Limnogeology Division Newsletter
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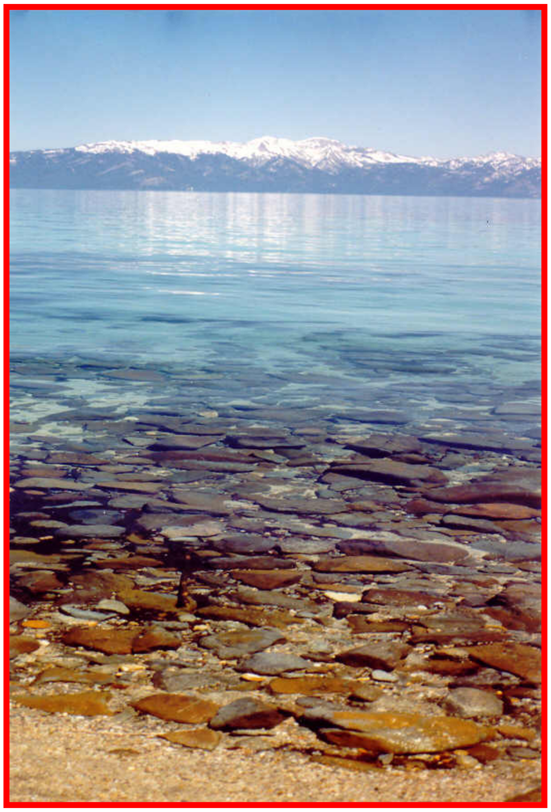

Lake Tahoe looking to Nevada from near Emerald Bay, CA (see workshop notes below)

Welcome: Welcome to the second issue of the third volume of the Limnogeology Division of the Geological Society of America (GSA). This issue is a little late (as mentioned below in the Division Chair's column) because we have decided to go to a Spring and Fall format.

This issue looks like it will be our largest so far. We have an important message from the Chair Tom Johnson about the Kerry Kelts fund, an article about Lake Malawi drilling project in Africa, written by Chris Scholz, Tom Johnson, Andrew Cohen, and B.J.A. King, our first real limnogeology article of the newsletter, an article about determining landscape evolution from Eocene lakes, written by Alan Carroll, a report on the Lake Tahoe coring workshop by Kenneth Verosub. In addition, we present the Kerry Kelts award winners for 2005. Meeting information is now available on the web, and the address is listed below. Unfortunately the article on Mars lakes did not materialize so if you were looking forward to that we are sorry for the disappointment. We are still eager to receive more articles from our Division members, especially any of you who may feel that your favorite aspect of limnogeology is not being covered sufficiently. So please give some thought to a submission.

Enjoy the newsletter, and see you in Philadelphia, I hope!

Michael Rosen, *Carson City*

Message from the Chair - Tom Johnson, Chair (2004-2006)

Greetings!

You may note that our Division newsletter is late on arrival this time, reflecting our decision to have them come out in spring and fall rather than winter and summer. The main stories in this issue are 1) the Lake Malawi drilling project, which was completed about one year ago and is now beginning to generate some very interesting results, particularly when they can be examined in the context of the Lake Bosumtwi drilling results from western tropical Africa; and 2) an Article by Alan Carroll on using Eocene lakes to determine the geomorphology and landscape evolution of the areas surrounding the lakes.

The Limnogeology Division is small, but healthy. We sponsored two highly successful and fully subscribed field trips at the GSA Annual Meeting in Salt Lake City last fall, and we have two great events in the works for the Philadelphia 06 meeting – See below under meetings! By now you have received a letter from the Division officers, encouraging you to contribute $100 to the Kerry Kelts Research Fund. We are on a campaign this year to build that fund to a $10,000 endowment. Contributing is easy – just go to the GSA web site (www.geosociety.org), click on "Donate to GSA", scroll down to the Kelts Fund, and enter in the amount you wish to donate. No pain until the credit card bill comes at the end of the month! Please do consider making a significant contribution – it will provide much needed stability to the division finances, and will allow us to better promote student research and participation in important professional activities such as the annual meeting and field trips.

While you are on the GSA website, check out the Limnogeology Division site (under "Sections and Divisions") for updates on meetings of interest, past division newsletters, and other news. Please think about submitting an article, no matter how brief, to the division newsletter. Michael Rosen, the editor, is always looking for more news to include in each issue, and the broader representation of division interests we publish, the better the product will be. Have a great summer, and I hope that I see you next fall in Philadelphia. Best wishes, ***Tom***

Limnogeology Division Awards for 2005

Three scholarships were given to students for the annual Kerry Kelts Awards. The winners were:

1) **Limnogeology** - Torrey G. Nyborg, Department of Earth and Biological Sciences, Loma Linda University. Title of his proposal is: *Depositional environment, tectonics, and animal track distribution of the Neogene fluvial-lacustrine Copper Canyon Unit, Death Valley National Park*

2) **Paleolimnology** - Christopher M. Moy, Dept. of Geological and Environmental Sciences, Stanford University. Title of his proposal is: *Latitudinal Shifts in the Southern Hemisphere Westerlies: Implications for Atmospheric* CO_2 *Through Southern Ocean Positive Feedback Mechanisms*

3) **Limnology** - Aggeliki Barberopoulou, Department of Earth and Space Sciences, University of Washington. Title of her proposal is: *How dangerous are seismic seiches: On the prediction of water wave amplitudes during strong ground shaking*

The Division wishes the winners well in their research. Many thanks for the submission of the other projects for consideration. The competition was strong this year, and we hope that as we build the Kelts fund up, there will be more submissions.

An award was given to Michael R Rosen (current secretary of the Limnogeology Division and Division Newsletter editor) for Outstanding Service to the Division, mostly for his contribution in editing the newsletter and making it the focal point of the division. *Aw Shucks! I'm glad people like the newsletter.*

Lake Malawi Feature Article

The Lake Malawi Drilling Project 2005

C.A. Scholz, Syracuse University
T.C. Johnson, University of Minnesota Duluth
A.S. Cohen, University of Arizona
B.J.A. King, University of Rhode Island

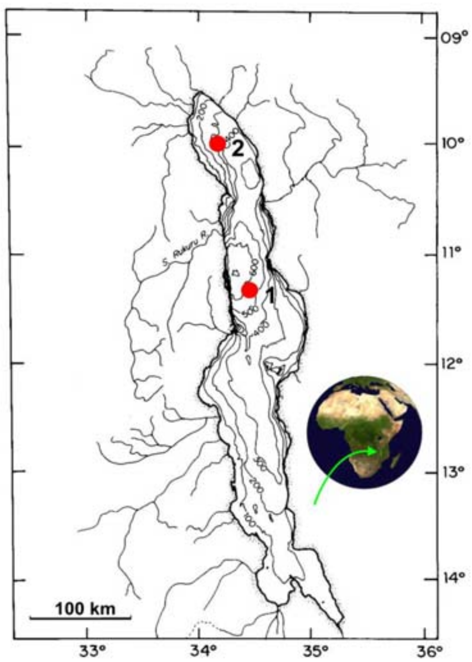

Figure 1. Bathymetry of Lake Malawi, with major river drainages and drill sites (in red).

Lake Malawi, East Africa, is one of the world's oldest and deepest lakes, and second only to Lake Tanganyika in tropical Africa. Lake Malawi is more than 550 km long, has a maximum water depth of 700 m (Fig. 1), and is estimated to be at least 5-8 million years in age.

Because of Lake Malawi's great size, depth, and remote location in interior Africa, this project posed some of the most significant challenges encountered in lake drilling. As this deep lake is landlocked, successful drilling required the construction of a dynamically positioned drilling barge in order to achieve the proposed scientific objectives.

Research efforts funded by grants from the National Science Foundation and the International Scientific Drilling Program covered four main areas:
1) Final Site Survey (November 2001), 2) Planning and Permitting of the Drilling Program (2002-2004),
3) Execution of the Drilling Program (Feb-March 2005), and 4) Initial Core Descriptions and Preliminary Analyses (June 05 – Jan 06).

1. Final Site Survey

Numerous seismic reflection surveys have been conducted on Lake Malawi over the past 20 years. From these studies the structural architecture of the Malawi Rift is now well understood, and analyses of these data sets have led to an understanding of the depositional and stratigraphic framework of the basin. Because of the great expanse of this lake, additional data were acquired in 2001 to help finalize the position of the proposed drill sites. These new data included 2200 km of single channel and multichannel data acquired with a small airgun array, as well as 1 kHz "boomer" data (Fig. 2).

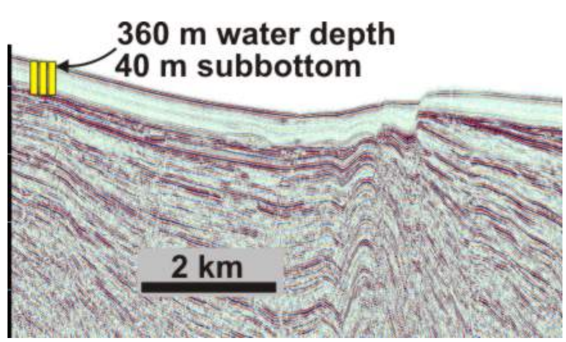

Figure 2. Single-channel airgun seismic profile acquired during 2001 site survey, with Site 2 drill core penetration superimposed (3 holes at this site).

2. Planning and Permitting

In the early phases of the project Syracuse University signed subcontracts with the University of Rhode Island for general contracting, and with DOSECC Inc. for procurement of the dynamic Positioning system. General contractor URI, under direction of Dr. Kate Moran, signed several additional sub-subcontracts for engineering and logistical support. These included subcontracts to 1) Lengeek Engineering, marine architects for the redesign of the fuel barge *Viphya*, 2) Malawi Lake Services, owners of the fuel barge adapted for the drilling project, 3) Seacore Ltd, the drilling contractor, 4) DOSECC Inc., for use of the dynamic positioning system, procurement of accommodation, galley and mess containers, and use of drilling tools, and 5) ADPS Ltd, for marine manning. Other services were provided to the project for logistical support (A.E. Oberem) and for project catering (C. Barlow).

Figure 3. Viphya drilling barge working at Site 1, central Lake Malawi.

In-country permitting was undertaken by C. Scholz, which involved ~10 weeks of meetings with Malawian authorities, over a period of three years. Because of the significant overland distances that equipment, personnel, and supplies needed to be transported along the rift valley during the course of the project, a local Malawian company was hired to proved logistical support, over a period of 1.5 years from the initial shipment of equipment in 2004 until the demobilization in April 2005.

3. Project Execution

Project mobilization commenced in August 2004, with the installation of steel foundations for the various components (DP, drilling rig, moonpool, transponder well, accommodation containers, etc.) on the Viphya Barge. This work was undertaken by Lengeek Engineering. Sea trials of the dynamic positioning system were conducted in December 2004, and in late January 2005 Seacore Ltd. began the installation of the drilling derrick aboard the barge. The scientific team, drilling team, and marine crew assembled in February 2005, and drilling commenced in March 2005. Following the completion of drilling at Site 2 at the end of March, the barge was returned to the two mobilization sites in southern Malawi (Chipoka and Monkey Bay ports).

A total of seven holes were drilled at two sites, penetrating a total of sedimentary section of nearly 650 m (380 m maximum subbottom depth in Hole 1B), with >95% recovery (see Table 1 for detailed breakdown). Based on initial age modeling of the core (see Findings section) the basal age at the deepest cored site is estimated to be 1.75 million years, and represents a continuous record. The high-resolution site (Site 2) was triple-cored back to ~100kyr BP. The deep site (Site 1) was double cored to a subbottom depth of 80 m, covering the past ~200 kyr.

4. Initial Core Descriptions and Preliminary Analyses (June 05 – Jan 06)

Between June 2005, when the sediment cores arrived at the National Lacustrine Core Repository in Minneapolis (LacCore) and the end of the grant period (January 2006), the scientific team visited the repository over three week-long intervals for initial core processing. During this time approximately 50% of the sampled core was scanned using the GEOTEK logger, split, imaged, described, and subsampled. See findings section below for further details.

Table 1. List of holes drilled during the Lake Malawi Scientific Drilling Project.

Site #	Water depth (m)	Sediment thickness cored (m)	Estimated basal age (ka)	Comments
1A	592	47.6	400	Initial Hole, Extended Nose only
1B	592	380.7	1750	Deep water, Deepest Hole, HPC+Extend. Nose
1C	592	81.1	200	Deep water, HPC, Ext. Nose
1D	592	21.0	60	Deep water, HPC, Ext. Nose
2A	359	41.1	95	Interm. water depth, laminated muds
2B	359	40.1	95	Interm. water depth, laminated muds
2C	359	37.0	75	Interm. water depth, laminated muds

Findings

Initial results from the Lake Malawi Scientific Drilling Project are based upon the 50% of the drilled core sections that have been split, imaged and analyzed to date. A preliminary age model, based on initial ^{14}C, luminescence, paleomagnetic and ^{10}Be age dates indicated that the basal age of the deep site (Hole 1B) is ~1.75 million years.

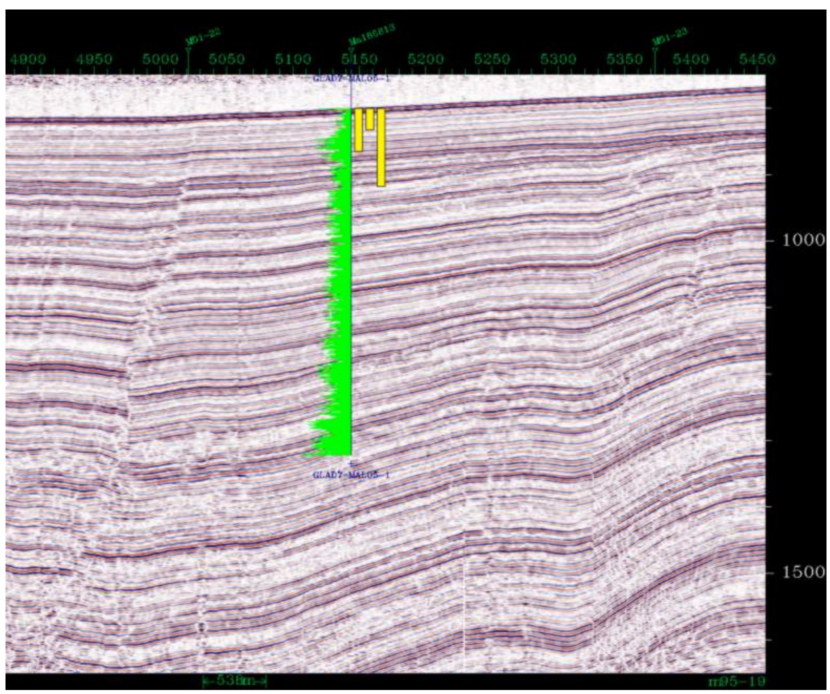

Figure 4. Seismic reflection profile from central Lake Malawi with Hole 1B GRAPE density profile superimposed. Hole 1B penetrated to 380 m subbottom, and preliminary age-dating places the bottom-hole age at ~1.75 million years. Penetration of the other three holes at this site shown in yellow.

Other important results, that need to be confirmed with additional analytic work include:

- Major changes in lake level have occurred in the Lake Malawi basin, with the amplitude of lake level change 500 m or more during some low lake stages.

- During the Last Glacial Maximum, the east African tropics were cool and dry, but in terms of lake level this was a minor event compared to much drier conditions that prevailed prior to 75 ka.

- There was a dramatic, sustained rise in the level of lake Malawi at ~70-75 kyr, that may be associated with an Africa-wide increase in P/E, as the results from drilling Malawi are consistent with new observations from Ghana and Lake Tanganyika.

- Ostracodes and other fossils are abundant in many of the carbonate bearing intervals, indicating oxic conditions at the lake floor – considerably different from today's lake, which is anoxic below 200 m depth and is undersaturated with respect to calcite. Littoral species assemblages present unambiguously demonstrate numerous lake level fluctuations of >500m throughout the lake's history.

The fact that this rise in effective moisture and lake level is temporally coincident with expansion of early modern human populations, and the African exodus needs to be considered in greater detail.

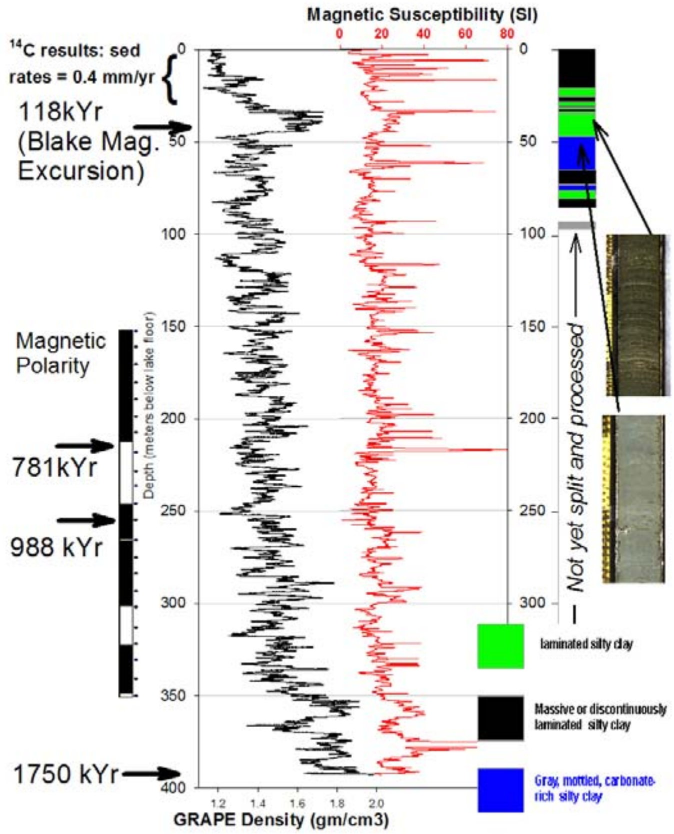

Figure 5. Hole 1B results: GRAPE density, magnetic susceptibility, select lithostratigraphy (where processed to date), paleomagnetic reversal stratigraphy, and preliminary age model, based on material processed to date. Note Brunhes-Matuyama boundary, Blake excursion.

Training and Outreach

This project provided numerous U.S. graduate and undergraduate students with research training opportunities. Four Malawian Geological Survey junior staff participated in the field program, and one of those staff (Baxter Chimlambe) visited Syracuse University in October-November 2005 and participated in sample analysis work.

Figure 6. Drilling project presentation to a northern Malawi secondary school, by Drilling Project science staff (U.S. graduate students and junior staff of the Malawi Geological Survey).

In addition to reaching our drilling objectives during the February-March field program, the project also undertook an extensive onshore outreach program, whereby every week the shore-based science team visited secondary schools and government offices in various localities in the northern part of the country.

Figure 7. A group of secondary school students hears a description of the project from Prof. Michael Talbot (science team member from Bergen) next to the Viphya barge at the project mobilization site.

Project Output

Scholz, C. A., Cohen, A. S., Johnson, T. C., and King, J. W., 2006. The 2005 Lake Malawi Scientific Drilling Project. Scientific Drilling, doi:10.2204/lodp.sd.1.04.2006.

Abstracts

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Johnson, T.C., Scholz, C.A., King, J., Cohen, A., 2005, Preliminary Results of The Lake Malawi Drilling Program, North-Central GSA meeting, Minneapolis, MN.

Johnson, T.C., Scholz, C.A., King, J., Cohen, A.S., 2005, Preliminary Results Of The Lake Malawi Drilling Project., GSA Annual Meeting, Salt Lake City, UT.

King, J., Heil, C., Peck, J., Scholz, C., Shanahan, T., and Overpeck, J.T., 2005, Use of Paleomagnetic Secular Variation, Excursion, and Reversal Records to Correlate African Lake Climate Records, AGU Fall meeting abstract.

Mortimer, E., Paton, D., Scholz, C., Strecker, M., 2005, Tectonic Evolution of the Northern Malawi rift, East Africa: Structural Controls on Sediment Dispersal in a Large Lake Basin, AGU Fall meeting abstract.

Lyons, R P., Scholz, C A., King, J W., Johnson, T C., Cohen, A S., 2005, Correlations of Scientific Drillcores and Seismic Reflection Data from Lake Malawi, Africa., AGU Fall meeting abstract.

Paulson, M., Moran, K., Lengeek, M., Jeffery, P., Frazer, A., and Scholz C. Scientific Drilling and Coring in Lake Malawi, Africa, 2006 Offshore Technology Conference, extended abstract OTC 18117.

Scholz, C.A., 2005, Initial Results of the Lake Malawi and Lake Bosumtwi Scientific Drilling Projects: Implications for Early Modern Human Population Dynamics, NSF Workshop on African Paleoclimates and Human Evolution, Front Royal, VA.

Scholz, C.A., 2005, Results of the Lake Malawi and Lake Bosumtwi Drilling Projects, DOSECC Annual Workshop, Austin, TX.

Scholz, C A., Johnson, T. C., King, J. Cohen, A S., Lyons, R P., Kalindekafe, L., Forman, S L., McHargue, L R., Singer, B S., 2005, Initial Results of Scientific Drilling on Lake Malawi, East African Rift, AGU Fall meeting abstract.

Eocene Lakes Feature Article

Paleogeomorphology from Lakes:
Examples from the Eocene Green River Formation

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Lake deposits fundamentally represent the downstream product of larger drainage systems, and as such they contain a significant record of upstream landscape evolution that has not yet been fully appreciated. Tectonically subsiding lake basins are especially enticing targets of study, due to nearly ubiquitous association of such basins with areas of active orogenic uplift. A revolution in our understanding of mountain belts is currently in progress, based on a growing body of data relating climate, erosion, and chemical weathering to uplift. Lake basins can play a vital role in this revolution, by providing unique and highly resolved records of local and regional interactions between continental tectonics and climate.

The Laramide basins of the western U.S. are an excellent place to examine such interactions, due to an abundance of careful past studies and to the preservation of widespread lake deposits (note, "Laramide" is used here to denote Maastrichian to Eocene basement-cored uplifts in the western U.S.; c.f., Dickinson et al., 1988). In particular, the carbonate-rich lacustrine facies of the Eocene Green River Formation provide extraordinarily rich sedimentologic, geochemical, and biological records, and recent $^{40}Ar/^{39}Ar$ geochronology studies of interbedded tuffs have dramatically improved age resolution within these strata (Smith et al., 2003; Smith et al., in prep). Many of these ages have resolution in the range of ±100 k.y. (2σ error), approaching 1% of the total 8 m.y. span of the Green River Formation. This age framework places the Green River Formation among the best-dated intervals of pre-Quaternary sedimentary rock anywhere, and permits highly detailed correlation of lacustrine sedimentation to other paleoclimate records and to regional tectonic histories.

At the most basic level, the onset of major lacustrine sedimentation in Laramide basins reflects a first-order change in erosion rates of the orogenic uplifts that defined these basins. Prior to the Laramide orogeny, up to ~6 km of sedimentary fill accumulated in the Sevier foreland basin. Much of this interval consists of marine mudstone, with interbedded fluvial to deltaic sandstone. During the early stages of Laramide uplift these deposits were uplifted and rapidly eroded into the adjacent basins. Carroll et al. (2006) estimated that the volume of Cretaceous sediment removed from the top of uplifts was roughly twice the volume of preserved Paleocene strata in Laramide basins. Due to this oversupply of sediment, Paleogene depositional environments were dominantly fluvial to paralic, as exemplified by the Fort Union Formation (famous for giant lignite deposits). Lakes did exist, but were mostly fresh water and usually short-lived.

Deposition of the Green River Formation coincided with widespread exposure of more resistant rocks in the core of the Laramide uplifts, such as Paleozoic marine carbonate, Proterozoic quartzite, and Archean gneiss (Carroll et al., 2006; Figure 1). Based on comparison with experimental studies and modern erosion rates (Sklar and Dietrich, 2001; Schaller et al., 2001), the sediment yield from the uplifts would have decreased dramatically with exposure of these more resistant surfaces. The adjacent basins therefore became starved for clastic sediments, allowing the expansion of large carbonate-producing lake systems in the Eocene. Eventually these lake basins were filled in, primarily due to a new influx of easily eroded detritus from the expanding Absaroka volcanic province to the north (Surdam and Stanley, 1980; Buchheim and Goodwin, 2000; Smith et al., in prep.).

At a more detailed level, several major lake-type transitions in the Green River Formation in Wyoming appear to record geomorphic changes in regional drainage patterns. For example, Pietras et al. (2003a) argued that the shift toward evaporative conditions that occurred with the onset of Wilkins Peak Member deposition resulted from renewed uplift of the southern Wind River range, which diverted rivers away from Lake Gosiute (Figure 2). This hypothesis is supported by a correlative clastic sedimentary succession, in which deltaic sandstone containing grains derived from north of the range is overlain by alluvial fan conglomerates derived from range uplift.

Just as physical records are useful for tracking changes in the distribution of detritus by drainage systems, geochemical records can be used to independently elucidate the provenance of waters that reach a lake. An excellent example is provided by the $^{87}Sr/^{86}Sr$ isotopic record contained in carbonate mudstone near the boundary between the Wilkins Peak Member to the overlying Laney Member. This boundary is marked by an abrupt change from dominantly evaporative facies to dominantly oil shale, and also by the sudden return of fish fossils (almost totally absent during the ~1 m.y. required for Wilkins Peak deposition). Strontium is derived from weathering of rocks exposed in the drainage basin. It is well-mixed in the lacustrine water column, and can substitute for Ca in carbonate minerals. If the isotopic composition of different drainage basin lithologies is heterogeneous, $^{87}Sr/^{86}Sr$ can therefore provide a means of tracing the drainage history of water entering a lake. In Wyoming, high $^{87}Sr/^{86}Sr$ results from weathering of old, Rb-rich basement rocks (such as the core of Laramide uplifts; ratios typically >>0.720) or of earlier-deposited sandstone and clay (c.f., Rhodes et al., 2002). Low $^{87}Sr/^{86}Sr$ results from weathering of marine limestone (0.707-709) or Eocene volcanic rocks (~0.705). Upper Wilkins Peak Member carbonate mudstone typically has low $^{87}Sr/^{86}Sr$ ratios, most likely reflecting input from Sr-rich marine limestone from the Uinta Mountains (to the south) or in Sevier thrust belt (to the west). At the Wilkins Peak/Laney Boundary, a dramatic increase in $^{87}Sr/^{86}Sr$ occurs over less than 50 cm, exactly coincident with the reappearance of fish fossils (Figure 3). Hubbard et al. (in prep.) interpret this sudden change to result from geomorphic capture of a new, more radiogenic drainage located to the east. Expansion of the Gosiute hydrologic basin also led to freshening of the lake and the resultant reappearance of fish.

The above examples only scratch the surface in terms of possible paleogeomorphic interpretations that can be made from lake deposits. Other examples include using $\delta^{18}O$ in lacustrine carbonates to detect capture of distant, high-elevation drainages by the lake (Doebbert et al., 2005), and linking changes in lacustrine sedimentation to major upstream structural events (e.g., Rhodes et al., in review). High-resolution lacustrine chronostratigraphy can be used to measure erosion rates (based on depositional rates), and to investigate rates of geomorphic processes over time intervals that can not be readily observed in the Holocene. For example, Pietras et al. (2003b) used $^{40}Ar/^{39}Ar$ dating to demonstrate that some cycles in the Wilkins Peak Member are far too short (<10 k.y.) to be precessional, and instead may represent autocyclic processes related to dynamic drainage instability (c.f., Hasbargen and Paola, 2000; Figure 4). In summary, lakes contain some of the best records of the past history of Earth surface processes, and "lacustrine paleogeomorphology" represents an exciting venue for future research.

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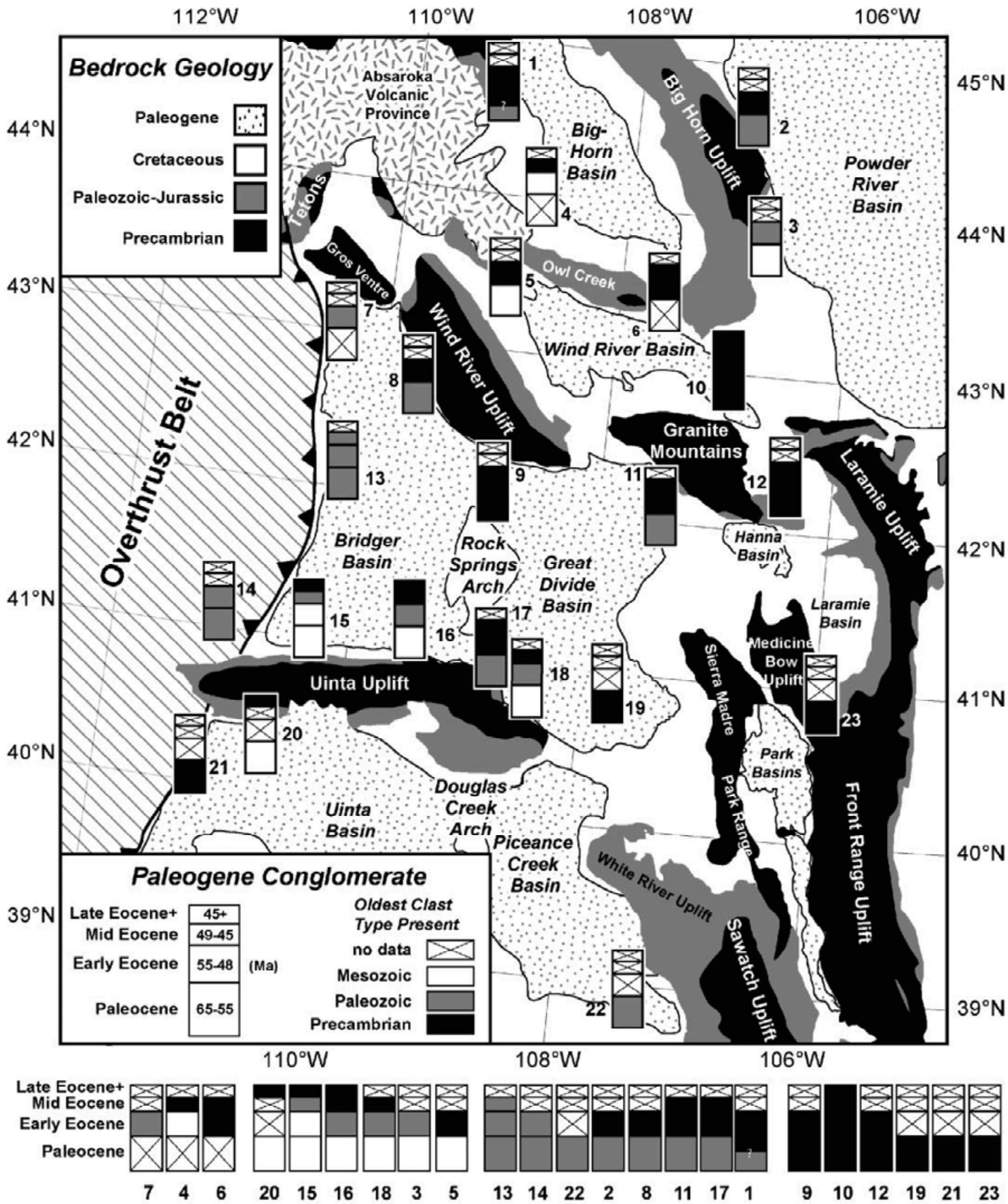

Figure 1. Simplified geologic map of Laramide orogenic basins and ranges, and summary of Paleogene conglomerate clast compositions adjacent to the ranges (from Carroll et al., 2006). Note that in most localities the clast stratigraphy is reversed from the original depositional stratigraphy, due to erosional unroofing of the uplifts. Resistant clast lithologies (Paleozoic, Precambrian) become progressively more common through time, and become widespread by the Early Eocene.

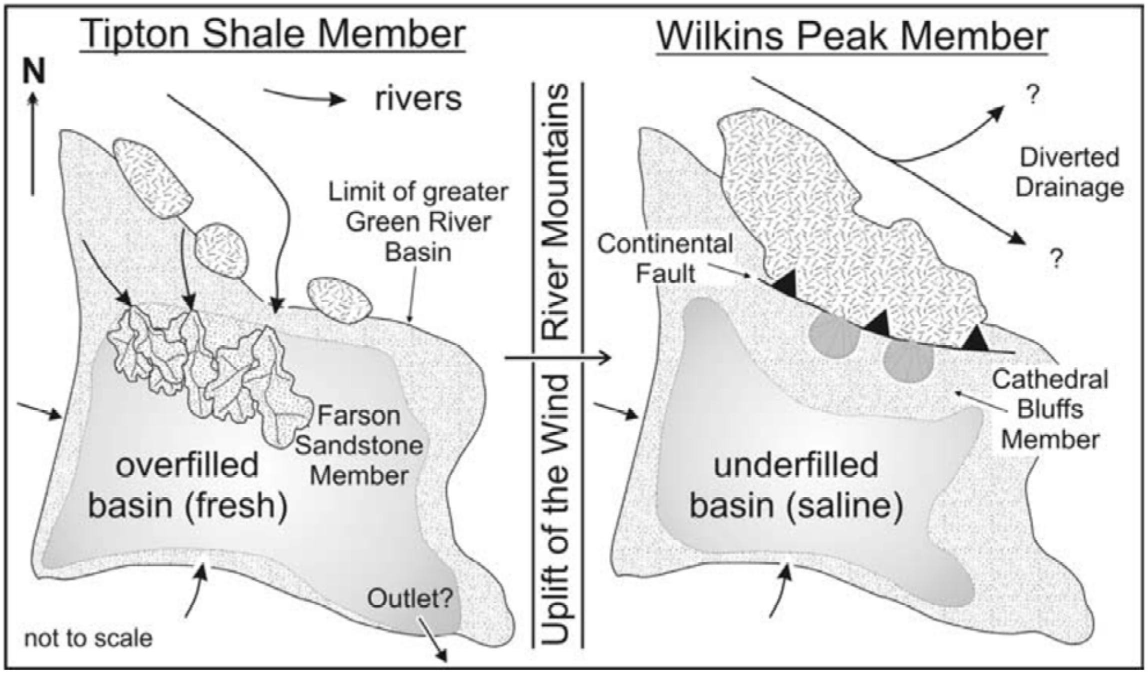

Figure 2. Schematic illustration of Early Eocene uplift of the southern Wind River Mountains, and consequent river diversion and evolution from an overfilled to underfilled lacustrine basin (Pietras et al., 2003a).

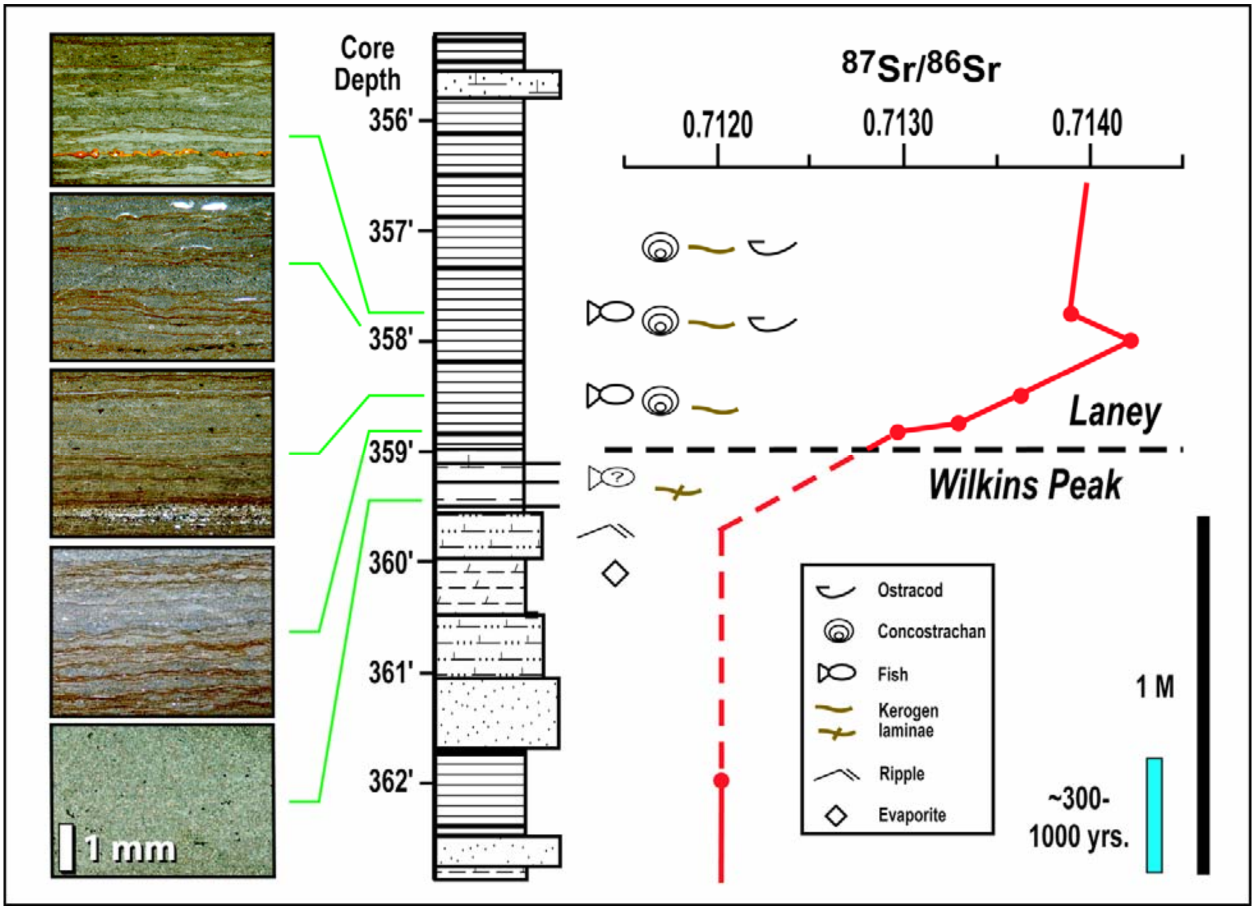

Figure 3. Strontium isotopic composition of carbonate mudstone at the Wilkins Peak Member-Laney Member boundary (Carroll et al., 2005; Hubbard et al., in prep.). Note coincidence between the onset of major oil shale deposition, reappearance of fish fossils, and dramatically rising $^{87}Sr/^{86}Sr$. Based on average depositional rates of ~100 mm/year for the oil shale facies, the change from 0.712-0.714 is projected to have occurred over ~5000 years.

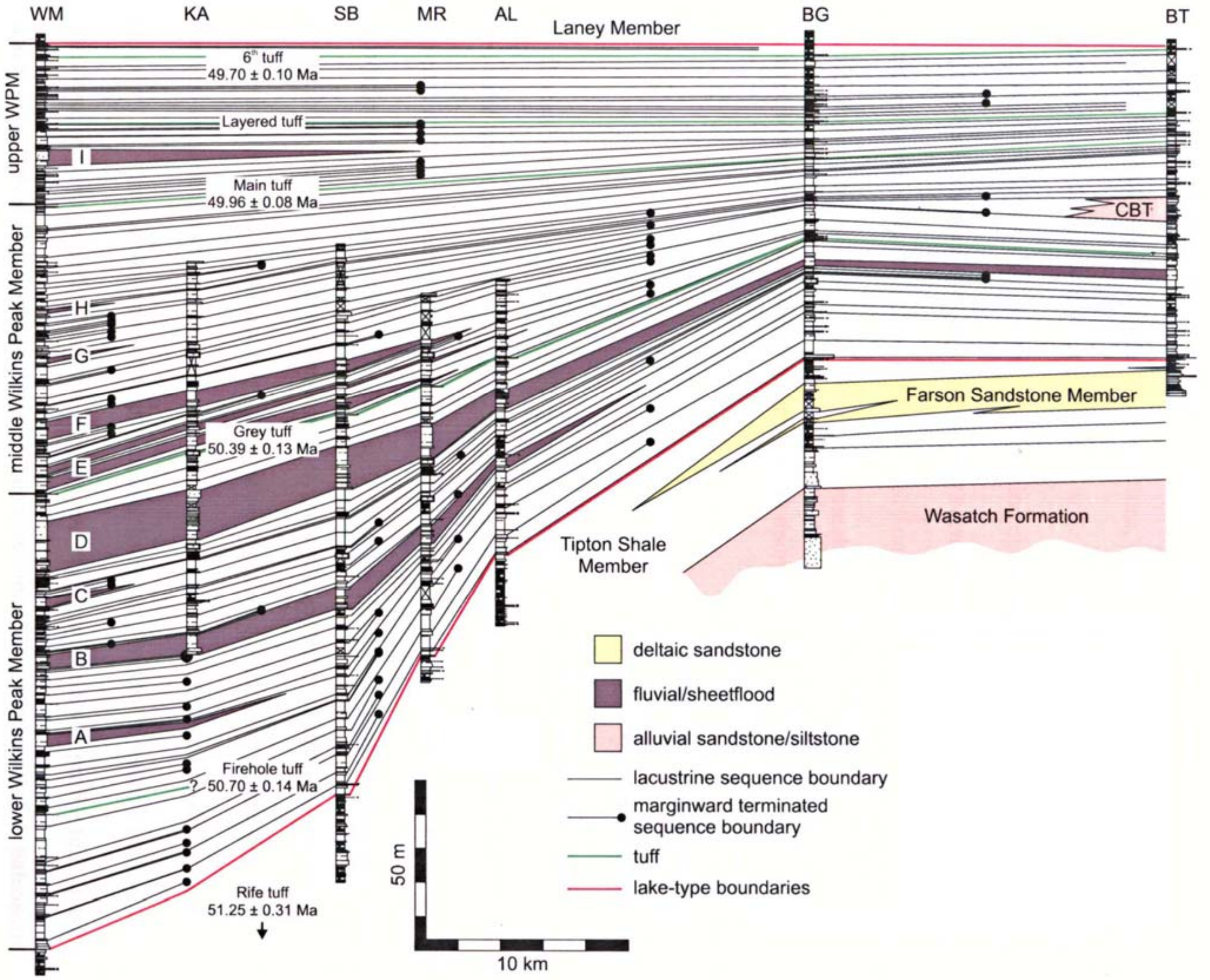

Figure 4. Detailed lake expansion-contraction cycles and tuff ages in the Wilkins Peak Member at White Mountain, Wyoming (modified from Pietras et al., 2003b). Average net duration of cycles between the Grey Tuff and the Main Tuff at the WM locality is ~10 k.y. Also note that the number of preserved cycles varies dramatically between different locations.

Lake Tahoe Core workshop report
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Verosub, K.L., University of California – Davis, Scientific Coring in the Lake Tahoe Basin, ***EOS***, v 87, no 1, p 4-5. January 3, 2006, Published 2006, American Geophysical Union.

Scientific Coring in the Lake Tahoe Basin

Lake Tahoe ranks among the largest, oldest, and deepest lakes in North America. In addition, the lake is located at a major tectonic boundary. These factors make the Lake Tahoe basin an exciting natural laboratory for studying the interaction between tectonics and climate in a high-altitude temperate setting. A recent meeting to explore the potential benefits of a comprehensive program of scientific coring in the Lake Tahoe basin attracted 67 researchers from 28 institutions. The meeting was supported by a grant from the Drilling, Observations, and Sampling of the Earth's Continental Crust (DOSECC) consortium with additional funding provided by the John Muir Institute for the Environment and the Tahoe Environmental Research Center at the University of California, Davis, the Institute for Geophysics and Planetary Physics at the University of California, San Diego, the Desert Research Institute in Reno, NV, the Academy for the Environment of the University of Nevada, Reno, and the U.S. Geological Survey.

Participants identified five broad areas where fundamental scientific questions could be addressed by coring and ancillary studies: paleoseismology/tectonics/basin evolution, the Quaternary climate record, the Holocene climate record, the fluvial/glacial/hydrologic record, and the deep-lake and sediment biosphere. In each case, basic scientific information gained through coring would provide new data that could also be used to address important societal problems, ranging from coping with global climate change to protecting and preserving the fragile environment of the Lake Tahoe basin.

Paleoseismology, Tectonics, and Basin Evolution

Lake Tahoe is located at the structural boundary between the Sierra Nevada microplate and the Basin and Range extensional province. Although its seismicity is currently low, the basin is traversed by several active faults, some of which show considerable offset. At the workshop, participants determined that suites of cores (10–30 meters long) taken in the lake on opposite sides of these faults would greatly improve understanding of the paleoseismological record of these faults and would provide new insights into the tectonic evolution of the basin. These insights, combined with detailed mapping and new trenching studies on land and real-time geodetic data gathered by the Plate Boundary Observatory component of the Earth-Scope program, could provide the most detailed description yet of a plate boundary transition, in this case the one between the North American and Pacific plates. An improved understanding of the paleoseismology and tectonics of the basin would allow planners and managers to make more informed decisions regarding seismic risk and other geologic hazards, including a possible recurrence of the huge landslide that almost certainly produced a devastating seiche (standing wave oscillations) around the shores of the lake sometime in the past 40,000 years. A better understanding of the tectonics of the basin would also provide new insights about a swarm of earthquakes in 2003 which has been interpreted as evidence for deep injection of magma in the basin.

Quaternary Climate Records

Previous studies suggest that the onshore and offshore sedimentary record in the Lake Tahoe basin encompasses over 500 meters and extends back at least 2.5 million years. Workshop participants were pleased to learn that in the near future, DOSECC's coring technology would be capable of recovering this entire sequence, and they were excited about the prospect of being able to obtain climate record from the central Sierra Nevada that span the last 2.5 million years (the Quaternary Period). This record would be significant because very few long records of climate exist from North America, and the Lake Tahoe record would be the first that could be subjected to modern, multiproxy analyses involving sedimentology, geochemistry (trace elements, isotopes, biomarkers), paleontology (ostracods, diatoms, pollen), and environmental magnetism. Because Lake Tahoe is presently located at the boundary where cold polar air interacts with moist tropical air, its climate record should be a particularly sensitive indicator of major shifts in the position of that boundary which has a significant influence on precipitation in the western United States. A Quaternary climate record from Lake Tahoe would also complement the more numerous Quaternary climate records that already exist for the northeastern Pacific Ocean, and would provide new insights into the coupling of marine and terrestrial climate processes, especially during glacial/interglacial transitions. These insights have important societal implications, ranging from a better understanding of the global response to elevated carbon dioxide levels to better modeling of the changes in precipitation patterns that these elevated levels could produce in California and Nevada.

Holocene Climate Record

Workshop participants also noted that the Holocene climate record from Lake Tahoe is of considerable interest and could be studied by collecting short cores (3–10 meters long) from various sites in the lake itself and from other lakes and bogs in the Tahoe basin. Submerged trees in Lake Tahoe and other lakes in the basin attest to long periods of apparently much drier conditions. A better understanding of the Holocene climate record in the Lake Tahoe basin would fill a critical gap in the current database for western North America and would make it possible to determine the drivers of Holocene climate variability in the Sierra Nevada. The societal benefit of an improved understanding of regional drivers is that it would enable the more accurate prediction of short- and long-term variations in water availability in California and Nevada. A key feature of previously studied short cores from Lake Tahoe is the presence of numerous turbidites, which may have been generated by large seismic events or by large storms. In either case, the turbidites represent an important feature of the Holocene record from Lake Tahoe, and a more comprehensive study of them could provide new information about climatic processes and/or tectonic processes.

Sediment Dynamics and Sedimentary Architecture

Turbidites represent only one aspect of the sedimentary architecture of the Lake Tahoe basin. Much of the basin is ringed with glacial deposits of various ages, and these deposits plus material derived from modern weathering environments contribute to the total sediment load delivered to the lake. Although this adds complexity, the drainage basin is small relative to the area of the lake, and most of the source areas are well exposed. At the workshop, participants developed a plan to use cores from the lake in conjunction with mapping and sampling on land to develop a complete sediment budget for the Lake Tahoe basin under different Holocene climatic regimes. Such a project would represent the first application to a large lake of the sources-to-sink approach now being used in the marine realm. Tandem examination of Lake Tahoe and Pyramid Lake, the ultimate sink for water flowing out of Lake Tahoe, could lead to a better understanding of the paleohydrologic record of other large, now-dry Nevada lakes. Because sediment influx and water turbidity are of great concern to residents of the Lake Tahoe basin, a better understanding of the key inputs to the sediment budget would provide planners and regulators with a firmer scientific basis for making decisions regarding development and other activities. Another concern in the Lake Tahoe basin is groundwater pollution, especially in the vicinity of South Lake Tahoe where the gasoline additive MTBE (methyl tertiary-butyl ether) is a major problem. The sediments there consist of interbedded coarse and fine material derived from successive glacial/interglacial cycles. Detailed onshore and offshore seismic studies, coupled with studies of longer (20–50 meters long) cores at key locations, could provide a much better understanding of the sedimentary architecture that controls the movement of groundwater and might indicate ways that the dispersal of pollutants could be further mitigated. These studies would also address fundamental questions about the deposition of sediments in glaciofluvial environments, such as the nature of the interfingering of different types of sediment as glaciers advance into and retreat from the lake. These questions have arisen in studies of modern environments ranging from Alaska to Antarctica.

Deep-Lake and Sediment Biosphere.

The fifth area of opportunity for scientific coring identified by the participants involves study of the biosphere at great depth in the water column as well as in sediments at the bottom of that water column. Although the search for life in extreme environments has led researchers to many exotic settings, that search has not yet extended to great depths in the world's largest lakes. Lake Tahoe is an excellent candidate for such studies because, in addition to having a water depth exceeding 500 meters, hydrothermal features are thought to exist on the lake floor. Thus, ancient sediment beneath Lake Tahoe is likely to host novel and relict biotic communities which would have had to solve unique ecological challenges, ranging from ultralow nutrient and energy input to physical immobilization within compacting sediment.

Other Important Considerations

Critical to the success of any scientific coring in the Lake Tahoe basin are the many studies of the ecology of Lake Tahoe that have been done over the past 40 years, including time series of water chemistry. These studies provide baseline data about the behavior of the modern lake, including spatial and temporal scales of variability, and make it possible to interpret new results in a much broader context. Also important to the success of a program of scientific coring is the support of local stakeholders and local permitting agencies. The clarity of Lake Tahoe is of paramount concern to those living around the lake, and extraordinary measures are in place to control the influx of sediment and nutrients. While the proposed coring projects would not jeopardize the lake in any way, misunderstanding about the goals or methods involved in the coring could jeopardize the projects themselves. At the workshop, participants discussed ways to create a broad base of local support through public information, public outreach, and education programs.

Other issues that were addressed include ancillary studies that are necessary for a coring program and the order in which they should be done; facilities and vessels in the Lake Tahoe basin that could be used in support of a coring program; procedures for processing, sampling, and curating the cores; and the scientific methods that would be used to study the cores.

At the end of the meeting, participants developed an outline for a formal report, the components of which are now being written. To receive notification when the report becomes available, contact tahoeworkshop@geology.ucdavis.edu. The Workshop on Coring in the Lake Tahoe Basin was held 15–18 September in Tahoe City, Calif.

—Kenneth L. Verosub

Meetings

Limnogeology Sessions at the GSA Annual Meeting, October 22-25, 2006, Philadelphia

Submit abstracts to the following Limnogeology Division sponsored sessions!
To submit an abstract, go to http://www.geosociety.org/meetings/2006/abstracts.htm.
Abstract deadline is July 11, 2006.

T3. Reconstructing Landscape Contexts of Human Occupation Surrounding Wetlands
GSA Archaeological Geology Division; GSA Limnogeology Division; GSA Geology and Society Division

Archaeological Geology; Limnogeology; Quaternary Geology/Geomorphology

Catherine H. Yansa, Michigan State University, East Lansing, Mich.;
Andrea K. Freeman, University of Calgary, Alberta

This session will provide examples of how valuable information about human activities in wetland and surrounding upland landscapes is obtained from the analysis of soils, sediments, and fossils from wetlands (lake, bog, marsh, and riparian). ORAL

T68. Gradients at Hydrologic Interfaces as Indicators of Key Earth-Surface ("Critical-Zone") Processes
GSA Hydrogeology Division; GSA Geobiology and Geomicrobiology Division; GSA Limnogeology Division

Hydrogeology; Environmental Geoscience; Geochemistry, Aqueous

David A. Stonestrom, U.S. Geological Survey, Menlo Park, Calif.;
Michelle A. Walvoord, U.S. Geological Survey, Lakewood, Colo.

Chemical and physical gradients at hydrologic interfaces provide information about processes that can sustain or threaten life. Key processes include weathering, nutrient cycling, regulation of natural water supplies, and transport of contaminants. ORAL and POSTER

T76. Detecting and Characterizing Fluxes of Water and Dissolved Constituents across the Groundwater–Surface Water Interface
GSA Hydrogeology Division; GSA Limnogeology Division

Hydrogeology; Geochemistry, Aqueous; Limnogeology

Brewster Conant, University of Waterloo, Waterloo, Ontario;
Donald Rosenberry, U.S. Geological Survey, Denver, Colo.

Session examines preferential flow paths and areas of exchange between groundwater and surface water across the sediment-water interface of streams, lakes, and wetlands and the processes controlling water fluxes, mass fluxes, and biogeochemical reactions.
ORAL and POSTER

T95. Dating and Environmental Interpretation of Lake, Loess, and Marine Sediment Sequences using Paleomagnetism and Rock Magnetism
GSA Limnogeology Division

Limnogeology; Paleoclimatology/Paleoceanography; Quaternary Geology

John A. Peck, University of Akron, Akron, Ohio;
John W. King, University of Rhode Island, Narragansett, R.I.

This session combines rock magnetic studies of environmental change from lake, loess, and marine sediments with paleomagnetic studies that provide robust chronologies for these sediment sequences on time scales from secular variation to reversals.
ORAL and POSTER

T96. Neogene and Quaternary Biological Paleolimnology: In Memory of J. Platt Bradbury
GSA Limnogeology Division

Limnogeology; Paleoclimatology/Paleoceanography; Quaternary Geology

Scott W. Starratt, U.S. Geological Survey, Menlo Park, Calif.

During his career, Platt Bradbury pioneered techniques in biochronology and paleoenvironmental analysis of late Cenozoic lake sediments from around the world. Papers on all aspects of lacustrine analysis, particularly those using biological proxies, are welcomed.
ORAL and POSTER

T97. Core Analysis of Lake Sediments (Posters)
GSA Limnogeology Division; ExxonMobil

Limnogeology

Elizabeth H. Gierlowski-Kordesch, Ohio University, Athens, Ohio;
Peter A. Drzewiecki, Eastern Connecticut State University, Willimantic, Conn.;
Kevin Bohacs, ExxonMobil Upstream Research Co., Houston, Tex.

Core analysis and comparison of modern lake sediments and fossil lake rock sequences will shed light on sedimentation processes as well as preservation potential of fossils and structures through time and space.
POSTER

Pre-Meeting Field Trips

Lacustrine Cyclicity and the Triassic-Jurassic Transition
Fri.–Sat., 20–21 Oct. Cosponsored by *GSA Sedimentary Division; GSA Limnogeology Division*.
Paul Olsen, Lamont-Doherty Earth Observatory, New York, N.Y., +1-845-365-8491, polsen@ldeo.columbia.edu; Jessica Whiteside.

Late Pleistocene to Modern Lacustrine Processes and Paleoclimatic History in the Finger Lakes, New York
Fri.–Sat., 20–21 Oct. Cosponsored by *GSA SedimentaryDivision; GSA Limnogeology Division*.
John Halfman, Hobart and William Smith College, Geneva, N.Y., +1-315-781-3918, halfman@hws.edu; Tara Curtin; Neil Laird; Pete Knuepfer.

Limnogeology Core Workshop at GSA Annual Meeting,Philadelphia

Core Analysis of Lake Sediments
Sat., 21 Oct. GSA Limnogeology Division Workshop.

Core analysis and comparison of modern lake sediments and fossil lake rock sequences will shed light on sedimentation processes, climatic effects, and the preservation potential of fossils and structures through time and space. Please bring posters and/or cores describing your lake sediments. Posters can also be submitted for the poster session held during the annual meeting.

Sponsored by ExxonMobil

For more information, contact Elizabeth Gierlowski-Kordesch, gierlows@ohio.edu.

Additional Meetings

To get the latest information on other Limnogeology meetings and workshops,

Go to the Limnogeology Division website at:

http://rock.geosociety.org/limno/news.html

If you don't have access to our website, please contact a Division officer for a list of meetings. Officer contact information is on page 1 of this newsletter.