MEETINGS

U.S. and Chinese Scientists Discuss the Ocean's Response to Climate Change

Climate Change and Coastal Oceans Workshop; Qingdao, China, 26–28 October 2008

PAGE 121

A 3-day workshop was held in China to discuss coastal ocean processes, the biogeochemistry of large river-dominated ocean margins (RiOMars), and climate change and variability studies; to formulate a strategy for a joint venture to assess how climate change has affected coastal oceans; and to predict the ocean's response to future change scenarios. The workshop, which brought together experts from Texas A&M University (TAMU) and five Chinese universities and institutes—Ocean University of China (OUC), Institute of Oceanology of the Chinese Academy of Sciences (IOCAS), Xiamen University (XU), Tianjin University of Science and Technology (TUST), and East China Normal University (ECNU), highlighted the similarities in topics important to North America and Asia.

As indicated by the 2007 Intergovernmental Panel on Climate Change report, climate change imposes far-reaching challenges on society. This workshop focused on two large, river-dominated coastal environments: the Mississippi-Atchafalaya system and the Changjiang estuary. Numerous parallels exist between the impacts of the Changjiang on the East China Sea and the Mississippi on the Gulf of Mexico. These RiOMars are ideal for examining the impacts of climate change because they are characterized by large, heavily populated watersheds in two countries that are important in determining the human carbon footprint. The hydrology, biodiversity, and geochemical characteristics of these systems have been greatly influenced by land use and regional-scale climate change. Workshop participants reviewed current progress in understanding physical and biogeochemical processes controlling the two RiOMars, brainstormed challenges in developing a multidisciplinary system capable of assessing and predicting impacts of global climate change on these RiOMars, and identified a multifaceted approach to address these challenges.

The workshop established three collaborative task forces to address key issues in nearshore/coastal process studies, biogeochemical process studies, and dynamical downscaling of global climate change studies. The nearshore/coastal task force was led by Steven F. DiMarco (TAMU) and Hao Wei (TUST and OUC); the biogeochemical task force was led by Thomas S. Bianchi (TAMU), Zhinan Zhang (OUC), and Minhan Dai (XU); and the dynamical downscaling task force was led by Ping Chang (TAMU) and Dexing Wu (OUC). The nearshore/coastal task force focused on studies of processes that control local marine environmental hazards, such as hypoxia, in the two systems through analyses and model simulations. The biogeochemical task force concentrated on characterizing the dominant past and recent changes in biogeochemical processes in these RiOMars through changes in the chemical composition and dynamics of dissolved and particulate materials in the water column and sediments. The dynamical downscaling task force aimed at developing fine-resolution, regional coupled climate models capable of resolving mesoscale oceanic and atmospheric processes in these systems for assessing future local impacts of global climate change projections. Research proposals that support investigations on these topics are being developed for both U.S. and Chinese funding agencies by the task forces.

The workshop was cosponsored by the U.S. National Science Foundation, TAMU, and OUC and is part of an ongoing initiative between TAMU and OUC that includes offering a joint Ph.D. degree in oceanography. More detailed information concerning the workshop can be found at http://geosciences.tamu.edu/climate/index.html.

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Connecting Scientific Drilling and Human Evolution

Scientific Drilling for Human Origins: Exploring the Application of Drill Core Records to Understanding Hominin Evolution; Addis Ababa, Ethiopia, 17–21 November 2008

PAGE 122

How did environmental history, particularly climate, affect the evolution of our hominin ancestors and closely related species? The formulation of testable hypotheses about the climate-evolution connection is impeded by limited numbers of hominin specimens and the geographic and temporal gaps that characterize their fossil record. Additionally, knowledge of Earth's environmental history close to these fossil finds remains limited. Scientists interested in the problem currently make use of temporally and geographically discontinuous outcrop exposures at the fossil sites, and/or deep-sea or lake paleoclimate records geographically distant from the hominin fossils, to address the Earth history side of this equation.

A workshop was held in Ethiopia to consider how scientific drilling might improve our understanding of the connection between Earth history and human origins. This workshop, funded by the International Continental Scientific Drilling Program and the U.S. National Science Foundation, brought together a diverse group of 60 Earth scientists, anthropologists, and archaeologists from 13 countries to develop a drilling plan for East African sedimentary basins where important fossil and stone tool discoveries have been made.

Sedimentary drill cores from both the ocean basins surrounding Africa and ancient lakes on the African continent have already proven useful in informing the debate about paleoclimate and human evolution. Drill cores provide continuous records of climate history from a single location, unbroken by the vagaries of outcrop exposure. The fine-grained sediments of both oceans and lakes preserve a wide variety of fossil and geochemical archives, allowing quantitative reconstructions of climate and ecosystem history. When these sediments are derived from drill cores, they have not been exposed to the destructive effects of outcrop weathering.

During the meeting, participants considered four areas already under detailed consideration by the steering committee for drilling: a northern Awash Pliocene depocenter (~3.8–2.9 million years old) in Ethiopia; Plio-Pleistocene lake beds (~2.0–1.5 million years old) in West Turkana, Kenya; and Pleistocene/Holocene lake beds (~1.2 million years old to present) at Olorgesailie and Lake Magadi in southern Kenya. They also evaluated other areas suggested by the workshop participants (a call for additional site suggestions by the scientific community is discussed in the full text of this meeting report, available in the electronic supplement to this *Eos* issue (http://www.agu.org/eos_elec)). The workshop promoted lively discussions of potential science objectives, as well as logistical and community outreach considerations for drilling near hominin sites.

Meeting participants assessed that the new drilling campaign should seek to collect the most valuable and immediately useful records, which would combine the positive attributes of completeness and high-quality preservation. In addition, participants recognized that drilling should be prioritized to sedimentary basins where the fossils and artifacts have actually been found, targeting time intervals when important questions can be asked regarding human evolutionary history.

Fortunately, in the East African Rift Valley, where the largest number of fossils, hominin species, and artifacts have been recovered, fine-grained lake beds occur abundantly, not only below extant lakes but also in sequences now exposed on dry land. These lacustrine deposits, with their documented capacity to provide high-quality paleoclimate records, coupled with proximity to hominin fossil sites and excellent preservation of microfossils and biogeochemical materials compared with exposed outcrops, make for compelling drilling targets, conference participants agreed. Through such investigations, clues to the relationship between earth history and human evolution may be revealed.

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What Can Water Vapor Reveal About Past and Future Climate Change?

AGU Chapman Conference on Water Vapor and Its Role in Climate; Kailua-Kona, Hawaii, 20–24 October 2008

PAGE 122

An AGU Chapman Conference on water vapor was held in Hawaii with approximately 120 attendees from nine countries. The meeting began with a keynote presentation on the hydrological cycle and climate change and continued with sessions on issues related to the upper troposphere/lower stratosphere region (UT/LS), the interactions of convection and water vapor, and the behavior of water vapor on large scales and in future and past climates.

The conference highlighted important advances in the scientific community's understanding since the previous Chapman Conference on this subject, in 1999. Basic understanding of the future hydrological cycle changes predicted by the current generation of numerical climate models has improved significantly, owing to analyses of the Coupled Model Intercomparison Project phase 3 (CMIP3) archive of model outputs, helping to guide future research. Speakers also presented evidence of much weaker and stronger hydrological cycles at the Last Glacial Maximum (about 20,000 years ago) and hot periods in the early Eocene (55 million to 33 million years ago), respectively. While no evidence was presented to question the anticipated positive feedback of water vapor on global warming, discussions noted the expectation of local changes in relative humidity in a warmer climate.

The very low humidities observed in the subtropical troposphere are now quantifiable to first order by a simple advection-condensation theory. Observations now confirm that supersaturation of water vapor over ice up to about 50% is common near the tropical tropopause (the boundary between the troposphere and stratosphere), and that strong storms can inject significant amounts of water to as high as 21 kilometers above sea level in the tropics, directly hydrating the stratosphere. Participants highlighted the newly appreciated roles of both frontal boundaries (or other mesoscale heterogeneities) and ample water vapor throughout the troposphere in fostering storm initiation and development. These and other findings have been facilitated by new observing techniques including radar and light detection and ranging (lidar) absorption, Global Positioning System (GPS) occultation, several new satellite sensors, and newly homogenized humidity data sets.

A recurring theme was the rapid growth in the measurement and use of stable isotopes of water. There are now three satellites in orbit capable of observing deuterium ratios in atmospheric water vapor. A campaign begun just prior to the meeting, running newly developed isotopic analyzers on Mauna Loa, had within 2 weeks obtained more in situ isotopic vapor data than all collected previously. Several presenters noted the potential for isotopic measurements in vapor, rain, and clouds to constrain atmospheric process models and help interpret isotopic evidence from past climates.

Remaining challenges include poor understanding of how and why heavy rains and droughts will change in a warmer world; mysterious trends during the past 2 decades in near-surface wind, rainfall, and evaporation; the acute need for better conceptual models of how convection interacts dynamically and microphysically with its environment; and inadequate understanding of the processes determining isotopic composition. Finally, significant worries were raised concerning possible interruptions to U.S. microwave and infrared satellite monitoring due to program delays, and strategies were discussed for developing future observing systems.

For more on the discussion of future observing systems, see the online supplement to this *Eos* article (http://www.agu.org/eos_elec/).

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Supplementary On-line materials

Scientific Drilling for Human Origins: Exploring the Application of Drill Core Records to Understanding Hominin Evolution. Workshop Report

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On-Line Supplementary Document

Scientific Drilling for Human Origins: Exploring the Application of Drill Core Records to Understanding Hominin Evolution. Workshop Report

This workshop, held in Addis Ababa, Ethiopia considered the role that scientific drilling might play in improving our understanding of the connection between earth history and human origins and evaluated specific drilling targets already under consideration. Relatively simplistic linkages between climate and human evolutionary history have been put forward for over 100 years, but these concepts became much more sophisticated with the advent of detailed climate records from deep sea drill cores. The ability to infer climate variation at a variety of time scales allowed anthropologists to propose new ideas of how Earth history might have influenced hominin evolution. Climate and tectonics (as expressed through change/stability in landscapes, resource abundance and predictability and seasonality) could generate adaptive change, speciation, extinction or stasis in hominin species by affecting species diet, mobility, social strategies, reproduction and demography. Testing linkages from the earth science side requires records from various locations and time intervals encompassing a range of biotic “events” (including intervals of stasis as well as change). Computer modeling experiments on the interaction of climate and ecosystem change would also provide critical tests of hypothesized links between human evolution and Earth history.

Prior studies had given us a general rationale for drilling hominin fossil sites. An East African Rift focus for an initial drilling program is most likely to yield immediate scientific benefits at a reasonable cost. Lake beds with the combined attributes of high sedimentation rates, temporal continuity, good geochronologic control, close proximity to fossil/artifact sites, and ease of truck-mounted drill rig access (an important cost consideration) are fortunately present in several areas of the rift valley.

An exploratory NSF grant allowed the steering committee to characterize four promising locations for a first phase of drilling, encompassing a range of critical time intervals for hominin evolution and types of drilling targets. Site studies consisted of logistical evaluations (road and water access for drill rigs, consultations with local drillers and stakeholders) and limited subsurface geophysics (reflection seismics, electrical and magnetic surveys). The workshop provided an opportunity to review the results of these surveys, as well as to consider other promising drilling targets.

One potential target is a large Pliocene paleolake depocenter in the northern Awash River valley (Afar region) of Ethiopia. The site, known as Ledi Geraru, is in the same depositional basin as some of the most important accumulations of Middle Pliocene hominin fossils in the world, including the *Australopithecus afarensis* fossil “Lucy”, the “first family” collection of *A. afarensis* fossils and the earliest known stone tools. With its thick sequence of fine-grained lacustrine sediments, including diatomites, this site could provide an excellent >3.4-2.9 Ma paleoclimate record, encompassing an interval of both morphological stasis and change for *A. afarensis*.

Another promising drill site lies on the west side of Lake Turkana, Kenya, in the depocenter of an early Pleistocene (~2-1.5Ma) predecessor of the modern rift lake. The region is renowned for its archaeological, hominin and other vertebrate fossil record, including over 500 hominin fossils and 100 archaeological sites. As with the Afar area, establishing an age model for the thick lacustrine sequence to be cored would be facilitated by the numerous dated and characterized tephras. A high resolution paleoclimate record here would span the time of the origin of several species of *Homo*, the earliest Acheulean stone tool technology, and the first dispersal of hominins out of Africa.

Two sites in southern Kenya would provide records of more recent events in hominin evolution. The Olorgesailie Basin was occupied by a paleolake between ~1.2-0.5Ma, and contains some of the most important middle Pleistocene

(Acheulean) archaeological sites in the world, along with abundant vertebrate fossils. As with the other areas discussed, it has well dated tephras throughout the lake beds that would be targeted for drilling. Nearby Lake Magadi, a playa in the sump of the Kenyan rift valley is also promising. Earlier trona exploration drilling and geophysical surveys revealed a thick sequence of lacustrine sediments spanning the last million years. Combining core results from the Olorgesailie and Magadi basins would allow researchers to distinguish intrabasinal hydrologic events from regional climate history and address hypotheses about water and food resources for hominins at a variety of time and spatial scales.

Additional sites in Kenya and Ethiopia were also considered (e.g. near Lakes Baringo and Chew Bahir) during the workshop. Many hominin fossil and archaeological sites would benefit from adjacent lake bed drilling and the workshop participants recognized that any drilling campaign to arise from this meeting should only be a first phase in what could emerge as an entirely new arena for scientific drilling. Much of the meeting discussion time was devoted to considering the science/logistical issues surrounding each area, and strategies for core sampling, analysis, curation and logging. By the end of the meeting a consensus had emerged that a project review committee should move ahead with a formal evaluation of all proposed sites, along with an analysis of funding options for the project.