations, and/or continuing education.

The position requires a Ph.D. in hydrology, hydrogeology, or a closely-related field. The successful candidate will have knowledge of both surface water and groundwater processes, knowledge of environmental issues related to hydrology, and skills applying computer modeling and GIS to hydrologic investigations. Demonstrable commitment to undergraduate education, undergraduate research, and practical experience will be considered in our assessment of candidate qualifications.

The Department of Earth Science at UVSC offers a Bachelor of Science in Earth Science, with concentrations in geology and geoscience management (see www.uvsc.edu/ssh/earth/index.html for details). Our campus is very well-suited for conducting hydrologic field work into courses. There are five ground water monitoring wells on our campus, as well as a wetland area with seasonal surface flow. Within 45 minutes of campus are hot-water and cold-water springs, in both bedrock and alluvium, and a variety of streams in alpine and valley settings. The UVSC Earth Science faculty has strong ties with other colleges and universities in the area (including the University of Utah and Brigham Young University) and with the professional hydrologic community in Utah.

To apply for the position, visit www.uvsc.edu. Click on “Search Postings” and then choose “Earth Science” from the department drop-down menu. Applications will be reviewed starting on December 17. Contact Dr. Daniel Horns (hornsda@uvsc.edu) for more information. UVSC is an affirmative action/equal opportunity employer, with a strong commitment to diversity. Women, minorities and individuals with disabilities are encouraged to apply.

ASSISTANT PROFESSOR IN GEOGEOGRAPHICS UNIVERSITY OF FLORIDA

The Department of Geological Sciences, University of Florida, invites applications from outstanding scientists for a tenure-track faculty position in geogeochemistry at the Assistant Professor level, to start fall 2008. We seek a creative scientist committed to high standards in research and teaching to complement Departmental research in tectonics, geomagnetism, seismology, geochemistry, and surficial processes. The successful candidate will have an established record of publication in peer-reviewed scientific journals, clear potential to lead an externally-funded research group, and enthusiasm for research involving highly talented and broadly diverse graduate and undergraduate students. We especially encourage applicants with expertise in any aspect of physical or chemical geodynamics, from core to surface, involving integration of quantitative modeling and field observations. For more information visit http://geol.ufl.edu/search.html.

Applicants should hold a Ph.D. at the time of application, and supply (a) a curriculum vitae, including publication list and details of current research funding; (b) a statement of teaching experience and interests; (c) a summary of current research activities and future goals, including a statement describing potential links with existing programs in the Department of Geological Sciences at UF; (d) contact information for at least three established scientists who are willing to supply letters of reference.

To ensure full consideration, applications should be submitted by 19 Dec. 2007 to the Search Committee chair, R. M. Russo, russo@ufl.edu, Department of Geological Sciences, P.O. Box 112120, 241 Williamson Hall, University of Florida, Gainesville, FL, 32608, USA; phone +1-352-392-2231; fax +1-352-392-9294. Evaluation of candidates will begin on the closing date and continue until the position is filled.

The University of Florida is an equal opportunity institution dedicated to building a broadly and inclusive faculty and staff.

GEOGEOGRAPHICS, SKIDMORE COLLEGE

FULL-TIME TEACHING ASSOCIATE

Description: The Geosciences Department invites applications for a full-time Teaching Associate to begin Fall 2008. This position requires teaching four sections of GE 101: Earth Systems Science laboratories in the Fall Semester and three sections of GE 102: The History of Earth, Life, and Global Change laboratories in the Spring. The Department seeks a candidate with strong teaching skills who will engage students in the laboratory classroom and in the field. A three-year renewable contract is attached to this position. Skidmore College is a liberal arts institution of approximately 2,200 students and 200 full-time faculty, located in upstate New York. Preference will be given to those candidates with teach-

Buy online at www.geosociety.org
ASSISTANT PROFESSORSHIP IN MINE

ASSISTANT PROFESSORSHIP IN MINERALOGY/GEOCHEMISTRY

The Department of Geology invites applications for a tenure-track Assistant Professorship in Mineralogy with complementary expertise in either geochemistry, low or high-temperature diagenesis, or petrography/petrol-
yogy. The department currently has 80 undergraduate majors, 25 MS students and 12 full-time faculty. Fullerton’s location offers convenient access to national parks, mountain, and coastal environments, providing many opportunities for field-based research and instruction. Applications will be accepted until the position is filled.

To apply, please send (1) a detailed curriculum vita; (2) a letter of application; (3) a teaching statement; (4) a description of the requirements, go to http://diversity.fullerton.edu/ for further information.

DEPARTMENT OF GEOLOGICAL SCIENCES

COLLEGE OF NATURAL SCIENCE & MATHEMATICS

CALIFORNIA STATE UNIVERSITY—FULLERTON

The Department of Geological Sciences at California State University—Fullerton invites applications for a ten-
ure-track Assistant Professor in Geochemistry beginning August 2008. The successful candidate is expected to develop an active, field-based, externally-funded research program in field-based research and instruction. Applications will be accepted until the position is filled.

The Department places a strong emphasis on field-
based research including hydrochemistry, geochemistry, and in area of expertise, is required. A Ph.D. in Hydrogeology or related area is required.

The Department offers undergraduate degrees in Geology and Geography and MS and Ph.D. degrees in Geology. Mailing address is Box 3753, Baylor University, Waco, TX 76798-3753. Baylor University is an Equal Opportunity/Affirmative Action employer and is committed to diversity in the classroom. Applications are accepted until the position is filled.

To apply, please send (1) a detailed curriculum vita; (2) a letter of application; (3) a teaching statement; (4) a description of the requirements, go to http://diversity.fullerton.edu/ for further information.

DEPARTMENT OF GEOLOGY

BAYLOR UNIVERSITY

The Department of Geology at Baylor University invites applications for a full-time, tenure-track Assistant or
ASSISTANT PROFESSORSHIP IN MINE

ASSISTANT PROFESSORSHIP IN MINE

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ASSISTANT PROFESSORSHIP IN MINE
includes: a discussion of relevant course work and/or experience in preparation for teaching, a list of courses you would feel comfortable teaching, and a statement of your research and teaching interests. (4) A statement of your research plans and goals; and (5) letters of recommendation from at least three references familiar with your teaching, research, and service. Applicants and referees should send materials directly to: Search Committee Chair, Geophysical Sciences, Department of Geosciences, Center, University of Maine, Orono, Maine, 04469. The anticipated starting date is September 1, 2008. Review of applications will continue until the position is filled. The University of Maine is an Equal Opportunity/Affirmative Action employer.

GEOLOGY, UNIVERSITY OF KANSAS

The Department of Geology and Geophysics at the University of Kansas seek applicants for an academic year, tenure- track faculty position. We seek an outstanding colleague whose research addresses fundamental problems related to glaciology and the environmental science related to glacial/Quaternary research mission, and who will complement existing programs in behavior of ice sheets, rates of geological processes, and climate change. Individuals with expertise in numerical modeling of ice sheets, remote sensing of ice sheets, landscape evolution, cosmogenic nuclide dating, and ocean-ice- atmosphere models are particularly encouraged to apply. The successful candidate will be expected to establish an externally funded research program that directly contributes to teaching graduate and undergraduate students, including courses in glaciology. Refer to www.geo.ku.edu and links to the Geophysics Faculty Search Chair, Department and the University of Kansas. This faculty position will directly support the National Snow and Ice Data Center and the role of polar ice sheets in sea-level change. CREIS is an NSF-funded Science and Technology Center established to fill a substantial additional description of that effort. The academic affiliation is expected to be with the Department of Geology, and approval for teaching will be possible. Appointment is expected to begin August 18, 2008.

Applicants should be expected to have a Ph.D. or terminal degree in geology or a related field by the start date of the appointment. For full position announcement, see http://www2.ku.edu/class/employment or http://www.geo. ku.edu. A letter of application outlining research and teaching interests, a complete curriculum vita, and names and contact information of at least three persons, who can be contacted for letters of reference, should be sent to Doug Walker, Department of Geology, 1475 Jayhawk Blvd., Rm. 120, Lindley Hall, University of Kansas, Lawrence, KS 66045-2124 (+1-785-864-2735, fax +1-785-864-5276, e-mail: dwalker@ku.ku.edu). Initial review of completed applications will begin on January 15, 2008, and will continue until the position has been filled. EO/AA employer. The University is committed to increasing the ethnic and gender diversity of its faculty, and we strongly encourage women and minority candidates to apply.

UNIVERSITY OF MICHIGAN

FACULTY POSITION, SOLID EARTH GEOPHYSICS

The Department of Geological Sciences at the University of Michigan invites applications for a tenure-track position as an assistant professor in low temperature aqueous geochemistry. We seek candidates with interests that complement existing strengths in glacial/Quaternary geochemistry, and potential for interdisciplinary and collaborative ecosystem-based research. A successful candidate will be responsible for (1) teaching an undergraduate environmental geology course and two other courses on aqueous geochemistry at undergraduate and graduate levels, (2) supervising graduate and undergraduate research projects, and (3) contributing to a collaborative ecosystem-based research program. The position has historically been a critical position for research on environmental geochemistry of surface waters and watersheds with close ties to state and federal regulatory agencies, and it has enjoyed both a national and international reputation. The successful candidate will be expected to establish a research program that complements existing strengths in the research on the structure and dynamics of the Solid Earth. The preferred start date is Fall 2008. The successful candidate will be expected to contribute to undergraduate/graduate teaching, including a graduate/graduate course in glacial/Quaternary geology, and make a difference!

ASSISTANT PROFESSOR, ENVIRONMENTAL GEOGRAPHY

SOKA UNIVERSITY OF AMERICA

ALISO VIEJO, CALIFORNIA

Soka University of America, a private, non-profit, liberal arts university located in southern California, seeks an assistant professor of Environmental Geography to be part of a new interdisciplinary Environmental Studies program. The successful candidate should have expertise in student-centered learning with a focus on preparing undergraduate students to be life-long learners and will teach courses in earth and environmental sciences. Such courses may include introductory earth sciences, soil science, environmental geography, geomorphology, atmospheric science, global climate change, urban and regional geography, geological field methods and other courses according to the applicant’s background and expertise. The ability to teach courses in GIS would be an asset. A strong commitment to undergraduate education and a program of faculty/student research is expected. A research focus on the environmental dimensions of Earth Systems science is a plus and preference will be given to candidates with a broad, multidisciplinary approach to environmental questions.

Applications must be postmarked before January 18, 2008. Candidates must mail a curriculum vitae, a statement of teaching and research interests, examples of published work, and names and contact information of at least three current references to Dr. John L. Isbell, Search Committee Chair, Department of Geosciences, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, WI 53201 (Fax: +1-414-229-5452; e-mail: jsb3@uwm.edu). The University of Wisconsin-Milwaukee is an Equal Opportunity/Affirmative Action Employer.

The University of Wisconsin-Milwaukee is a large research oriented institution located on the north side of Milwaukee. The Department of Geosciences offers B.S., B.A., M.S., and Ph.D. degree programs and is staffed by 12 full-time faculty. Southeastern Wisconsin has easy access to many classic Quaternary glacial sites.

ASSISTANT PROFESSOR, ENVIRONMENTAL GEOLOGY

SOKA UNIVERSITY OF AMERICA

ALISO VIEJO, CALIFORNIA

Soka University of America, a private, non-profit, liberal arts university located in southern California, seeks an Assistant Professor of Environmental Geology/Geography to be part of a new interdisciplinary Environmental Studies program. The successful candidate should have expertise in student-centered learning with a focus on preparing undergraduate students to be life-long learners and will teach courses in earth and environmental sciences. Such courses may include introductory earth sciences, soil science, environmental geography, geomorphology, atmospheric science, global climate change, urban and regional geography, geological field methods and other courses according to the applicant’s background and expertise. The ability to teach courses in GIS would be an asset. A strong commitment to undergraduate education and a program of faculty/student research is expected. A research focus on the environmental dimensions of Earth Systems science is a plus and preference will be given to candidates with a broad, multidisciplinary approach to environmental questions.

Applications must be postmarked before January 18, 2008. Candidates must mail a curriculum vitae, a statement of teaching and research interests, examples of published work, and names and contact information of at least three current references to Dr. John L. Isbell, Search Committee Chair, Department of Geosciences, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, WI 53201 (Fax: +1-414-229-5452; e-mail: jsb3@uwm.edu). The University of Wisconsin-Milwaukee is an Equal Opportunity/Affirmative Action Employer.

The University of Wisconsin-Milwaukee is a large research oriented institution located on the north side of Milwaukee. The Department of Geosciences offers B.S., B.A., M.S., and Ph.D. degree programs and is staffed by 12 full-time faculty. Southeastern Wisconsin has easy access to many classic Quaternary glacial sites.

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Opportunities for Students

GDL Foundation Scholarships in Structure and Diagenesis. The GDL Foundation supports study and research that looks at chemical and mechanical interactions, or structural diagenesis, in sedimentary basins. Practical applications of this work are of particular interest.

We are currently seeking applications from M.S. and Ph.D. candidates for one-year scholarships up to $5,000. Amounts awarded are based on specific proposals for research as well as participation in professional meetings and conferences where this work is shared with others. Completed applications are due on or before November 26, 2007. Successful applicants will be notified by December 10, 2007.

Applications available at: www.gdlfoundation.org. Direct questions to info@gdlfoundation.org.

Graduate Student Opportunities: The Department of Geological Sciences at Case Western Reserve University (www.case.edu) is seeking qualified students for its graduate program. Current research strengths in the department include: surface processes, soil erosion, sediment transport, geologic sequestration of carbon, geohazard assessment, planetary materials, planetary geology and geophysics, and high-pressure mineral physics and chemistry. Financial assistance may be available for qualified applicants interested in pursuing M.S. or Ph.D. degrees. For more information, please see http://geology.case.edu or contact the department at geogradinfo@case.edu.

Applications for graduate study at Case are accepted on a rolling basis, though students requesting financial assistance in Fall 2008 are encouraged to apply by February 1, 2008. Case is committed to diversity and equality. Students from all backgrounds are encouraged to apply.

New Mexico Highlands University, Graduate Assistantship. Graduate assistantships are available for students wishing to pursue an MS in Geology beginning Fall 2008 term. The NMHU Environmental Geology Program offers a field-intensive curriculum emphasizing earth materials, mineral-rock-water interactions, environmental geophysics, and natural geologic hazard assessment. Program strengths are in mineralogy, petrology, geochemistry, rock-paleomagnetism, structural geology, volcanology, and collaborative endeavors with the Forestry Program and the new Forest and Watershed Restoration Institute. Nestled in the foothills of the Sangre de Cristo Mountains, Highland’s campus has been cited as one of New Mexico’s best-kept secrets. A low student-faculty ratio, state-of-the art laboratory facilities, and committed faculty provide students with a superior learning experience. The graduate assistantship includes a stipend of $10,100 and tuition waiver per academic year. Application review begins 01/15/08. For more information, contact Dr. Michael Petronis, Department of Forestry Program and the new Forest and Watershed Restoration Institute.

USGS Mendenhall Postdoctoral Research Fellowship Program (Fiscal Year 2009)

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 including: shale-gas resource potential; climate change; karst geomorphology and hydrology; greenhouse gas fluxes from the land/sea margin; coastal change; mapping 3D distribution of hydrogeologic properties; geological materials and human health; applications of airborne gravity gradient measurements; petroleum system processes; unconventional energy resources; earthquake simulations; uncertainty assessments; tsunamigenic earthquakes; detection of anomalous hydrothermal and volcanic activity; rates of magma production; geologic storage of carbon dioxide; modeling debris flows and rock avalanches; urban hazards; slip rate indicators; risk and vulnerability of communities to natural hazards; applied remote sensing; dynamics of volcanic tephra plumes; landforms associated with active faults; landscape change; valuating landscape and ecological services.

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.

Program Contacts: Dr. Rama K. Kotra, rkotra@usgs.gov, 703-648-6271; Ms. Sarah Griffin-Bemis, sggriffin@usgs.gov, 703-648-7395.

U.S. Department of the Interior
U.S. Geological Survey
Positions are available beginning April or September 2008. The department offers a competitive program leading to an MS degree in Geological Sciences with areas of emphasis including hydrogeology, geochemistry, geomorphology, paleontology, stratigraphy/sedimentology, planetary geology, geophysics, and tectonics. Prospective students are encouraged to contact faculty directly to discuss potential research topics. Qualified students are eligible to receive teaching assistantships that carry a tuition waiver and a stipend of $12,150/year. Students are eligible to receive teaching assistantships directly to discuss potential research topics. Qualified students are eligible to receive teaching assistantships that carry a tuition waiver and a stipend of $12,150/year.

Prospective students are encouraged to contact faculty directly to discuss potential research topics. Qualified students are eligible to receive teaching assistantships that carry a tuition waiver and a stipend of $12,150/year. For program and application information, visit the department Web site at www.ohiou.edu/geology/ or contact the graduate chair, Greg Springer (springeg@ohio.edu), for additional information.

Graduate Student Opportunities, Ohio University. The Department of Geological Sciences at Ohio University is seeking qualified students for its graduate program. Positions are available beginning April or September 2008. The department offers a competitive program leading to an MS degree in Geological Sciences with areas of emphasis including hydrogeology, geochemistry, geomorphology, paleontology, stratigraphy/sedimentology, planetary geology, geophysics, and tectonics. Prospective students are encouraged to contact faculty directly to discuss potential research topics. Qualified students are eligible to receive teaching assistantships that carry a tuition waiver and a stipend of $12,150/year.

For program and application information, visit the department Web site at www.ohiou.edu/geology/ or contact the graduate chair, Greg Springer (springeg@ohio.edu), for additional information.

Jonathan O. Davis Scholarship, Division of Earth and Ecosystem Sciences, Desert Research Institute. The family and friends of Jonathan O. Davis, a prominent Quaternary geologist and geoarchaeologist, and a DRI faculty member, have established an endowment that provides a yearly national Jonathan O. Davis Scholarship, as well as a stipend, for a University of Nevada–Reno student. Jonathan was tragically killed in an automobile accident in December 1990. It is the wish of his family and friends to support graduate students working on the Quaternary geology of the Great Basin, research close to Jonathan’s heart. The national scholarship is $4,000 and the University of Nevada–Reno stipend is $1,500.

The stipend, also administered by the Division of Earth and Ecosystem Sciences, is open to graduate students enrolled in an M.S. or Ph.D. program at any university in the United States. The stipend, also administered by the Division of Earth and Ecosystem Sciences, is open to graduate students enrolled in an M.S. or Ph.D. program at any university in the United States. In December 1990. It is the wish of his family and friends to support graduate students working on the Quaternary geology of the Great Basin, research close to Jonathan’s heart. The national scholarship is $4,000 and the University of Nevada–Reno stipend is $1,500.

Applications should include: A cover letter explaining how the individual qualifies for the award. Please include your social security number and state whether you are applying for the national scholarship or for the UNR stipend. A current résumé or vitae. A two-page, single spaced description of the thesis/dissertation research, which also clearly documents the geological orientation and research significance. Figures, tables, and references do not count against the two-page limit. A short statement on how funding would be used. A letter of recommendation from the thesis/dissertation supervisor, which emphasizes the student’s ability and potential as a Quaternary scientist.

You too can run a GSA short course! Share your unique knowledge and experience with peers, students, or earth science teachers in our dynamic annual meeting setting. Learn how to submit your short course proposal at www.geosociety.org/meetings/2008/scProposals/. Questions? Contact Jennifer Nocerino, +1-303-357-1036, jnocerino@geosociety.org.

Field trip proposal deadline: 4 December 2007.

Short course proposal deadline: 4 December 2007.
University of Wyoming

Aqueous and Environmental Geochemistry

The Department of Geology and Geophysics at the University of Wyoming invites applications for a tenure-track Assistant Professor position in the broadly defined area of aqueous and environmental geochemistry beginning in August 2008.

We are interested in promising scientists in fields of research including, but not restricted to, aqueous and environmental geochemistry, mineral-fluid interface geochemistry, microbiological geochemistry, reactive and contaminant transport, watershed chemistry and weathering, and groundwater geochemistry. The successful candidate will be involved in the undergraduate and graduate teaching mission of the Department of Geology and Geophysics, and will be expected to develop an active externally funded research program that complements and expands upon departmental strengths.

The Department of Geology and Geophysics has well-equipped and staffed laboratories for SEM, XRD, EPMA, TIMS for radiogenic isotopes, and a full range of aqueous geochemical analyses from automated titrations to ICP-MS. Several user facilities on campus afford easy access to a wide variety of analytical techniques, from stable isotope analysis to PCR. The Department of Geology and Geophysics is working closely with the newly created School of Energy Resources (SER), an institute dedicated to energy-related teaching and research in support of state, national, and international energy-related activities (including carbon sequestration, environmental impact, and renewable energy resources). The Helga Otto Haub School of Environment and Natural Resources and William D. Ruckelshaus Institute also offer venues for integrating research across disciplinary boundaries. Additional information on the Department Geology and Geophysics can be obtained at http://home.gg.uwyo.edu/. Information about the School of Energy Resources is available at http://uwacadweb.uwyo.edu/SER/ and the Haub School and Ruckelshaus Institute at http://www.uwyo.edu/ENR/enrschool.asp.

Applications should include a statement of research and teaching interests and accomplishments, curriculum vitae, and the names and contact information for three individuals who can provide letters of evaluation. Review of completed applications will begin November 1, 2007; however, applications will be accepted until January 31, 2008. Send an electronic copy of your application to: Ms. Carol Pribyl at cpribyl@uwyo.edu; if you have additional application materials to send, please direct them to the Geochemistry Search Committee, Department of Geology and Geophysics, University of Wyoming, 1000 East University Avenue, Dept. 3006, Laramie, WY 82071-2000.

The University of Wyoming is an equal opportunity/affirmative action employer.
YALE UNIVERSITY: INTERDEPARTMENTAL POSTDOCTORAL FELLOWSHIP, GEOSCIENCES
The Department of Geology and Geophysics at Yale University (www.geology.yale.edu) seeks applicants for a postdoctoral fellowship in research that links geosciences (studies of the solid earth, oceans, atmosphere, climate, and the evolution of life) with other sciences, including, for example, astronomy and astrophysics; environmental studies; physics; chemistry; biology; engineering; anthropology; medical science and public health; economics and political science.

This Postdoctoral Associate position is awarded for two years, contingent on satisfactory progress, and provides a stipend ($48,000/yr) and base research funds ($5,000/yr), plus health care benefits and expenses for relocation.

The Interdepartmental Postdoctoral Fellowship will have at least two faculty collaborators: the primary sponsor will be from Geology and Geophysics, while others are from one or more other Yale departments. Interested candidates should first contact a faculty member in Geology and Geophysics to define a research theme and to identify other appropriate faculty collaborators.

Applicants should submit a curriculum vita, a list of publications, an interdisciplinary research proposal (2–3 pages, in which the Yale collaborators are identified), and a brief letter of endorsement from each of the Yale faculty collaborators. Applicants should also arrange for three reference letters to be sent directly to the Department. The deadline for receipt of all application materials is January 2, 2008, and decisions will be announced by February 29, 2008. Successful candidates are expected to begin their program at Yale between July 1 and December 31, 2008.

Application materials and reference letters should be sent by e-mail to interdepartmental.fellowship@geology.yale.edu or by post: Interdepartmental Postdoctoral Fellowship, Yale University, Department of Geology and Geophysics, PO Box 208109, New Haven, CT 06520-8109. Yale University is an equal opportunity/affirmative action employer; applications from women and minority scientists are strongly encouraged.

YALE UNIVERSITY: BATEMAN POSTDOCTORAL FELLOWSHIPS IN GEOSCIENCES
The Department of Geology and Geophysics at Yale University (www.geology.yale.edu) announces an annual competition for one or more Bateman Postdoctoral Fellowships. We welcome applicants with research interests across the full range of disciplines within the Earth Sciences, including studies of the solid earth, oceans, atmosphere, climate dynamics, geochemistry, paleoclimatology, and the evolution of life. Each of these Postdoctoral Associate positions is awarded for two years, providing a stipend ($48,000/yr) and base research funds ($5,000/yr), plus health care benefits and expenses for relocation. Applicants should contact a sponsor in the Department to identify potential research projects, and then submit a short (2–3 pages) statement of research interests and proposed research, a curriculum vita, and list of publications. Applicants should also arrange for three reference letters to be sent directly to the Department. The deadline for receipt of all application materials is January 2, 2008, and decisions will be announced by February 29, 2008. Successful candidates are expected to begin their program at Yale between July 1 and December 31, 2008.

Application materials and reference letters should be sent by e-mail (bateman.fellowship@geology.yale.edu) or by post: Bateman Postdoctoral Fellowship, Yale University, Department of Geology and Geophysics, PO Box 208109, New Haven, CT 06520-8109. Yale University is an equal opportunity/affirmative action employer; applications from women and minority scientists are strongly encouraged.
INTRODUCTION

Coal-bed and culm-bank fires are formidable forces of nature ignited by natural phenomena, including lightning strikes and forest fires, or by human-related activities like mining accidents or burning trash in abandoned mines. Spontaneous combustion due to exothermic reactions in coal exposed during mining is especially problematic, making further mining dangerous, while polluting surrounding communities (Fig. 1; Stracher and Taylor, 2004).

COAL FIRES IN TIME AND SPACE

Uranium-thorium/helium ratios and fission-track dates from detrital zircons in clinker and unconformable relationships between baked and unbaked sedimentary rocks demonstrate that coal fires occurred naturally in the geologic past, dating as far back, for example, as the Pliocene in the Powder River basin of the United States (Heffern and Coates, 2004) and the Pleistocene in northwest China (Kroonenberg and Zhang, 1997).

People have mined coal for heating and cooking for thousands of years. Although written accounts of coal fires date to at least the time of Alexander the Great (Stracher et al., 2005), the worldwide proliferation of these fires has increased dramatically since the industrial revolution, especially in the major coal-producing countries, including China, the United States, India, South Africa, Russia, and Indonesia (Stracher and Taylor, 2004). Currently, thousands of coal fires are burning—some for centuries and many uncontrollably, with flames as high as 20 m and temperatures exceeding 1000 °C—from eastern Asia and northern China into the coal basins of Russia, Europe, Africa, north and south America, and Australia. The economic losses are enormous, estimated at US$125–250 million in China, and it’s projected that over US$651 million will be necessary to contain or extinguish coal fires in the United States. In India, ~1453 million tons of coal are locked up in 70 fires in the Jharia coalfield alone (Stracher, 2004, 2007a).

THE EFFECTS OF COAL FIRES

Constructive

Coal fires are constructive in that they transform landscapes, frequently generating new chemical products at the same time. Sinkholes, valleys, and slump blocks produced by volume-reduced coal during burning; chemically altered or pyrometamorphic rocks; and paralavas are the most obvious features of ancient and modern fires. Red clinker, used for landscaping and construction, in addition to coal-tar deposits and the mineralized byproducts of combustion like godovikovite and voltaite that encrust active-gas vents and fissures, are the results of complex and poorly understood thermochemical processes (Fig. 2; Stracher et al., 2005; Stracher, 2007b).

Destructive

To most people, coal fires are destructive because they consume a valuable energy resource, destroy floral and faunal habitats, and promote human suffering as a consequence of heat, subsidence, and pollution. Field measurements and laboratory analyses reveal that during burning, these fires spew carbon monoxide, benzene, toluene, and dozens of other toxins into the atmosphere and soil, along with the greenhouse gases methane (during heating of the coal) and carbon dioxide (see recorded...
values in the GSA Data Repository1). The per-annum global emissions of the components in coal-fire gas have never been quantified. However, the toxins have made people sick, sometimes fatally. Illnesses include carbon monoxide poisoning, arsenosis, fluorosis, bronchitis, stroke, lung cancer, pulmonary heart disease, and chronic obstructive pulmonary disease (Stracher and Taylor, 2004; Finkelman et al., 2002; Pone et al., 2007).

Acids, aerosols, and toxic-particulate matter released from coal fires may be transported long distances. In China, for example, such pollutants have adversely affected 88 cities, with the effects of acid rain spilling over into Japan, Korea, and the Philippines. Sulfate aerosols released from Jharia, India, fires have reduced by 15% the intensity of solar radiation reaching the Indian subcontinent. Over 200 coal fires in Pennsylvania have contributed to making it one of the leading acid-rain producers in the United States (Stracher and Taylor, 2004).

WHY STUDY COAL FIRES?

“Coal-fires science” has not been at the forefront of geologic research. The fires and their effects offer challenging opportunities for collaborative, innovative, and interdisciplinary research. For example, cost-effective methods for preventing, identifying, and extinguishing coal fires that are difficult or currently impossible to locate in underground workings need to be developed by utilizing current foam, liquid nitrogen, and newly developing fire-fighting technology. This requires collaborative expertise in economics, engineering, remote sensing, and environmental science, at the very least. Additionally, deciphering the origin of mineral assemblages formed from gas exhaled at vents or fissures associated with folded and faulted strata requires collaborative work in geochemistry, thermodynamics, mineralogy and petrology, structural geology, and instrumental analysis.

From a pedagogical perspective, currently active coal fires exemplify the uniformitarian foundation of geology because they can be studied in “real time.” Mineral assemblages nucleated at active-gas vents and fissures, for example, are useful for establishing criteria for identifying paleo-fires (Stracher et al., 2005).

COAL-FIRES RESEARCH

Coal-fires science is gaining international attention, generated by presentations at symposia and by field trips at international meetings, including the American Association for the Advancement of Science (AAAS) in Denver, Colorado, USA, in 2003; the Geological Society of America (GSA) in Denver in 2004, 2005, and 2006; and the International Conference on Coal Fires Research in Beijing, China, in 2005.

In commemoration of the AAAS meeting, a special edition of the International Journal of Coal Geology: Coal Fires Burning around the World: A Global Catastrophe presented the scientific and engineering communities in 2004 for the first time with a collection of diverse papers about these fires, including detection and containment procedures and health effects (Stracher, 2004). In December 2007, a GSA Reviews in Engineering Geology book: Geology of Coal Fires: Case Studies from Around the World, will cover a broader spectrum of topics including spontaneous combustion, greenhouse gases, mineralogy, petrology, the geophysics of coal fires, and public policy. It is my hope that this Groundwork article and these two volumes will serve as a “springboard” for generating interdisciplinary research in coal-fires science.

REFERENCES CITED


Figure 2. Fumarolic sulfur (yellow) and salammoniac (white) deposits from an active underground coal fire atop oxidized, pyrometamorphic debris (red) and coal-bearing shale (dark green to black) in a subsidence basin, Falcon Hills, Kuznetsk coal basin, western Siberia, Russia. Source: Elina V. Sokol, Russian Academy of Sciences, Novosibirsk, and Ekaterina A. Nigmatulina, Novosibirsk State University.

1GSA Data Repository item 2007283 is available at www.geosociety.org/pubs/ft2007.htm. You can also obtain a copy by writing to editing@geosociety.org.
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 8, University Station / Austin, TX 78713 or jobs@jsg.utexas.edu.

The University of Texas at Austin is an Affirmative Action / Equal Opportunity Employer
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.

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 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.
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Professor, Department of Geology & Geological Engineering
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