SIXTH ANNUAL RESEARCH SYMPOSIUM
UNIVERSITY OF MAINE
INSTITUTE FOR QUATERNARY STUDIES

1998

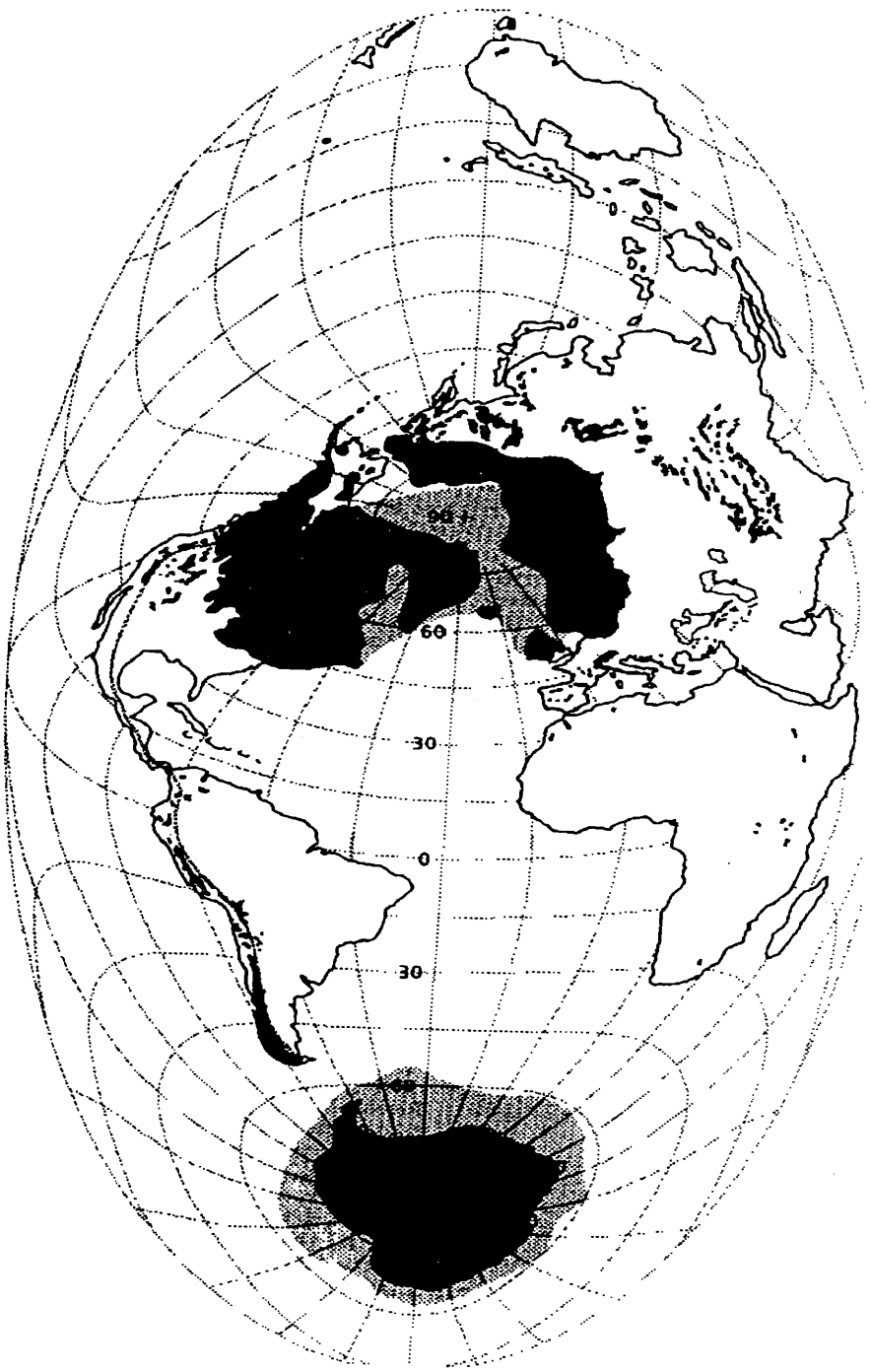
Thursday, MAY 7,
0830-1700
Friday, MAY 8,
0830-1500

WOOLLEY ROOM
COMMUNITY
CENTER

DORIS TWITCHELL
ALLEN VILLAGE

UNIVERSITY OF
MAINE

ORONO, ME



Presentations by:
University of Maine
Faculty, Staff and
Students and
Maine Geological
Survey Scientists

UNIVERSITY OF MAINE
INSTITUTE FOR QUATERNARY STUDIES
SIXTH ANNUAL
RESEARCH SYMPOSIUM
MAY 7 AND 8, 1988

DORIS TWITCHELL ALLEN VILLAGE: WOOLLEY ROOM

PROGRAM

THURSDAY, MAY 7

0830: **COFFEE**

0855: **WELCOME AND INTRODUCTION: Daniel F. Belknap**

SESSION 1 - CLIMATE, GLACIOLOGY, AND MODELING

0900: **Kirk A. Maasch**, **Robert J. Oglesby**, **Susan Marshall**, and **Gary T. Bates:** Improving Climate Model Representations of Snow Hydrology

0920: **Paul Prescott, James L. Fastook** and **Terence J. Hughes:** The Calving Dynamics of Jakobshavns Isbrae

0940: **James L. Fastook:** Where Does All the Water Go?

1000: **Heather Franco:** Millennial scale climate variability: A low-order model relating Heinrich and Dansgaard-Oeschger events

1020: **COFFEE BREAK**

SESSION 2 - GEOARCHAEOLOGY

1040: **Daniel F. Belknap:** Geoarchaeology in coastal environments: examples from Peru, Delaware and Maine

1100: **Lee E. Battick:** Geoarchaeology of the Sebasticook fish weir

1120: **Daniel H. Sandweiss:** Mid to late Holocene variation in El Niño frequency

1140: **Stacy Shafer:** Late Holocene Coastal Development on the Northwest Coast of Peru: Change Detection Analysis of Beach Ridge Sets using Remote Sensing Techniques

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1200: **LUNCH Doris Twichell Allen Village**

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SESSION 3 - POSTER SESSION

1300 -

Poster **Karen E. Mack, Alice R. Kelley, David Sanger** and **Stephen Bicknell:** Investigations in the Milford Reservoir, Maine: An Interdisciplinary Approach

Poster **Heather McInnis:** Early Maritime Adaptations on the Coast of Peru: Subsistence and Maritime Adaptations at Quebrada Jaguay, Camana, Peru

SESSION 4 - QUATERNARY GEOLOGY

1340: **Harold W. Borns Jr, Parker E . Calkin, and Robert Ackert:** Evidence for Thicker Ice in Interior West Antarctica

1400: **Brenda L. Hall and George H. Denton:** Millennial-Scale Surface-Level Changes of Closed-Basin Antarctic Lake

1420: **George H. Denton:** Anomalous Erosional Topography in Victoria Land, Antarctica

1440: **COFFEE BREAK**

1500: **Meredith A. Kelly:** Surficial deposits in Upper Victoria Valley, Antarctica: Glacial Moraines or Lake-Ice Conveyer Deposits?

1520: **L. Kirk Lurvey:** Relict Landforms Preserved in Eastern Maine

1540: **Alice R. Kelley:** Isostatic Adjustment as a Paleoenvironmental Control in the Penobscot River Valley, Maine

1600: **Joseph T Kelley, Stephen M. Dickson, Daniel F. Belknap** and **Walter A. Barnhardt:** Nearshore Sand Volume as a Component of Littoral Sand Budgets in Maine, Northern New England, USA

1620: **David C. Smith** and **Harold W. Borns Jr.:** Louis Agassiz (1807-1873) and the State of Maine – The Beginning of Modern Geology

FRIDAY, MAY 8

0830: **COFFEE**

0855: **WELCOME AND INTRODUCTION: George L. Jacobson, Jr.**

SESSION 5 - ECOLOGY AND PALEOECOLOGY

0900: **Andrea Nurse:** The Effects of Interspecific Competition and Habitat Change on the Life History of *Cypripedium arietinum*

0920: **Richard A. Jack:** The Paleoecological History of Appleton Bog, Maine, with Preserve Management Recommendations

0940: **Jacobson, G.L., Jr.:** Influences of Regional Climate Variability on the Spread of Agriculture in Southern Sweden During the Past 6000 Years

1000: **Thomas D. Henze:** Post-Glacial Depositional Conditions as Interpreted from the Lithostratigraphy of Peaked Mountain Pond, northern Maine.

1020: **COFFEE BREAK**

1040: **Molly Schauffler:** Late-Holocene Development of Spruce-Fir Forests on Coastal Maine Islands – a Progress Report

SESSION 6 - PALEOCEANOGRAPHY

1100: **James D. Wright:** Eastern Pacific Climates During the Holocene: Implications for Climate Dynamics during the Hypsithermal Period

1120: **Detmar Schnitker:** The Deglaciation of the Gulf of Maine

SESSION 7 - ARCHAEOLOGY

1140: **Newsom, Bonnie D.:** Ceramic Period Occupations at the Seboeis Site (108-38), Central Maine

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1200: **LUNCH Doris Twichell Allen Village**

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SESSION 7 - ARCHAEOLOGY (CONTINUED)

1300: **John P. Mosher:** Early and Middle Archaic Subsistence

1320: **Kristin D. Sobolik:** *Mustela macrodon* from North America

1340: **Richard T. Will:** Archaeological Resource Survey of the Proposed Maritimes & Northeast Natural Gas Transmission Pipeline

1400: **David Sanger:** The Wabanaki Confederacy: an Organizational Principle for the Maritime Peninsula?

1420: **COFFEE BREAK**

1440: **Thor Heyerdahl: DISTINGUISHED RESEARCH ASSOCIATE: KEYNOTE DISCUSSION**

ABSTRACTS

(listed alphabetically by author)

Geoarchaeology of the Sebasticook Fish Weir

Battick, Lee E., Institute for Quaternary Studies, University of Maine. lbattick@maine.maine.edu

A prehistoric wooden fish weir complex was recently identified at an inlet to Sebasticook Lake in central Maine. Radiocarbon dates indicate the weir underwent multiple episodes of construction and maintenance from 5080-1760 BP. The Sebasticook fish weir is one of a few prehistoric "wet" sites identified in northeastern North America and provides archaeologists with a rare opportunity to examine evidence of Archaic and Ceramic period technologies, subsistence and corporate behaviors.

While preserved weir stakes are exposed in the inlet channel at extreme low water, it is not clear whether the weir was actually placed in the stream channel or in a shallow area of the lake proper. Sediment cores taken near the inlet record a paleo- channel 3m deeper than the present channel. Basal dates on detrital organic matter indicate the paleo-channel began infilling by 6100 BP. The paleo-channel may have been cut by a stream at lower lake level, or higher velocity than that of the modem Sebasticook River. Seismic profiles of lake sediments suggest that a wave cut terrace formed at -8m below present lake level during a period of lower water. Migration of the inlet channel in response to lower lake level or higher stream velocity may have shifted the focus of the weir over time. Additional seismic profiling and sediment coring aimed at determining lake level history and the evolution of the inlet channel should help establish the relationship of the weir complex to changing lake levels and depositional patterns as well as provide information on regional climate change.

Geoarchaeology in Coastal Environments: Examples from Peru, Delaware and Maine

Belknap, Daniel F., Dept. Geological Sciences, School of Marine Sciences, and Institute for Quaternary Studies, University of Maine, Orono, ME. belknap@maine.maine.edu

A model of preservation potential for marine archaeological sites (Kraft, Belknap and Kayan, 1983) suggests that discovery of drowned sites (intact) on the shelf is extremely unlikely. However, geoarchaeology provides reconstructions of the landscape in which the ancient peoples made a living, allowing better understanding of the archaeological record, and a model for exploration for offshore and hidden coastal sites. In turn, archaeology provides dates and constraints on paleoenvironments in the geological studies. This model is based explicitly on coastal Delaware and the eastern Mediterranean, yet provides a general predictive model for preservation potential of coastal sites. In the Delaware, coastal plain sites, in a setting of relative sea-level rise, preservation potential is greatest on the flanks of incised valleys, in backbarrier settings, where burial preceeds ultimate coastal erosion.

Investigations in northwestern Peru link archaeological sites to beach ridges influenced by El Niño cycles. This coast has prograded over the past 6 ka, preserving a rich record of geology and archaeology. Research in 1997 suggests that at least one set of sandy ridges (Chira) are preserved primarily because of midden shells which prevent them from blowing away.

The Maine coast is geomorphically complex, with rocky headlands, deep tidal embayments and estuaries, as well as sandy beaches. It has also experienced a complicated Quaternary history of deglaciation and sea-level changes. Human occupation of this diverse coast has likely occurred throughout the Holocene, but because of a local rise in sea level of 55 m over the past 10,500 years, the early record of human occupation and activities is drowned or has been destroyed by littoral processes. Kellogg (1982, 1991) developed a predictive model for location of coastal sites based on southerly exposure, beaches for canoes, and proximity to resources, that was tested in existing middens (e.g., Todd Site). Seismic reflection profiling, sidescan sonar imaging, and vibracoring have been used to reconstruct paleogeography and sample natural stratigraphic sections to extend this model to former shorelines at lower sea-level positions.

Comparison of these three settings reveals the relative influences of sea-level change, climate, sediment supply, paleogeographic setting, and human usage of the coastal landscape and other resources. Modification of the basic model to account for different sea-level regimes and climatic settings should increase its usefulness as a general predictive tool.

Evidence for Thicker Ice in Interior West Antarctica

Borns, Harold W., Jr., Institute for Quaternary Studies, University of Maine, **Calkin, Parker E.,** SUNY Buffalo and **Ackert, Robert,** M.I.T. and Woods Hole Oceanographic Institution

High level moraines on the late Cenozoic volcano, Mt. Waesche in the Executive Committee Range of Marie Byrd Land record higher levels of the West Antarctic ice sheet. The present elevation of the ice sheet is 2000 m and the moraines are present upward for another 100 m before bare bedrock is encountered.

Preliminary cosmogenic surface exposure ages of the moraines decrease systematically downward from ~282 ka to ~11 ka at the present ice surface. The bedrock surface just above the highest moraine dates at ~405 ka.

The highest moraine, more topographically "subdued" than the ones below, probably represents the highest level of ice during the penultimate glaciation. The moraine about 10 m below dates at 19.7 ka and represents the level of the ice at the last glacial maximum (LGM) while those below represent lowering levels during deglaciation.

This is the first glacial evidence from central West Antarctic for a more expansive ice sheet at the LGM and contradicts the interpretation of the gas bubble pressures in the Byrd Station ice core that suggests an ice surface level ~200m lower than at present at the LGM.

Anomalous Erosional Topography in Victoria Land, Antarctica

Denton, George H., Institute for Quatemary Studies and Dept of Geological Sciences, Univ. Maine. (debbies@maine.maine.edu)

H.T.V. Smith published a paper in Science in 1965 (v. 148, p.941-942) under the above title in which he described unique erosional terrain cut in dolerite bedrock at the head of Wright Dry Valley in Victoria Land, Antarctica. This terrain consists of a labyrinthine complex of interconnecting channels, some as much as 1000 m deep. He interpreted this topography in terms of fluvial erosion resulting from catastrophic flooding analogous to that which produced the Channeled Scabland of eastern Washington.

It now turns out that similar anomalous erosional topography is widespread in the Victoria Land sector of the Transantarctic Mountains. This topography occurs on valley floors, valley walls, mountain ridges, and high plateaus. It occurs on dolerite, sandstone, and crystalline bedrock. It features channels, potholes, scabland relief, fields of transverse gravel ridges, and "ripple" forms in granite and sandstone bedrock. All these features can be tied into a single erosional surface of middle Miocene in age that can be traced across at least three major blocks of the Transantarctic Mountains. The interpretation of this erosion surface represents a major puzzle that must be resolved in order to understand the evolution of a polar ice sheet in Antarctica. Any suggestions are appreciated.

Where Does All the Water Go?

Fastook, James L., Dept. Computer Sciences and Institute for Quaternary Studies, University of Maine. shamis@gandalf.umcs.maine.edu

Melt water produced by an ice sheet whose bed reaches the pressure melting point has the potential to spread the wet-based region of the ice sheet far beyond the area predicted by a simple temperature model. A simple model of water motion is presented which allows for basal water to move beneath the ice sheet. The continuity equation for basal water is solved using the finite-element method. A comparison between two different mass balance schemes shows this calculation to be quite sensitive, suggesting that current parameterizations of mass balance, while adequate for ice sheet configuration modeling, are not accurate enough to be used with the basal water calculation.

Millennial scale climate variability: A low-order model relating Heinrich and Dansgaard-Oeschger events

Franco, Heather, Dept. of Geological Sciences, University of Maine, heather@iceage.umeqs.maine.edu

Millennial climate variability occurs on two, seemingly related time scales. The first is a 1 to 3 thousand year (kyr) period. These variations are typified by so-called Dansgaard-Oeschger events which are stadial to interstadial oscillations during the Late Pleistocene, measured in the $\delta^{18}O$ values of the Greenland ice cores. The $\delta^{18}O$ values record a shift of up to 8°C in the average temperature. The second period of millennial scale variation is 5 to 12 kyr. Heinrich events are the main proxy for this quasi-period. The 1 to 3 kyr variations are known to continue into the Holocene, but the longer period variations are not. This may be due to physical mechanisms involving the Laurentide ice sheet, the source of Heinrich events, which are not directly related to a coeval climate change. My thesis project will examine the relationship between these two periods of variation.

The method to be used to address the significance of the association between the 1 to 3 and 5 to 12 kyr climate variations is low-order dynamical modeling. A low-order model is a set of equations describing a system. This type of model is one that requires an understanding of the interactions between the variables of the climate system because the system must be simplified for the model. The goal of this project is to modify and couple two existing models; a sea-ice/ocean model and an ice sheet mechanics. The output of this procedure will display how the atmospheric temperature at sea level effects the internal dynamics of an ice sheet and how the icebergs effect the extent of sea-ice and the circulation of the ocean. Coupling the models will lead to a better understanding of how these processes and time scales are related. The outcome of this coupling will then be compared to actual occurrences seen in the geologic record.

Millennial-Scale Surface-Level Changes of Closed-Basin Antarctic Lakes

Hall, Brenda L., Department of Geological Sciences and Institute for Quaternary Studies, University of Maine, 5790 Bryand Global Science Center, Orono, Maine 04469, Brendah@maine.maine.edu, and **Denton, George H.,** Department of Geological Sciences and Institute for Quaternary Studies, University of Maine, 5790 Bryand Global Science Center, Orono, Maine 04469.

Millennial-scale oscillations are believed to be the building blocks of abrupt climate change. Yet the cause of such oscillations is problematic. One step toward determining the origin of millennial-scale events is to discover their geographic extent and timing. Here we present evidence of millennial-scale surface-level changes of closed-basin, amplifier lakes in the Dry Valleys (77-78 °S) region of Antarctica. Using over 200 radiocarbon dates of lacustrine algae within relict deltas and shorelines, we have constructed preliminary surface-level curves for lakes in Taylor, Wright, and Victoria Valleys. Peaks in lake-level are generally synchronous among the valleys. In Taylor Valley, high lake levels (up to 300 m above the present lake) occurred at 18,600, 18,100, 17,200, 16,300, ~15,600, 14,900, 13,900, 13,300, 12,800, 12,300, 11,700, ~10,500, ~9300, ~8900, and ~6000 ^{14}C yr B.P. In Wright Valley, high lake levels (up to 470 m above present-day Lake Vanda) occurred at 25,700, ~19,900, ~19,000, 14,500-15,400, 12,700, 12,000, 10,800, 7900-8400, ~6000, and 2700 ^{14}C yr B.P. Farther north in Victoria Valley, we recorded high lake levels (up to 160 m above present-day Lake Vida) at ~18,900, 13,800, 13,000, 12,000-12,400, 10,600, 9000, and ~5700 ^{14}C yr B.P.

The importance of these lake-level data is that they are one of only a few records from the Antarctic that show evidence of millennial-scale climate change. Moreover, they suggest that millennial-scale climate change was not limited to the glacial period, but has occurred in the present interglacial period. The cause of such large and abrupt variations in lake level is not well-known, but is believed to relate to climatically induced changes in meltwater production. Future work will concentrate on determining the relationship between climatic parameters and meltwater production.

Post-Glacial Depositional Conditions as Interpreted from the Lithostratigraphy of Peaked Mountain Pond, northern Maine.

Henze, Thomas D., Institute for Quaternary Studies, University of Maine, Orono, ME, thenze51@maine.maine.edu

Post-glacial stratigraphic records from New England and the adjacent Canadian provinces do not give uniform evidence for environmental changes during the Late-glacial. At some ponds and lakes within the region, accumulation of a more minerogenic lithology occurred during the Younger Dryas chronozone, at others, the Younger Dryas sedimentological signal is either attenuated or non-existent. The lithostratigraphy of Peaked Mountain Pond includes a sedimentological signal, and resembles that reported for more than twelve ponds in maritime Canada and eastern Maine. The cause of heterogeneous lacustrine core stratigraphies accumulated during the Late-glacial in this region might be due to the gradation of Late-glacial climate, or due to the gradation of environmental response to a changing climate. A spatial array of data must be assembled to discriminate between these spatially defined scenarios. Peaked Mountain Pond is well situated to provide one data point in such an array.

Because the age and distribution of lithological changes do not show how such changes were deposited, their cause must be interpreted at locations where pronounced transitions are evident.

Using a cross-section composed from cores, I interpret stratigraphic relationships and the sedimentology of various units of the Peaked Mountain Pond lithostratigraphy to indicate reworking of previously deposited sediment and changes in water level. Subsequent stages of this project will include the development of an integrated radiocarbon chronostratigraphy and a biostratigraphy based on plant macrofossils.

The Paleoecological History of Appleton Bog, Maine, with Preserve Management Recommendations

Jack, Richard A., Ecology and Environmental Science Program, University of Maine richardjack@umit.maine.edu

I reconstructed a paleoecological history of the last 9,900 ^{14}C years for the northernmost Atlantic white-cedar (*Chamaecyparis thyoides*) dominated peatland using pollen, macrofossil, and charred particle remains from peat cores at three sites ~500 m apart. Pollen analysis revealed that all three sites had minor Atlantic white-cedar populations prior to increasing to dominance. These data were confirmed via macrofossil analysis in two of three cores. Atlantic white-cedar populations rose to dominance in each core at different times and at different rates, suggesting that many sites are required to evaluate the establishment of a species in a peatland.

Detailed stratigraphic analysis of plant macrofossils and charred particles in one core revealed fire return intervals between 700 and 1,600 years. Appleton Bog could have a much longer stand replacement interval than southern stands, or alternatively, regeneration may have progressed via stand-wide blowdown. Neither of these hypotheses

could be entirely eliminated using my current data. Continuous recruitment of Atlantic white-cedar seedlings fits my data best and I postulate that an atypical (for the species in historical time) uneven-aged forest, was common in prehistoric time. A shifting mosaic of windthrow canopy gaps and less frequent fire, combined with a reduced competitive ability in red maple near its northern limit of dominance in peatlands, probably explains the success of Atlantic white-cedar at Appleton Bog in recent millennia. Using this interpretation, I argue for no active management. Prescribed burning or selective logging would only be necessary to perpetuate the stand in the absence of natural windthrow.

Influences of Regional Climate Variability on the Spread of Agriculture in Southern Sweden During the Past 6000 years

Jacobson, G.L., Jr., Institute for Quaternary Studies, University of Maine, Orono, ME
jacobson@maine.maine.edu

Earliest agricultural practices in southern Sweden date to approximately 6000 BP. In the rich agricultural region of Skania, archaeological and paleoecological data spanning that period show a general progression of increasingly intensive land-use, beginning with grazing of livestock in the forests and ending with modern industrial agriculture. Although some changes in land-use activities appear to have been abrupt, neither climate nor cultural factors (e.g., population pressure, introduction of new crops or practices, local conflicts, etc.) could be ruled out as primary stimuli. The role of climate in the expansion (and occasional contraction) of agriculture was assessed by evaluating changes in vegetation history of a small upland region in southern Sweden - the Highlands of Smoland - where local climate and soils have remained marginal for agriculture. Paleoecological records from this area reveal primarily the natural influences of changing Holocene climate on the vegetation. Climate-dominated records from the Highlands suggest that changes in land-use practices in nearby areas of intensive agriculture were not driven primarily by variations in climate.

Isostatic Adjustment as a Paleoenvironmental Control in the Penobscot River Valley, Maine

Kelley, Alice R. , Department of Geological Sciences, Rm 111, 5790 Bryant Global Sciences Center, University of Maine, Orono, ME 04469, akelley@maine.maine.edu

The profound effect of isostatic adjustment of the earth's crust following the last glaciation has been well documented in the coastal areas of northern New England and Canada. Investigations by Balco (1996) in the Moosehead Lake area of Maine demonstrate that the inland portion of the region has also experienced geomorphic changes associated with isostatic adjustment. Balco's work suggests that the spillway of Moosehead Lake, Maine's largest lake, changed from the drainage of the Penobscot River to the Kennebec River in the Early Holocene. He proposes that such a switch would decrease the discharge of the Penobscot River by approximately 12%, and increase the flow of the Kennebec River by 25%.

A geologic event of this magnitude should be recorded in the alluvial sediments of each river valley. This talk will present evidence from archaeological excavations in the central Penobscot River Valley which support a change in deposition associated with isostatic adjustment within the early Holocene.

Just as variations in river volume and gradient effect the sedimentary record, these changes also influence environments within the river valley, and help shape the paleoenvironmental record of the region. On the basis of this work, isostatic adjustment following glaciation is an additional factor to be considered as a part of a paleoenvironmental reconstruction in glaciated landscapes.

Balco, Gregory A., 1996, Postglacial Land and Lake Levels, Moosehead Lake, Maine, Master's Thesis, Department of Geological Sciences, University of Maine, Orono, Maine.

Nearshore Sand Volume as a Component of Littoral Sand Budgets in Maine, Northern New England, USA

Kelley, Joseph T., Maine Geological Survey (and 1,2,3), **Dickson, Stephen M.,** Maine Geological Survey (and 2), **Belknap, Daniel F.,** Dept. Geological Sciences[1], School of Marine Sciences[2] and Instiutute for Quaternary Studies[3], University of Maine, Orono, and **Barnhardt, Walter A.** U.S. Geological Survey, Menlo Park, CA. walterb@octopus.wr.usgs.gov

Sand and gravel (S&G) provide important habitats for commercial fish in the Gulf of Maine, and are an increasingly valuable commodity for use as beach replenishment along eroding shorelines. To understand the distribution and volume of S&G along the Maine coast, we evaluated seismic reflection (>5,000 km) and side scan sonar profiles (>3,000 km), vibracores (>50) and bottom samples (>1,700) between the shoreline and 100 m isobath from Canada to Massachusetts. Sand occupies only 8% of the seafloor, but is nearly constant in areal abundance with respect to depth. There are four major repositories for S&G: 1) directly offshore of major sand beach systems, 2) along shelf

valleys between the modern beach and the lowstand-shoreline position, 3) surrounding reworked Pleistocene moraines, and4) near the late Quaternary lowstand-shoreline at 50-60 m depth.

In a region with abundant glacial moraines (Wells), $145x10^6$ m^3 of S&G are part of the modern shoreface, of which 33% exists as a possible shoal retreat massif. Seaward of the small river (Saco Bay), $56x10^6$ m^3 of S&G are found in the shoreface, compared with only 22 million m3 in the region's largest berm and dune system. Off the large Kennebec River (Cape Small) more than a billion cubic meters of S&G exist in a lowstand delta and associated modern shoreface. Off the largest river in the region (Penobscot River), there are no (S&G) deposits yet recognized. Cores and seismic data suggest that shelf valley deposits are spatially varible and generally thin (<1m). Lowstand deposits were stranded in deep water by rapid Holocene sea-level rise, and are potentially very large, but remain largely undefined by cores because of their depth. Morainal deposits are typically small and usually armored with coarse gravel. Modern shorefaces contain the largest quantity of S&G, but because of their intimate association with eroding beaches, they will probably never be available for replenishment purposes.

Surficial deposits in Upper Victoria Valley, Antarctica: Glacial Moraines or Lake-Ice Conveyer Deposits?

Kelly, Meredith A., Institute for Quaternary Studies, University of Maine, Orono, ME 04469.
Meredith.Kelly@umit.maine.edu

An important question about the evolution of the East Antarctic IceSheet concerns the transition from temperate to polar glacialconditions. One method by which to investigate the transition is todevelop records of glacial environments from surficial depositspreserved in the Dry Valleys.

At present, two hypotheses exist to explain the origin of deposits in Upper Victoria Valley. One hypothesis describes the deposits as glacial moraines and associated outwash. Such interpretation implieslarge fluctuations in Victoria Upper Glacier. The other hypothesis is that the deposits were formed by a lake-ice conveyer. Lake-ice conveyer deposits form in permanently ice-covered lakes which exist only in cold, polar environments.

To test these hypotheses, I am conducting a study of the geomorphology and sedimentology of the surficial deposits in Upper Victoria Valley. I mapped the deposits in the field based on morphology, surface texture, and stratigraphy exposed in hand-dug excavations. Sediment from the deposits will be analyzed for grain size, sorting, lithology, and weathering characteristics. Classic glacial moraines near the Conrow Glacier in eastern Wright Valley were also mapped and sampled for comparison with the deposits in Upper Victoria Valley.

Field observations of morphology, sedimentology, and stratigraphy suggest the deposits in Upper Victoria Valley are significantly different from the moraines near Conrow Glacier. Rather, the deposits in Upper Victoria Valley have many features characteristic of lake-ice conveyer deposits. Such interpretation would imply cold, polar conditions in Upper Victoria Valley.

Mapping results afford a relative chronology of glacial environments based on the stratigraphic position and weathering characteristics of the deposits. Radiocarbon dates of fossil algae found in deposits will supplement the chronology.

Relict Landforms Preserved in Eastern Maine

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llurvey51@maine.maine.edu

Recent literature and discussion has been focused on the apparent survival of pre-glacial landforms preserved beneath ice sheets due to cold-based conditions (Sugden and John, 1976; Dyke, 1993; Kleman, 1994; Kleman and Borgström , 1994; Glasser, 1995). During a recent mapping of glacial landforms in the area surrounding the Narraguagus and Pleasant River Valleys, in eastern Maine, several boulder depressions were discovered. These boulder depressions are similar to those described in Sweden by Kleman and Borgström (1990) and have also been discussed by Batterson (1989) and Parent et. al, (1996). These boulder fields or "blankets" are dense masses of boulders covering any kind of substratum (Kleman, pers comm.) and are interpreted to be periglacial features preserved during the last glaciation. These landforms represent areas of cold-based ice.

These boulder depressions are located immediately south of the mountains of the Tunk Mountain Range. I have observed that these mountains (in contrast to those of MDI) fail to demonstrate a typical streamlined (glacially carved) morphology, but instead exhibit distinct domed shapes. I suggest the Tunk highland area was occupied by frozen-based ice allowing preservation of landform morphology as suggested by the newly discovered boulder depressions.

Improving Climate Model Representations of Snow Hydrology

Maasch, Kirk A., Institute for Quaternary Studies and Dept. of Geological Sciences, University of Maine, kirk@iceage.umeqs.maine.edu; **Oglesby, Robert J.**, Dept. Earth and Atmospheric Sciences, Purdue University; **Marshall, Susan**, Dept. Geography and Earth Sciences, University of North Carolina, Charlotte; and **Bates, Gary T.**, Climate and Global Dynamics Division, National Center for Atmospheric Research

The extent and duration of the seasonal snowpack plays an important role in determining local, regional and global climate. In this study previous work that led to an improved representation of snow albedo in regional and global climate models is broadened and expanded to include representation of the following processes: (i) partitioning of energy between melt, evaporation of meltwater, and refreezing within the snow pack (current parameterizations usually assume all available energy goes into melt only); (ii) the 'dirtiness' of snow (due to dust and other particulate loading); (iii) heat added to a snowpack by rain; and (iv) the vertical temperature profile within a snowpack. In addition, a new parameter, called 'WFLUX', is introduced as a useful glaciological parameter that is based on the net energy available for snowmelt. The new snow hydrology formulation is implemented into two widely used climate models: a global GCM, the NCAR CCM3/LSM, and a regional climate model, the RegCM2 version of MM4. A suite of new simulations has been made with RegCM2 for various sections of the United States for the 1992-1993 snow season. Calibration and validation of the new snow hydrology is accomplished by comparison to available ground and satellite-based datasets of snowcover, including both mean conditions and year-to-year variability. The goal is not just to improve the simulation of the present-day seasonal cycle (which is reasonably-well simulated by many current climate models) but also to improve the predictive capability of models when used to address questions of past climate (especially those involving glaciation) and possible future climatic change. The improved snow representation is used in global simulations and in regional simulations of the United States western mountains, Great Lakes, and northeast regions.

Poster

Investigations in the Milford Reservoir, Maine: An Interdisciplinary Approach

Mack, Karen E. (Institute for Quatemary Studies), kemack@maine.maine.edu, **Kelley, Alice R.** (Department of Geological Sciences), **Sanger, David** (Department of Anthropology and Institute for Quaternary Studies), **Bicknell, Stephen** (Department of Anthropology), Univ. Maine.

Since 1988 the University of Maine, under contract with Bangor Hydro-Electric Company, has conducted interdisciplinary research in the Milford Reservoir. To date three prehistoric archaeological sites have been extensively excavated in the area of Pushaw Stream and its confluence with the Stillwater River. These sites have revealed 8,000 years of prehistoric occupation. Data gathered has provided us with insights into previously established models of prehistoric settlement patterns, resource exploitation, and culture history.

Geoarchaeological investigations have contributed information related to Late Pleistocene and Holocene fluvial conditions in the area and geologic setting of sites at time of occupation. Comparison of geologic data gathered at sites throughout the region has aided in a further understanding of site location and preservation models. By combining stratigraphic data, gathered during site excavations, with water balance history developed for the region, links have been made between climate and the Late Holocene sedimentary history of the study area.

Poster

Early Maritime Adaptations on the Coast of Peru: Subsistence and Maritime Adaptations at Quebrada Jaguay, Camana, Peru

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Quebrada Jaguay 280 (QJ 280, Camana, Peru) is one of the few South American archaeological sites with a Paleoindian component exhibiting marked maritime adaptations. This investigation of faunal remains recovered from excavations at QJ 280 helps define the subsistence base and maritime adaptations at the Early Preceramic site, dated to between 11,100 and 7,500 BP. These remains provide information on the species and habits exploited by site inhabitants, on the technology used to procure these resources, and on changes in environment, technology, and/or cultural preferences during Paleoindian and early Archaic times on the south coast of Peru.

Early and Middle Archaic Subsistence

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People using two different stone tool technologies were living in New England during the Early and Middle Archaic periods (10,000 to 5900 ^{14}C BP). Little is known about the relationship between the two technological traditions, the people who used them, or the types of subsistence. The proposed research will be to investigate human subsistence in New England during the Early and Middle Archaic periods. The question is whether or not there are

subsistence differences that may help clarify the relationship between the people who relied on stone biface technology and those who did not. Due to New England's acidic soils and to other taphonomic factors, the only botanical and faunal remains available are those that have been burned by fire. Calcined bone is fragmentary by nature, the bones of small animals are more likely to be identifiable then are those from large animals. Even so, calcined assemblages provide one of the few means for examining prehistoric diet. Data sets will be derived from primary research on calcined bone assemblages, and on a literature search of published sources and contract archaeology reports. The data will be incorporated into a Geographic Information System to identify spatial patterning.

Ceramic Period Occupations at the Seboeis Site (108-38), Central Maine

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During the summers of 1996 and 1997, Bangor-Hydro Electric contracted with the University of Maine to conduct a Phase II archaeological assessment of cultural resources being impacted by the Howland Dam. This project showed prehistoric archaeological sites clustered within two localities along the lower Piscataquis River-the Seboeis Stream locality, situated at the Piscataquis River/Seboeis Stream confluence, and the Maxy Brook locality, located at the confluence of the Piscataquis River and Maxy Brook. Eighteen sights underwent Phase II excavations. This paper focuses on one site within the Seboeis Stream locality. The Seboeis site (108-38) is a pre-contact habitation site that shows well-stratified evidence of Early and Middle Ceramic Period occupations. To date, few research efforts have focused on Ceramic Period sites from the interior regions of Maine. A well-preserved ceramic assemblage, combined with good stratigraphic context and radiocarbon dates, makes the Seboeis site an important element in understanding Ceramic Period occupations of Maine's interior.

The Effects of Interspecific Competition and Habitat Change on the Life History of Cypripedium arietinum.

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Cypripedium arietinum R.Brown is a small, woodland orchid found only between 42 - 50 degrees north latitude in eastern North America and between 25 - 35 degrees north latitude in higher altitudes of western China. Quaternary climate changes accelerated speciation and extinction of a number of upper Tertiary and early Quaternary circumboreal flora species, possibly including this species. Current *C. arietinum* distribution suggests limited range expansion from unglaciated areas. *Cypripedium arietinum* populations in Maine have declined from sixteen historic sites to three known stands. A stand of *C. arietinum* in Wayne Bog provides a good opportunity to assess effects of long-term climate change and short-term habitat control on an isolated rare plant population. What is the vegetation history of the Wayne Bog region since deglaciation? Could changes in climate and vegetation influence the ability of *C. arietinum* to disperse? Can the longevity of the orchid stand be determined through contiguous core analysis for pollen, phytoliths, and macrofossils? Have anthopogenic and natural disturbances affected the Wayne Bog stand? This five-year research program is a combination of paleoecological and modern ecological studies designed to monitor orchid response to habitat change, seed dispersal, and *in situ* seed germination. Historic habitat change will be assessed using procedures established by Jacobson et. al. (1991) at Crystal Fen. Pollen and phytolith reference collections will be catalogued, and core samples will be analyzed for vegetation and stand history.

The Calving Dynamics of Jakobshavns Isbrae

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Jakobshavns Isbrae is the world's fastest alacier. It has a maximum velocity of 8 km/a at its calving front, which floats in Jakobshavns Isfjord in Disko Bugt on the west coast of Greenland. It retreated 27 km from 1850 to 1964, after which the calving front has stabilized, perhaps because it is pinned to bedrock at one point. The remainder of the last 10 km floats in the fjord and is supplied by an ice stream that extends 100 km into the Greenland ice sheet. The University of Maine has been studying Jakobshavns Isbrae since 1974, and analysis of data is ongoing, notably calving dynamics.

Past and present ice sheets are drained by ice streams, which are fast currents of ice that develop near the margins of ice sheets and discharge up to 90 percent of the ice. Ice streams can turn on and off. An important question is if Jakobshavns Isbrae turned off, would its calving rate of 8 km/a continue and, if so, for how long? If it calved at that rate for 30 years it would carve out the Greenland Ice Sheet all the way to the central ice divide.

Surface crevassing is ubiquitous on the floating part of Jakobshavns Isbrae. We have identified two calving mechanisms. Slabs the size of city skyscrapers calve due to bending shear stresses along the calving front. Tabular

icebergs the size of city blocks calve along longitudinal and transverse crevasses that intersect and form at or behind the grounding line, are carried passively to the calving front, and reactivated by the bending stresses. Both kinds of calving are related to water depth, ice height above water, surface strain rates, ice rheology, crevasse patterns, and boundary conditions along the grounding line, the fjord sidewalls, and around the basal pinning point. A full stress analysis in the map plane was undertaken using finite-element modeling and hundreds of ice velocity and elevation measurements, mostly on the floating ice, to quantify the calving mechanisms. Results to date are presented. A major unresolved problem is whether the floating part can be treated using the assumptions of continuum mechanics, or whether intersecting crevasses require that it be treated as an assembly of weakly coupled blocks.

Mid to late Holocene variation in El Niño frequency

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Review of the malacological record from coastal Peruvian archaeological sites dating between 5000 and 2000 BP suggests a change in El Niño recurrence intervals. Between ca. 5000 and 3000 BP, El Niño apparently had a lower frequency than the historic mean; by 2700-2500 BP, the recurrence interval for significant events had become more frequent, similar to the historic mean. Some other paleoclimate records for the Pacific Basin also suggest that fully modern climate was not achieved until 3000-2000 BP. Along the north and central coasts of Peru, a region suffering major impact from El Niño, a tradition of temple mound construction begun shortly after 5000 BP comes to an abrupt halt around 2700 BP. The temporal coincidence with the hypothesized increase in El Niño frequency suggests a possible causal relation.

The Wabanaki Confederacy: an Organizational Principle for the Maritime Peninsula?

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Archaeologists recognize considerable similarity between pre-European cultures of the Maine-Maritimes Provinces area, also known as the Maritime Peninsula. The similarities recognized are at the level of artifacts and adaptive strategies. Several hypotheses that might explain these similarities are presented. Some possible themes are circumscription and marginal effects, environmental possibilism, and common adaptation. None of these are wholely satisfactory. A well known historical institution, the Wabanaki Confederacy, provides a socio- political model that may help explain much of the commonality in material culture recognized in the archaeological record. But whether this institution is a cause or an effect remains debatable.

The Deglaciation of the Gulf of Maine

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The almost enclosed Gulf of Maine was filled with continental ice at the height of the last glaciation and has gradually evolved into the biologically productive body of water of today. This study examined this evolution which is recorded within the sediments on the Gulf of Maine bottom. AMS ^{14}C dating of benthic foraminifers contained in glacimarine sediments indicate that seawater entered into the Gulf by at least 17,600 yrs B.P. The $\delta^{18}O$ of benthic foraminifers indicate the inflow of typical North Atlantic Slope Water through the deep Northeast Channel, as it occurs today. The areal distribution and thicknesses of glacimarine sediments and the absence of diatoms from sediments older than about 14,000 yrs suggests the presence of an ice shelf over the Gulf of Maine until that time. The glacial ice in the Gulf of Maine formed a topographically buttressed ice shelf, producing much glacial-marine sediment. During deglaciation from ca. 18 ka to 14 ka a system of successive small ice shelves probably existed as ice stream input was buttressed by a series of banks and shoals, providing temporary stability. A low-diversity fauna of typical ice-margin benthic foraminifers occupied the ocean floor beneath the ice shelves. Breakup of successive ice shelves created calving embayments, producing finer sediments with dropstones, more affected by currents with icebergs plowing the shallower basin margins. Diatoms and "polar" planktonic foraminifers inhabited these seasonally ice-free environments. Cessation of ice-rafting marks the beginning of diatom and foraminiferal successions that track the evolution of the Gulf of Maine from an ice-marginal to a temperate/boreal environment of high productivity.

Late-Holocene Development of Spruce-Fir Forests on Coastal Maine Islands – a Progress Report

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Regional pollen records from lakes and bogs throughout Maine indicate that spruce and fir became dominant in the region only in the last 1000 years. This recent expansion appears to be part of a large regional expansion of southern populations of spruce across eastem North America, presumably as the climate cooled. Where did the southern populations of spruce occur in Maine during the mid-Holocene? How do histories of development and disturbance compare among spruce stands? My comparison of fossil pollen and charcoal records from coastal forested hollows in spruce stands in Acadia National Park and on Roque Island with those from inland sites at Big Reed Preserve supports the hypothesis that for thousands of years prior to the regional late-Holocene spruce rise, spruce was predominant along Maine's coast, but not inland. The pollen stratigraphies from several of the coastal sites indicate a mid-Holocene rise in spruce, a possible consequence of a cooling maritime climate due to changes in tide amplitude and decreased Gulf of Maine temperatures between 5 ka and 4 ka bp. In this progress report I will focus on (1) results from a site on Schoodic Peninsula where spruce has thrived for the last 5000 years and (2) my examination of the apparently good correspondence between modern pollen deposition and the taxa present in local forest stands in Maine.

Late Holocene Coastal Development on the Northwest Coast of Peru: Change Detection Analysis of Beach Ridge Sets using Remote Sensing Techniques

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The Northwest Peruvian coast is actively prograding, abandoning previous beach faces as new sediment is accreted onto the shoreface. During the Late Holocene eight to nine remnant beaches were preserved in ridge sets of varying morphologies (Chira, Colan, Piura and Santa). An average of one ridge is preserved for every 500 years of time since 5000 yrs BP. The Peruvian Coastal Desert is one of the driest places on Earth. El Nino rains are the only source capable of mobilizing enough material to form a coastal ridge large enough to be preserved in the geomorphic record. Seismic activity and resultant landslides may contribute to the sediment source by loosening material which is later mobilized by the El Nino rains (Sandweiss et al., 1983; Sandweiss, 1986).

The present study uses imagery and field data to test the potential relationship between coastal processes, El Nino and seismic activity in the modern environment. Progradation rates and shoreline change are examined at ridge locations north of the Chira River and Piura River, as well as at the base of ephemeral stream valleys in Colan. Aerial photographs are digitally overlaid at several time intervals from 1946 to 1993. Ridge and shoreline features are extracted from the images. Temporal correlations between coastal activity, present El Nino and seismic events are noted. The goal is to determine a possible cause and effect relationship responsible for the creation of new beach ridges. This mechanism may then be extrapolated back to explain the formation and preservation of the older ridges.

Louis Agassiz (1807-1873) and the State of Maine – The Beginning of Modern Geology

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Louis Agassiz established a holistic view of ice ages. He first developed his theories at Neufchatel. He moved to the United States in 1846 where he was appointed Professor of Natural History at Harvard. Agassiz continued his geological observations in northern New England while setting up the Museum of Comparative Zoology as part of the Harvard and Boston scientific world. In September and October 1864 he took a long working holiday in Maine. His observations on this field trip, coupled with his work in Massachusetts, New Hampshire and on the White Mountains led him to the conclusion that northern New England had undergone a major ice event in the past.

Agassiz continued his interest in Maine, providing commentary and advice on the establishing of the Maine State College. He offered recommendations on faculty appointments, the development of the scientific curriculum and helped establish the Maine State College in its role as a state institution involved in research and technology.

Agassiz recruited several Maine persons to act as his graduate assistants in the Museum of Comparative Zoology. Many of these persons travelled with Agassiz on a number of lengthy field trips on a vessel which acted as a sea-going college. C. A. Stevens, of Norway, Maine, cousin of Addison Verrill, one of Agassiz's students, accompanied the Agassiz group on these travels, and he wrote well received juvenile novels describing Agassiz and his methods of teaching. Although juvenile fiction, these volumes outline clearly how Agassiz and his students increased their store of knowledge.

Agassiz was a leader in developing American science. His work in Maine helped him to organize his thoughts and in turn, created a scientific atmosphere in Maine and New England.

Mustela macrodon from North America

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Mustela macrodon (extinct sea mink) is known only from ArchaicNative American shell middens dating less than 5,100 years old along coastal and off-shore islands of the Gulf of Maine, northeastern North America. The species is distinct from all known extant subspecies of *M. vison* (mink), but still belongs to the North American subgenus *Vison*. Metric comparisons are made between M. macrodon and five subspecies of *M. vison*, using skull, mandible, humerus, radius, femur, and tibia skeletal elements. *M. macrodon* is larger in overall size, robustness, and disproportionately larger in the dental region. There are many parallels, due to habitat, between coastal/coastal island mink of Gulf of Maine and those of the Alexander Archipelago, southeastern Alaska, where the overall largest living subspecies of mink is found (*M. v. nesolestes*)

Archaeological Resource Survey of the Proposed Maritimes & Northeast Natural Gas Transmission Pipeline

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An archaeological resource survey of the proposed Maritimes & Northeast natural gas transmission pipeline was conducted in Maine in 1996 and 1997. Survey of the mainline involved examination of a 90 foot wide corridor extending from the Piscataqua River in South Eliot to the St. Croix River in Baileyville. Additional survey involved investigation of corridors for lateral pipelines off the mainline to Cousin's Island, Skowhegan, Bucksport, and Millinocket. More than 350 miles of pipeline corridor were examined. Survey methods involved developing a stratified sampling design from a variety of data sources and then shovel testing areas designated as having "high," "moderate," or "low" sensitivity for the presence of archaeological sites. Fieldwork involved subsurface testing of areas within each sensitivity grouping. Twenty prehistoric archaeological sites were discovered. The majority of them were uncovered in areas designated with high sensitivity for prehistoric sites. No prehistoric sites were uncovered in areas scored with low sensitivity. Sites range in age from the Paleoindian period to the Contact period. The data show that most sites were found near water and that most sites were also deposited in sand rather than silt or clay. Information collected from this cultural resource management project provides empirical support for traditional archaeological beliefs regarding prehistoric settlement patterns in Maine.

Eastern Pacific Climates During the Holocene: Implications for Climate Dynamics During the Hypsithermal Period

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Warmer mid-Holocene climates, termed the Hypsithermal, occurred in many mid- to high-latitude regions throughout the world. Two mechanisms could account for these warmer temperatures: (1) a decrease in the surface wind forcing which would result in warming in eastern equatorial regions as well as in the mid- to high-latitudes; or (2) an increase in the wind-driven circulation, allowing subtropical western boundary currents to deliver more heat to the higher latitudes. Each mechanism would produce different effects on the eastern boundary environments. In the former scenario, a decrease in the surface wind velocities would allow the eastern sides of the subtropical gyres to warm; while, the latter scenario would lead to cooling in these regions. Faunal and stable isotopic evidence from mollusk shells collected in middens along the coast of Peru give conflicting results for mid-Holocene climates (~6500 to 5000 yrs. B.P.) in this region. Planktonic foraminiferal stable isotope records from cores collected at 11°S on the continental margin of Peru were generated to reconstruct the open marine climatic variability during the Holocene. Preliminary $\delta^{18}O$ results indicate that the surface waters in this region were slightly cooler at 6000 yrs. B.P. than at present. The $\delta^{13}C$ records suggest that upwelling may have been more intense during the mid-Holocene which would account for the cooler sea surface conditions.