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web pages created by workshop participants with ideas for novel approaches or new topics for teaching about energy in geoscience.

In addition to teaching materials, the website houses collections of visuals and references to enhance teaching. Presentations and related references from the teaching energy workshop provide access to recent research, emerging topics, perspectives on energy policy and examples of effective pedagogy for teaching about energy. The energy visualization collection contains video clips, diagrams and animations relating to fossil fuels, nuclear power and alternative energy sources. A directory of recommended books spans both traditional and renewable energy forms, while a page of recommended resources points the way to web resources such as government reports, data sets and online activities for students.

All of these materials can be found at http://serc.carleton.edu/NAGTWorkshops/energy. Faculty are encouraged to submit their own teaching materials to the web collections via online forms for submitting information and uploading files.

SESSION NO. 48, 9:00 AM

Sunday, 18 October 2009

T131. Ancient Coastal and Subsea Sites: New Findings and Problems (Posters) (*GSA Archaeological Geology Division, Smithsonian Institution*)

Oregon Convention Center, Hall A

48-1 **BTH 444** Marino, Domenico

ANCIENT HARBORS AND SUBMERGED ISLANDS: NEW EVIDENCE FROM CROTON, ITALY

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Pliny the Elder, in his *Natural History*, described a small archipelago of five islands which were visible in the sea of Croton in the first century A.D. He even transcribed their names: "the island of the Dioscuoroi, Calypso's, Tyris, Eranusa, and Meloessa." (*H.N.* III 10.95-98). Two of them were still visible in the detailed nautical charts that seafarer and geographer Piri Reis, after having traveled in this area, drew at the court of Suleiman the Magnificent in A.D. 1521-1526. Currently, not only these islands have disappeared, but the entire coastline of Croton appears to have gone through dramatic changes since the Greek and Roman age.

In the summer of 2009, a joint Italian-American expedition has began a systematic project of research in the the shallow waters south of Croton aimed to map all the submerged archaeological evidence present in the coastal area. The recent discovery in the search area of submerged tufa quarries which were in use in the Greek Archaic and Classical Age (sixth-fourth centuries B.C.), can be used to precisely date and quantify the amount of coastline changes that have taken place in the area since antiquity.

Inserting the new data into a GIS, the shape of the ancient coastline of Croton is being reconstructed, and the archaeological material still in situ, whenever present, used to date the inhabitation phases. The possible location of the Graeco-Roman harbor of the city is also being proposed.

48-2 **BTH 445** Garrison, Ervan

38,000 YEAR-OLD SUB-FOSSIL EVIDENCE FOR THE ATLANTIC GRAY WHALE, ESCHRICHTIUS ROBUSTUS, SOUTH ATLANTIC BIGHT, GEORGIA (USA)

GARRISON, Ervan, Geology, The University of Georgia, GG Building, Athens, GA 30602, egarriso@uga.edu

38, 000 year-old sub-fossil evidence, including a nearly complete dentary (left mandible) and two vertebrae, of the extinct Atlantic Gray Whale, *Eschrichtius robustus*, have been excavated from a shell bed deposit located in the South Atlantic Bight, 30 kilometers offshore St. Catherine's Island, Georgia. The discovery of the dentary was initially made in 2006 but recovery was not completed until the summer of 2008. The two vertebrae were found nearby the jaw section and had been eroded from the shell bed by bottom currents. Direct dating of the sub-fossils, with the Accelerator Mass Spectometer radiocarbon technique (AMS), using bioapatite, suggests a common age for the skeletal materials but it speculative to assume these are elements of the same animal. The ages determined for the sub-fossils are in good agreement with the age of the shell bed previously determined by AMS dating of inclusions and by direct dating of the sediments using Optical Stimulated Luminescence (OSL) dating. Surviving architectural features of the mandible provide convincing evidence that the discovery is that of a Pleistocene aged member of the monospecific *Eschrichtiae* clade. As such it is the oldest known evidence of this extinct taxon in the Atlantic Basin.

48-3 **BTH 446** Belknap, Daniel F.

DROWNED ARCHEOLOGICAL SITE POTENTIAL IN THE WESTERN GULF OF MAINE: AN EXAMPLE FROM BASS HARBOR, ME

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Because of its relatively late deglaciation and subsequent isostatic adjustments, the Gulf of Maine was earlier believed to have had limited subaerial exposure and potential for submerged archeological sites. Recent detailed bathymetric and seismic reflection profiles and accompanying vibracores from outer Bass Harbor, ME contradict earlier assumption and demonstrate that the Gulf of Maine has great potential to host drowned sites. In Bass harbor, multibeam bathymetry shows two moraines that were eroded to supply spits. The moraine-spit system formed a lake/estuary basin that was sheltered from complete erosion by nearby islands. Scallop draggers recovered mid-Archaic artifacts from a ridge which cores reveal to be a paleo-spit. Numerous in situ Crassostrea and Mya shells and Zostera stems date the estuary to between 7.8-9.2 (cal.) ka. Several factors led to excellent preservation of drowned habitats and artifacts here and probably elsewhere in the Gulf of Maine: 1) irregular bedrock and glacial outcrops create many basins capable of supporting lakes and wetlands at times of lower sea levels; 2) the bedrock sheltered many locations from exposure to erosive waves; 3) local, relative sea-level experienced a "slowstand" between 11.5 ka (cal) and 7.5 ka during which it only rose from about -23 m to -19 m depth. This slow rise in sea level thoroughly reworked glacial deposits and built spits and other coastal features. These, in turn, formed and protected freshwater wetlands and later estuarine settings that focused human activity. Clearly, a time of stable sea level is conducive to constructing coastal environments and preserving them along with associated artifacts.

48-4 **BTH 447** Strong, Nikki

RATES AND PATTERNS OF COASTAL EROSION FOR THE PANAMA VIEJO HISTORICAL AND ARCHEOLOGICAL SITE

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The Panama Viejo Historical and Archeological Site, the location of the oldest colonial city on the Pacific Ocean, is located on the Gulf of Panama in the south-central region of the Republic of Panama. Panama Viejo is built on coastal bar and fluvial sediments and pyroclastic rock bordering a shallow cove. These marine, fluvial, and volcanic sediments that underlie historical Panama Viejo are prone to mechanical wave erosion, especially on those parts of the shore exposed to the dominant NNE winds. As such significant erosion and subsequent shoreline retreat have occurred since the city of Panama Viejo was first established almost 500 years ago, yet there are no quantitative estimates of rates and the extent of coastal erosion during this time period. It was the purpose of this study, therefore, to estimate the extent and rates of historical (~1500 AD - present) coastal erosion and to estimate current trajectories of coastal erosion for the Panama Viejo site. Towards that goal we use aerial imagery and historic map data formatted into a GIS environment to 1) calculating the temporal and spatial distribution of coastal erosion for historical Panama Viejo since its first establishment 500 years ago up to modern times, 2) extrapolating patterns and rates of erosion, for purposes of archeological reconstruction, for pre-colonial Panama Viejo, and 3) calculate present-day trajectories of future coastal erosion for the general area surrounding the historical site. We find that much of the historical boundaries of Panama La Vieja once extended 100 meters or more seaward of the present day shoreline, these shoreline areas having eroded due to mostly natural wave-driven erosion, while other parts of the coastal area have prograded seaward and choked entire bays with fine grained sediments eroding from the upstream reaches of the drainage basin, likely in response to anthropogenic activity.

SESSION NO. 49, 1:30 PM

Sunday, 18 October 2009

Geoscience Education II

Oregon Convention Center, C123

49-1 **1:35 PM** Reynolds, Stephen J.

RESOLVING THE BREADTH VERSUS DEPTH VERSUS INQUIRY DILEMMA IN INTRODUCTORY COLLEGE GEOLOGY COURSES

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Instructors of introductory geology courses, especially those with large classes, constantly face the dilemma of how to balance the coverage of diverse topics versus an in-depth treatment of key concepts or spending time helping students do scientific inquiry. As part of a class-redesign effort, we developed a suite of approaches and assessment tools that allow us to simultaneously address these three competing aspects of *breadth*, *depth*, and *inquiry*. The class is a semester-long course with ~220 students, nearly all nonmajors. At the start of the semester, students receive a What-to-Know (WTK) List in which each item is linked with a two-page spread in the textbook. Students are then responsible for each item, and know they are responsible even if that subject is not covered in lecture. Freed from the necessity to cover every topic, we devote much class time to having students observe, interpret, and discuss geology. To demonstrate their *breadth of knowledge*, students take weekly, online multiple-choice quizzes derived from items on the WTK List. To assess *deep knowledge*, there are four exams, during which students construct two fully developed concept sketches. For each exam, the instructor selects the two concept-sketch questions from 9 to 12 possible questions provided to students along with the WTK list. During each exam, we pass out blank sheets of paper and then display two concept-sketch questions on an overhead. Students draw and explain each concept sketch on one side of the paper. Some advantages of this style of exam are that (1) students ideally develop complete answers — and therefore deep knowledge — for each of the 9 to 12 possible concept-sketch items, (2) it is difficult for students to bluff their way through a concept-sketch exam, and (3) there are no photocopying costs. To assess *inquiry skills*, students complete each of the chapter-ending *Investigations* from the textbook, either online or on paper worksheets done in class and in small groups. Using this overall three-pronged approach, students are exposed to and assessed on a broad range of topics, but also need to have in-depth knowledge of about 40 topics. The decoupling of multiple-choice items from concept-sketch questions resulted in significant improvement in the quality of concept sketches and in student fluency with geologic concepts and language.

49-2 **1:50 PM** Stokes, Alison

UNDERGRADUATE STUDENTS' CONCEPTIONS OF GEOLOGY: WHAT ARE THEY, AND DO THEY CHANGE?

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Students' understandings and experiences of 'geology' as a science are seldom documented, and yet these can provide valuable information which can be used to inform and develop aca-