THE LOUIS J. AGASSIZ SYMPOSIUM, SEVENTH ANNUAL RESEARCH SYMPOSIUM UNIVERSITY OF MAINE INSTITUTE FOR QUATERNARY STUDIES

1999

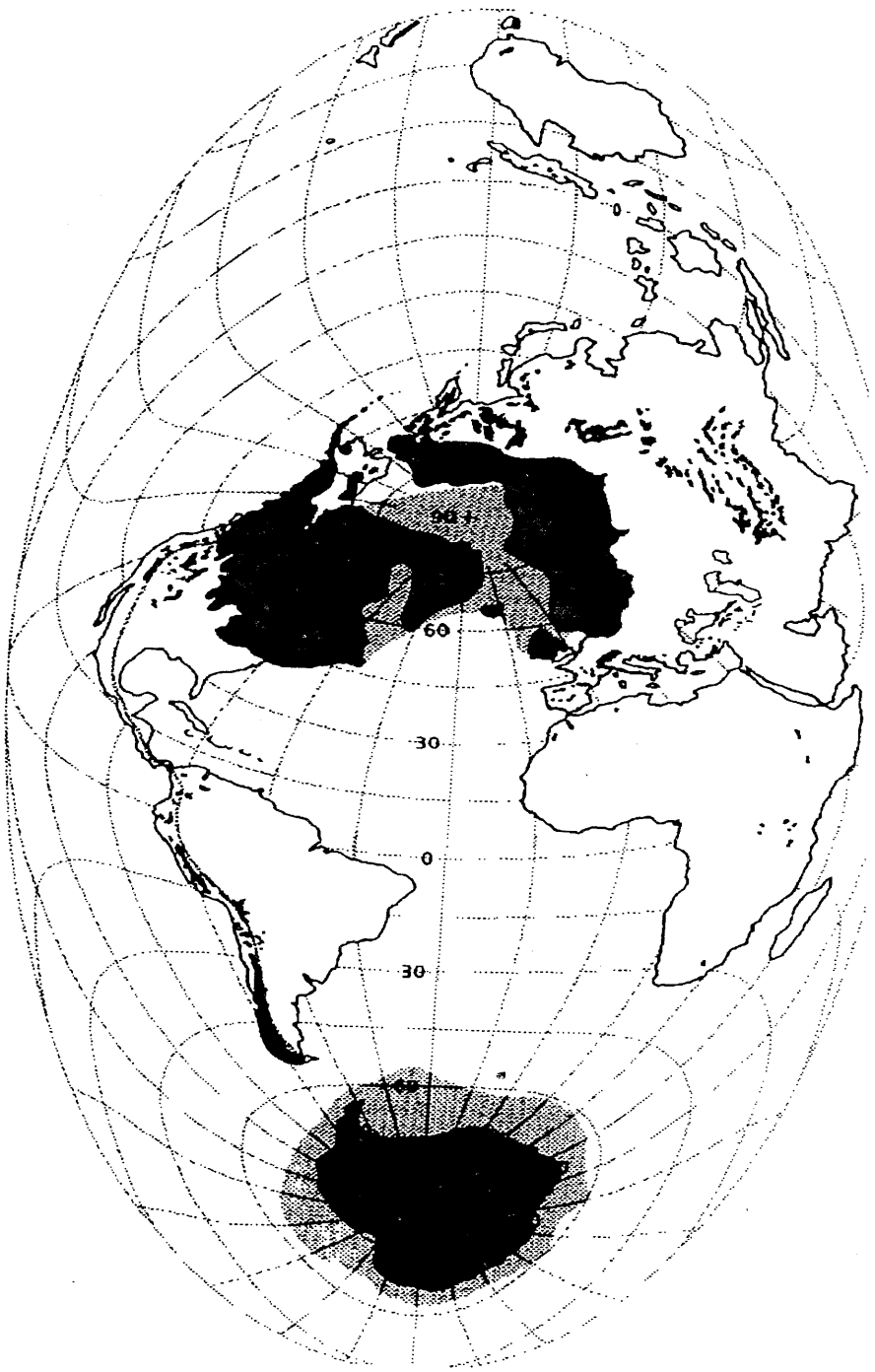
Wednesday, MAY 5, 1900-2000
(Room 100 BGSC)
Thursday, MAY 6, 0830-1700
Friday, MAY 7, 0830-1500

WOOLLEY ROOM COMMUNITY CENTER

DORIS TWITCHELL ALLEN VILLAGE

UNIVERSITY OF MAINE

ORONO, ME



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

REVISED SCHEDULE AND ADDED ABSTRACT

SESSION 3 - POSTER SESSION

1300: DAVIS, Ronald B. and ANDERSON, Dennis S., Research and Data Bases on Maine's Inland Organic Wetlands (Peatlands) and Their Environments IncludingClimate

DIEFFENBACHER-KRALL, Ann C.: The Relationship Of Modern Plant Macrofossils To Water Depth

HALL, Brenda, DENTON, George H. and CONWAY, Howard: Holocene Grounding-Line Retreat in the Ross Sea Embayment: Implications for the Future Stability of the West Antarctic Ice Sheet

LAGERKLINT, I. Marianne: Late Glacial Climate Study In A Complicated Setting West Of Equatorial Africa

NURSE, Andrea M., Ice-Contact Deposits And Fluvial Outwash Till In The Upper Sandy River Valley, Western Maine.

SESSION 4 - QUATERNARY GEOLOGY

1340: LORREY, Andrew M.: Landscape Evolution And Polygon Development on a Debris-Covered Glacier Surface, Beacon Valley, Antarctica.

1400: LEWIS, Adam R., Does Massive Buried Ice In Beacon Valley, Antarctica, Have Paleoclimatic Significance?

1420: KREUTZ, Karl, Ice-Core Based Paleoclimate Records From The Tien Shan And Himalayan Ranges: Towards Reconstructing Asian Monsoon Circulation

1440: **COFFEE BREAK**

1500: FRANCO, Heather and MAASCH, Kirk A., Examining The Timing Of The North Atlantic's Heinrich Events

SESSION 5 - PALEOECOLOGY

1520: MCINNIS, Heather, Paleoindian Maritime Adaptations On The Coast Of Peru: Quebrada Jaguay Site QJ 280

1540: CAMERON, Dawn, The Role Of Allogenic And Autogenic Factors On Development Of A Plateau Bog In Coastal Maine

1600: DALY, Julia F., BELKNAP, Daniel F. and KELLEY, Joseph T., Constraining Holocene Relative Sea-level Curves by Applying the Indicative Meaning of Salt-marsh Floral and Faunal Zones

1620: HENZE, Thomas D., and LEHMANN, Charlotte: Analyses for Carbonate Made on Lacustrine Mud from Peaked Mountain Pond, T10-R11, Maine: Inconsistent Results and Conflicting Interpretations.

PALEOINDIAN MARITIME ADAPTATIONS ON THE COAST OF PERU: QUEBRADA JAGUAY SITE QJ 280

MCINNIS, Heather, Institute for Quaternary Studies, University of Maine, hmcinnis@midmaine.com

A Paleoindian age component at Quebrada Jaguay 280 (Camaná, Peru) provides evidence of one of the earliest known maritime-based sites in South America. Investigation of vertebrate and non-molluscan invertebrate faunal remains from QJ 280 helps define the subsistence base and maritime occupations at this Early Preceramic site, dated between 11,000 and 7,500 ^{14}C yrs BP. These remains provide information on species and habitats exploited, technology and processing techniques and on changes in cultural preferences and/or environment from Paleoindian to early Archaic times on the coast of Peru. Results of this study support the hypothesis that early residents of this site were fully adapted to a maritime environment, yet spent only part of their time on the coast.

UNIVERSITY OF MAINE
LOUIS J. AGASSIZ SYMPOSIUM
INSTITUTE FOR QUATERNARY STUDIES
SEVENTH ANNUAL RESEARCH SYMPOSIUM
MAY 5, 6 and 7, 1999

DORIS TWITCHELL ALLEN VILLAGE: WOOLLEY ROOM

PROGRAM

Wednesday Evening, May 5

1855: **WELCOME AND INTRODUCTION:** Daniel F. Belknap

1900: DENTON, George W., Geology and climate research in the southern Hemisphere

THURSDAY, MAY 6

0830: **COFFEE**

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

SESSION 1 - CLIMATE, GLACIOLOGY, AND MODELING

0900: ACKERT, Robert P., BARCLAY, D.J., BORNS, H.W., Jr., CALKIN, P.E., and KURZ, M., Geologic Evidence of Higher Ice Sheet Elevations in Interior West Antarctica

0920: FASTOOK, James, West Antarctic Ice Sheet: Advance and Retreat in the Ross Sea Sector

0940: LEWIS, Adam, NELSON, John, SCOFIELD, John, and HUGHES, Terence J., Deducing Basal Conditions Along Byrd Glacier From Ice Hardness Variations

1000: REUSCH, Douglas, and HUGHES, Terence J., Calculating Constraints on Ice Along the Central Flowband of Byrd Glacier

1020: **COFFEE BREAK**

SESSION 2 - GEOARCHAEOLOGY Moderator: John Mosher

1040: MACK, Karen E. and WILL, Richard T., Initial Investigations of a Prehistoric Village at the Mouth of the Saco River

1100: WILL, Richard T., Some Recent Middle Holocene Dates From Archaeological Deposits Located Along the Saco River

1120: MOSHER, John P., Middle Archaic Period Subsistence in Northern New England: A Comparison Between the Gulf of Maine Archaic Tradition and the Stark/Neville Complexes

1140: BATTICK, Lee, Seismic Profiling, Coring, and Geoarchaeological Evidence for Lake-level Changes, Sebasticook Lake, Maine.

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1200: **LUNCH** **Doris Twichell Allen Village**

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SESSION 3 - POSTER SESSION

1300: HALL, Brenda, DENTON, George H. and CONWAY, Howard: Holocene Grounding-Line Retreat in the Ross Sea Embayment: Implications for the Future Stability of the West Antarctic Ice Sheet

DIEFFENBACHER-KRALL, Ann C.: The Relationship Of Modern Plant Macrofossils To Water Depth

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FRIDAY, MAY 7

0830: **COFFEE**

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

SESSION 6 - QUATERNARY SCIENCE AND SOCIETY

0900: JACOBSON, George L., Jr., Quaternary science and public policy: opportunities, obligations, and obstacles

SESSION 7 - QUATERNARY GEOLOGY

0920: BELKNAP, Daniel F., KELLEY, Joseph T. GEHRELS, W. Roland, and BARNHARDT, Walter A., Determination Of Late Quaternary Crustal Warping Around The Gulf Of Maine From Regional Comparison Of Relative Sea-Level Curves.

0940: JOHNSON, Jesse, The Finite-Element Method For Introducing Isostasy To Existing Ice Sheet Models

1000: KELLOGG, Davida E., and KELLOGG, Thomas B., The Dynamic Explanation For Diatoms In The Sirius Group: A Hodgepodge Of Thinking About A "Hodgepodge Of Diamicts"

1020: KELLOGG, Thomas B. and KELLOGG, Davida E., Wind-Blown Diatoms In Antarctic Ice Cores: Provenance Indicators Of Former Storm Tracks

1040: **COFFEE BREAK**

SESSION 7 - ARCHAEOLOGY

1100: SOBOLIK, Kristin D., BIGELOW, Gerald, CRADER, Diana, MOSHER, John, SPIESS, Arthur, and WILL, Richard: Zoogeography Of Maine: Data From The Prehistoric Record

1120: MOORE, Edward: Technological Continuity Among Paleoindian Lithic Assemblages

1140: ROBINSON, Brian S., Cultural and Environmental Boundaries in the Gulf of Maine Region: Archaic Period Burial Ceremonialism, 8500-3400 B.P.

1200: SANDWEISS, Daniel H., El Niño and Peru's Cultural Patrimony

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1220: **LUNCH Doris Twichell Allen Village**

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1330: **Keynote Speaker: BETTY J. MEGGERS,** Holocene Climatic Fluctuations In Amazonia And Their Impact On Human Groups

ABSTRACTS

(listed alphabetically by author)

GEOLOGIC EVIDENCE OF HIGHER ICE SHEET ELEVATIONS IN INTERIOR WEST ANTARCTICA

ACKERT, Robert P., Woods Hole Oceanographic Institute, rackert@whoi.edu; **BARCLAY, D.J.,** Buffalo State College, **BORNS, Harold W., Jr.,** University of Maine; **CALKIN, Parker E.,** University of Colorado; and **KURZ, M.,** Woods Hole Oceanographic Institution.

A lateral moraine band on Mt. Waesche, a volcanic nunatak in interior West Antarctica provides estimates of past ice sheet surface elevations. 3He and 36Cl surface exposure ages indicate that the proximal part of the moraine, up to 45 m above the present ice surface, was deposited during the Younger Dryas chronozone (11-10 ka). Higher ice surface are consistent with warmer temperatures and increased accumulation in West Antarctica which have been inferred during this interval from the Byrd ice core. The distal part of the moraine likely records multiple earlier ice sheet highstands. Simple ice sheet modeling indicates that the grounding line in the Ross Sea has are treated about 500 km since that time.

SEISMIC PROFILING, CORING, AND GEOARCHAEOLOGICAL EVIDENCE FOR LAKE-LEVEL CHANGES, SEBASTICOOK LAKE, MAINE.

BATTICK, Lee, Institute for Quaternary Studies, Univ. Maine, Orono, ME 04469-5790. Lee_Battick@umit.maine.edu

Sebasticook Lake in Newport, Maine is an artificially dammed, 16.8 km^2 lake with a natural level of 59 m above MSL (53 m below the postglacial marine limit). It contains one of the few "wet" archaeological sites in northeast North America, a complex of fish weirs constructed at the Sebasticook River inlet between 5080 ± 120 and 1760 ± 120 ^{14}C yrs BP (Petersen et al., 1994). Weirs were constructed of sharpened poles and wattle. They were probably used to catch anadromous fish migrating up the Kennebec River and Sebasticook River Drainage. Besides sharpened stakes, a birch bark container as well as Late Archaic lithic artifacts were found at the site. Weir poles are exposed at present when the lake is lowered in the fall to drain excess nutrients. Vibracoring in 1993 revealed an incised channel cut 4 m below pre-dam water level into the Pleistocene Presumpscot Formation, a glaciomarine mud. This channel is filled with organic detritus including bark and twigs, with a date of 6,100 ± 120 ^{14}C BP from the flank of the channel. The weir stakes intrude into the organic fill as well as into the glaciomarine mud. Twenty-six kilometers of high-resolution 3.5 kHz seismic reflection profiles were completed in 1994. These data covered the weir site as well as basins and margins of the lake. Bedrock and till are draped by well-stratified Presumpscot Formation, and by a more transparent unit interpreted as glaciolacustrine mud. The uppermost unit in the basin is gyttja, while shallows are capped by a strong reflector that may be gas (from paludal deposits) or possibly sand and gravel strata. A distinct angular unconformity is cut into the Pleistocene units, forming terraces at 6-8 m below lake level. These terraces are interpreted as lake-level lowstand shorelines, formed in the early Holocene, contemporaneous with the incision of the Sebasticook River inlet. This interpretation agrees with similar lake-levels changes documented in Lake Auburn, Mansell Pond, and other sites in Maine. Ongoing work includes lake basin coring, and side-scan sonar imaging in Sebasticook Lake, to further determine environmental changes and relationships to prehistoric human activities.

DETERMINATION OF LATE QUATERNARY CRUSTAL WARPING AROUND THE GULF OF MAINE FROM REGIONAL COMPARISON OF RELATIVE SEA-LEVEL CURVES

BELKNAP, Daniel F. Dept. Geological Sciences, School of Marine Studies, and Institute for Quaternary Studies, University of Maine, belknap@maine.edu, **KELLEY, Joseph T.** Maine Geological Survey and Dept. Geological Sciences, School of Marine Studies, and Institute for Quaternary Studies, University of Maine, jtkelley@maine.edu, **GEHRELS, W. Roland,** Dept. Geographical Sciences, Univ. of Plymouth, United Kingdom, and **BARNHARDT, Walter A.** Western Marine and Coastal Surveys, U.S. Geological Survey.

The rim of the Gulf of Maine contains a detailed record of late Quaternary relative sea-level changes. Late Pleistocene events are recorded in shorelines and fossiliferous glaciomarine sediments emerged on land or in the shallow marine. Submerged paleo-shorelines and fossiliferous littoral sediments document lowstand positions and timing. Mid-to-late Holocene relative sea-level curves are well documented in salt marshes. Finally, tide-gauge data constrain regional patterns of warping acting in historic times. The late Pleistocene curve from Maine reveals a rapid drop from highstand at 14-13 ka 60-80 m above present (isostatic depression), to a lowstand 50-60 m below present by 10.8 ka (isostatic rebound), followed by a rapid, and then slowing rise to -20 m at 8 ka (eustatic rise and marginal bulge passage), followed by renewed rapid and then slowing rates in the mid-to-late Holocene. This curve can be shown to resemble those for the Scotian Shelf and St. Lawrence River if a model of a decaying, northward-migrating marginal bulge passing through the region is accepted. These data are strongly at odds with published numerical models of global scale that suggest a much more muted rate and amplitude of change for this region. We suggest that a more realistic accounting is required for 4-dimensional variations in lithospheric and mantle properties in this setting on a continental margin, near the edge of the Laurentide ice sheet, and in a non-equilibrium state of ice build-up and decay. Holocene marsh peat curves show a continued warping across the Gulf of Maine. For example, at 5 ka there is a difference in sea-level data from Wells, ME of -3 m to Barnstable, MA, while the difference is -8 m to Yarmouth, NS. This apparent relative warping down to the southeast, persists in the record of 11 modern tidal gauge data records as well (e.g., over a common range 1930-1990, a rate of rise of 2.1 mm/yr in Portland, ME vs. 3.4 mm/yr in Halifax, NS). Modeling of tidal-range change cannot account for either of these Holocene trends. Neotectonic warping along the Maine coast is not supported by the data, but we cannot rule out such an effect NW-SE across the Gulf of Maine. We suggest a residual glacioisostatic trend (long-wavelength marginal bulge) and/or hydroisostatic warping as the most likely causes of this regional differential warping.

THE ROLE OF ALLOGENIC AND AUTOGENIC FACTORS ON DEVELOPMENT OF A PLATEAU BOG IN COASTAL MAINE

CAMERON, Dawn, Institute for Quaternary Studies, University of Maine, Orono, ME, dawn@iceage.umeqs.maine.edu

Plateau bogs are a unique type of coastal raised bog, distinguished by morphometry, hydrology and plant communities, which in Maine are found east of Penobscot Bay. The restricted geographic range of these bogs suggests that higher moisture, temperature and inputs of marine aerosols in coastal regions may be partially responsible for their shape. It is not known how plateau bogs develop and what causes their unusual morphometry. Determining the sequence of events that leads to this unique shape may allow for understanding the mechanisms of both coastal and inland raised bog development and for predicting the long term stability of these ecosystems. This project investigates a plateau bog in Jonesport, Maine and how its developmental pattern compares to previous studies of both coastal and inland raised bogs. Five peat cores were taken along a transect from the center of the bog to its edge. Stratigraphic markers, such as visible changes in peat type, bulk density, and trends in macrofossil data, were used to reconstruct changes in plant communities and infer past surface conditions. Determining the timing of these changes in five cores using radiocarbon dating shows whether the changes were synchronous or time-transgressive across the bog, which demonstrates the importance of allogenic versus autogenic controls, respectively, in peatland development.

Four depositional stages were identified within Jonesport Heath. Initial deposition in all peat cores consisted of an aquatic stage that later developed into a wooded fen. Ombrotrophic conditions began at the center approximately 4300 years B. P. and by 3920 B. P. spread laterally to its modern extent. The synchronous expansion of Sphagnum peat across the peat mound can be attributed to the influence of allogenic factors. Within the ombrotrophic peat layer, two stages are distinguished by differences in accumulation rates, patterns of Sphagnum-lichen growth, and other variables such as macrofossil density. The final transition to modern conditions occurred between approximately 1200 years B. P. in the central core to 500 years B. P. near the bog's margin. This time-transgressive peat horizon was likely induced by autogenic factors linked to peat accumulation. This field study provides evidence for both allogenic and autogenic factors directing the development of Jonesport Heath.

CONSTRAINING HOLOCENE RELATIVE SEA-LEVEL CURVES BY APPLYING THE INDICATIVE MEANING OF SALT-MARSH FLORAL AND FAUNAL ZONES

DALY, Julia F., Department of Geological Sciences, julia@iceage.umeqs.maine.edu, **BELKNAP, Daniel F.** and **KELLEY, Joseph T.,** Department of Geological Sciences, School of Marine Studies, and Institute for Quaternary Studies, University of Maine.

Records of Holocene sea-level change reflect the influence of local, regional, and global processes. Identifying the relative influence of different processes is best accomplished by comparing curves from several locations. However, it is critical that comparable information is being conveyed by each curve. Conventional construction of sea-level curves has fit lines though a series of data points, often resulting in the presentation of a curve with misleading precision. We present sea-level curves for several areas based on previously published data, but re-plotted as envelopes to emphasize the actual precision of sea-level histories for each area. In addition, we have calibrated the data to a common time frame. Associated with each index point on a sea-level curve is a vertical and temporal uncertainty. Previously published curves have not always indicated these uncertainties, especially the vertical range. This vertical range is constrained by the paleoenvironmental significance of a salt-marsh sample as determined from the vegetation or foraminiferal assemblage associated with each sample. Floral and faunal zones can be determined in the modern environment, and vertical ranges for each zone with respect to mean sea level established. This determines the indicative meaning of the sample. This vertical range is often not presented in published sea-level curves. Because of this vertical uncertainty for each index point, and temporal uncertainties associated with each sample due to analytical error in dating techniques, data that have conventionally been plotted as points should be plotted as rectangles. Rather than fitting a line through these rectangles, similar to the conventional construction of sea-level curves, the corners of these rectangles should be considered to define an envelope of sea-level change. This envelope more accurately represents the history of sea-level change for an area by defining upper and lower vertical limits on the position of sea level for any given time (e.g. Gehrels et al., 1996). This uncertainty more accurately represents the limits to the precision of these curves, and allows for better comparison between records.

INLAND ORGANIC WETLANDS (PEATLANDS) AND THEIR ENVIRONMENTS INCLUDING CLIMATE

DAVIS, Ronald B. Department of Biological Sciences and Institute for Quaternary Studies, University of Maine, Ronald_Davis@umit.maine.edu, and **ANDERSON**, Dennis S. Department of Biological Sciences, rbt385@maine.maine.edu.

INTERHEMISPHERIC LINKAGE OF PALEOCLIMATE DURING THE LAST TERMINATION

DENTON, George H., Department of Geological Sciences and Institute for Quaternary Studies Bryand Global Sciences Center, University of Maine, Orono, Maine 04469

A great challenge facing paleoclimatologists is to identify the timing and mechanisms of abrupt climate changes in the Northern and Southern Hemispheres during the last termination. This task requires detailed paleoclimate records from key locations in the Southern Hemisphere designed to answer the following questions. Are the abrupt mode flips seen in Greenland ice cores regional or global? Was there early warming in the Southern Hemisphere? Or did the two hemispheres warm abruptly and simultaneously? Or did one warm abruptly and the other gradually? Is the Younger Dryas climate reversal registered in the Southern Hemisphere? The Bˆlling warm peak? Or did the two hemispheres feature antiphased climate oscillations during Bˆlling-Younger Dryas time? Unfortunately, there are now sharply different paleoclimate signatures within the Southern Hemisphere that lead to sharply contrasting answers to these questions.

Stable isotope records correlated with new trapped-gas chronologies afford evidence for asynchronous interhemispheric climate changes between Greenland and Antarctic ice cores. The Byrd ice core in West Antarctica does not show the abrupt changes during the last termination so evident in the North Atlantic. Instead, a gradual change in the stable-isotope signal in the Byrd ice core began several thousand years before the first abrupt warming registered in Greenland ice cores at the Oldest Dryas/Bˆlling transition (1, 2). Also, stable isotope oscillations recorded in the Byrd and Vostok ice cores during Bˆlling/Allerˆd and Younger Dryas times were out of phase with their

Greenland counterparts. These results are consistent with some Southern Ocean marine cores in showing a Southern Hemisphere lead through important climate transitions (3). This Antarctic lead seemingly precludes any hypothesis that climate changes are a response to Northern Hemisphere events (2). The asynchronism strongly suggests, moreover, that the interhemispheric connection is not through the atmosphere. Rather, it favors models that call for overall ocean heat extraction from the Southern Hemisphere during times of vigorous North Atlantic thermohaline circulation (4, 5), producing a seesaw effect between the hemispheres as a whole (6). Another possibility is that the Antarctic asynchrony is not hemisphere wide, but is confined to regions south of the Antarctic Circumpolar Current. If so, the out-of-phase oscillations might be attributed to a bipolar seesaw behavior of thermohaline circulation. By this mechanism, decreased (increased) downwelling of North Atlantic Deep Water was replaced by increased (decreased) downwelling in the Southern Ocean. The resulting out-of-phase import of ocean heat into the North Atlantic and Southern Oceans is what would have caused antiphased climate signals in the Greenland and Antarctic ice cores (7).

To complicate the situation, there is also strong evidence for synchronous interhemispheric climate change. A new ice-core record from Taylor Dome in East Antarctica shows nearly the same sequence of abrupt late-glacial climate change as recorded in Greenland ice cores (8). Abrupt warming to near-interglacial conditions occurred in early B^lling time, followed by Younger-Dryas-age climate reversal. Moreover, a paleoclimate record from integrated pollen and glacial geology evidence shows that abrupt climate changes in the southern Chilean Lake District were similar to these in the North Atlantic region (9, 10, 11). The major glacial-interglacial transition occurred in two steps, one beginning at 14,600 14C yr B.P. and the other at 12,700-13,00014C yr B.P. A relatively minor reversal climate reversal set in close to 12,200 14C yr B.P., after an interval of near-interglacial warmth, and continued into Younger Dryas time. Several of these climate shifts in the southern Lake District match those from New Zealand at nearly the same Southern Hemisphere middle latitudes.

Although they can redistribute heat between the hemispheres, changes in ocean circulation cannot solely account either for the synchronous planetary cooling of the LGM or for synchronous interhemispheric warming steps of the abrupt glacial-to-interglacial transition. Instead, such changes must include an important atmospheric signal, probably a change in the greenhouse content of water vapor associated with abrupt global ocean-atmosphere reorganizations.

References: (1) Sowers and Bender, 1995, Science 269, 210-214; (2) Blunier et al., 1998, Nature 394, 739-743; (3) Hays et al. 1976, Science 194, 1121-1132; (4) Crowley, 1992, Paleoceanography 7, 489-497; (5) Stocker et al. 1992, J. Climatology 5, 773-797; (6) Stocker, 1998, Science, 282, 61-62; (7) Broecker, 1998, Paleoceanography 13, 119-121; (8) Steig et al., Science 282, 92-95; (9) Denton et al., 1999, Geografiska Annaler; (10) Heusser et al., 1998, Geografiska Annaler; (11) Moreno et al., 1999, Geografiska Annaler.

THE RELATIONSHIP OF MODERN PLANT MACROFOSSILS TO WATER DEPTH

DIEFFENBACHER-KRALL, Ann C., Institute for Quaternary Studies, University of Maine, Ann_Dieffenbacher@apollo.umenfa.maine.edu.

Paleohydrologists sometimes use plant macrofossils as one of several independent lines of evidence to infer changes in past lake-levels. Typically, this usage relies on an assumption that the seeds of aquatic species are not dispersed far from the source plants. The water depth over the coring site at the time the seeds were deposited is inferred from the water depth at which the species generally grow today. Paleoecologists can make more meaningful ecological interpretations of fossil remains by comparing fossil assemblages to modern assemblages. The objective of this study was to examine the modern water-depths at which different macrofossil types are found in sediment. The results should aid the interpretation of fossil seeds in paleohydrological studies. I calibrated macrofossil types to water depth and tested whether seeds can be used successfully as proxy evidence for lake level. A total of 221 surface sediment samples from 18 lakes in Maine and Massachusetts were examined for plant-macrofossil content, and vegetation was surveyed in the immediate vicinity of each sediment sampling-site. The seeds of some taxa were found in sediment from water-depth ranges much broader than those in which living plants occur. However, in combination, even macrofossil types with broad depth ranges can be used effectively to reconstruct water depth. Test samples indicate that the water depth/macrofossil calibration works well for alkaline lakes in New England.

WEST ANTARCTIC ICE SHEET: ADVANCE AND RETREAT IN THE ROSS SEA SECTOR

FASTOOK, James, Dept. Computer Science and Institute for Quaternary Studies, University of Maine, shamis@umcs.maine.edu

Advance and retreat of the Ross Sea Sector of the West Antarctic Ice Sheet is depicted with an ice sheet model using a parameter which controls the magnitude of calving from the ice shelf. The simulation begins with the present configuration and advances the grounding line out beyond the present ice shelf margin by reducing the calving. Retreat in then initiated by restoring the calving to a nominal value which reproduces the known retreat history and leaves the retreated grounding line stabilized near its present configuration. Flow directions at the maximum extent are in agreement with studies from the Ross Sea outer shelf. Also reported are surface elevation variations at interior locations such as Mt Waesche, where trimlines above the present ice surface have been identified by Borns and Ackert.

EXAMINING THE TIMING OF THE NORTH ATLANTIC'S HEINRICH EVENTS

FRANCO, Heather and **MAASCH, Kirk A.,** Department of Geological Sciences and Institute for Quaternary Studies, University of Maine, Orono, ME, kirk@iceage.umeqs.maine.edu

Immense volumes of icebergs were discharged into the North Atlantic ocean somewh at regularly throughout the last glacial period. Heinrich events, as they are known, seem to have a dominant period near seven thousand years (ky), but the actual range is f rom 5-16 ky. These events appear to correlate with the amplitude variations of shorter cl imate cycles ({\it i.e.} Dansgaard-Oeschger cycles). An ice sheet model in which surges are ca used by internal dynamics was used to determine the effect of changing external cond itions on the basic physical processes of the ice sheet. The model produces a time series of average ice sheet height, basal water amount, and surge rate which are compared to the timing of Heinrich events. The accumulation rate and the initial height were varied f rom 70-400 m/ky and 850-3000 m respectively for a series of model runs. These two parameter s have long term averages that vary on time scales with longer periods than the time bet ween ice rafting events. Accumulation rate is also influenced by the shorter Dansgaard-Oesch ger temperature variations. These are the most significant parameters to study as they impact the surface and basal conditions of an ice sheet.

Model runs using constant accumulation rates within the range given above yi eld a temporal spacing of 6-13.5 ky. Changes in initial glacier height have a large impact on the volume of ice discharged. Longer periods between ice rafting also occur with larger ice sheets (up to 25 ky). The main finding is that the actual variations in accumulation and ice sheet height, which have both longer and shorter periodicities than the observed 5-16 ky, reproduce the time range seen in the marine record of ice rafting.

HOLOCENE GROUNDING-LINE RETREAT IN THE ROSS SEA EMBAYMENT: IMPLICATIONS FOR THE FUTURE STABILITY OF THE WEST ANTARCTIC ICE SHEET

HALL, Brenda, University of Maine and Woods Hole Oceanographic Institution, brendaH@maine.edu, **DENTON, George H.**, Insititute for Quaternary studies and Dept. Geological Sciences, University of Maine, and **CONWAY, Howard**, University of Washington.

At the last glacial maximum (LGM) the West Antarctic Ice Sheet extended over 1400 km beyond its present grounding line in the Ross Sea Embayment. The timing of deglaciation of grounded Ross Sea ice is critical for isolating mechanisms that control West Antarctic Ice Sheet (WAIS) dynamics. Here, we reconstruct grounding-line migration past three geographically spaced terrestrial data points (Scott Coast, Hatherton Glacier, Roosevelt Island) in the Ross Sea Embayment. Most recession occurred in mid- to- late Holocene time in the absence of significant sea-level rise or climate forcing. We suggest that events that triggered ice recession predestined the behavior of the present ice sheet. Current grounding-line instability may reflect ongoing ice recession, underway since early- to- mid Holocene time. One implication is that the WAIS could continue to retreat even in the absence of external forcing.

ANALYSES FOR CARBONATE MADE ON LACUSTRINE MUD FROM PEAKED MOUNTAIN POND, T10-R11, MAINE: INCONSISTENT RESULTS AND CONFLICTING INTERPRETATIONS.

HENZE, Thomas D., Institute for Quaternary Studies, University of Maine, thenze51@maine.edu, **LEHMANN, Charlotte,** School of Marine Sciences, University of Maine

Researchers interested in the environmental history of a lake or its surroundings often measure the loss of mass after ignition (LOI) of lacustrine sediment samples to obtain proxies for organic and carbonate content. For some types of sediment, LOI at 925°C is a proxy for carbonate content, in others the 925°C LOI signal is difficult to explain. Parallel series of late-glacial mud samples taken from some Peaked Mountain Pond cores provide 925°C LOI and 550°C LOI data that vary proportionally at most levels. Both LOI data sets appear to depend upon sediment organic content. We analyzed parallel series of sub-samples of lacustrine mud, (>80 % dry inorganic content), using a LOI at 925°C procedure and a loss-on-reaction (LOR) with hydrochloric acid procedure. These analyses yielded conflicting results for carbonate and proxy carbonate content. In another experiment, we compared coulometric analyses to LOI. Total inorganic carbon coulometry indicated less than 0.25 % carbonate, about an order of magnitude less than LOI at 925°C suggests. We conclude the following: this LOR method is ineffective for the detection of small amounts of carbonate in mud, and LOI at 925°C is not an accurate proxy for carbonate content in the mostly inorganic lacustrine mud from Peaked Mountain Pond. We suspect that 925°C LOI data for this type of mud may include signals of clay mineral dewatering and alteration, iron oxidation, carbonate ignition, and the alteration of unspecified compounds in combination. The 925°C LOI data is insufficient to allow us to distinguish among such components.

QUATERNARY SCIENCE AND PUBLIC POLICY: OPPORTUNITIES, OBLIGATIONS, AND OBSTACLES

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THE FINITE-ELEMENT METHOD FOR INTRODUCING ISOSTASY TO EXISTING ICE SHEET MODELS

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The finite element method provides a powerful technique for finding numerical solutions to differential equations over irregular domains. The essence of the technique is to break the region of interest into a finite set of sub-domains, or elements, and then to solve across the elements using a variational technique in which the solution is approximated as a finite series expansion of appropriate basis functions. Finite element analysis has been successfully applied to an ice sheet model which includes conservation of three basic flux-like variables; mass, momentum, and energy.

It is believed that the isostasy of the underlying lithosphere can play an important role in ice-sheet dynamics. With this in mind a one-dimensional ice-sheet profile has been constructed using the finite element analysis technique. The model includes all major components included in previous models, as well as a new routine which utilizes a well recognized technique for modeling the isostasy of the earth. The isostasy technique makes use of the theory of bending beams and plates, in particular, the theory of a hydrostatically supported beam with a load placed upon it. The result of this theory is a fourth-order differential equation, with key parameters being the flexural rigidity of the plate, the density of the underlying material, and the relaxation time of the beam. Solutions of such an equation have been computed analytically and produce both the characteristic depression and forebuldge consistent with findings in the field.

Several tests and comparisons have been devised for the model. The results closely match those produced by other isostasy models. As a final experiment, the model's output has been compared to the data obtained by Barnhardt et al. (1995) for relative sea-level change in the western Gulf of Maine. The results are reasonable; however, the evidence for a migrating glacial forebuldge has not yet been reproduced.

THE DYNAMIC EXPLANATION FOR DIATOMS IN THE SIRIUS GROUP: A HODGEPODGE OF THINKING ABOUT A "HODGEPODGE OF DIAMICTS"

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Since the so-called "dynamic" explanation, which posits a large-scale Pliocene warming and deglaciation in Antarctica, was first proposed to account for the presence of diatoms in Sirius Group sediments, the questionable empirical evidence presented to support it has come under withering criticism. Yet, in spite of the demonstrated inadequacies of supporting data, the "dynamic" scenario continues to be presented as viable in the literature. In this paper, we question not only these data, but the entire chain of reasoning, proceeding backwards from the presence of diatoms at altitude in the Transantarctic Mountains, to their supposed emplacement by a wet-based ice sheet following flooding of interior East Antarctic basins by warm marine water, to the hypothesized Pliocene warming. We find that "tests" intended to distinguish between the "dynamic" and the competing "stable" hypothesis (mostly over-broad conjectures about the identity, age, and provenence of diatom species found in Sirius sediments as opposed to those in eolian deposits) are inadequate to the task because they are not mutually exclusive; that data presented in favor of the "dynamic" hypothesis are biased, inaccurate, and have been over interpreted or simply misrepresented in order to suit the authors' preferences; and that the philosophical principle supposed to be the "clinch" the argument is actually a simplistic misconstruction of the desideratum commonly known as "Occam's Razor." We conclude that the links in the chain of reasoning from diatoms in the TAMS to Pliocene Antarctic deglaciation do not hold upon examination.

WIND-BLOWN DIATOMS IN ANTARCTIC ICE CORES: PROVENANCE INDICATORS OF FORMER STORM TRACKS

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Marine and nonmarine diatoms occur throughout ice cores drilled at Taylor Dome, Dome C, and South Pole on the East Antarctic Ice Sheet. Similar diatoms occur in snowpits at Siple Dome on the West Antarctic Ice Sheet. Our data demonstrate widespread eolian transport of diatoms to the Antarctic ice sheets, in both space and time, with highest fluxes in the Holocene, and isotope stages 5b, 5c, and 7. Because there are no local diatom sources near any of these locations, the diatoms must have been carried by winds from coastal antarctic or extra-antarctic locations. We have postulated that diatoms recovered from ice cores may be useful provenance indicators, indicating the path followed by storm systems that penetrate to the Antarctic interior. To test this hypothesis, we are compiling a synthesis of all reported occurrences of diatoms (over 300 species) at Antarctic locations and on offlying subantarctic islands and the adjacent southern continents. Because diatom taxonomy has undergone major changes in the last two decades (especially since the invention of the electron microscope), we are also compiling the lastest taxonomic data for each species in order to combine forms that are known by more than one name. Our preliminary results suggest that while some diatoms are widespread and found virtually everywhere in the high southern latitudes, other species are restricted to distinct areas and should be ideally suited as provenance indicators.

ICE CORE BASED PALEOCLIMATE RECORDS FROM THE TIEN SHAN AND HIMALAYAN RANGES: TOWARDS RECONSTRUCTING ASIAN MONSOON CIRCULATION

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The southwest Asian monsoon system represents the earth's largest seasonal shift in atmospheric conditions. Strong evidence exists for a link between monsoon intensity and ENSO during the modern observational period; however, the number of high-resolution paleoclimate records available for investigating ENSO/monsoon coupling, as well as decadal-century scale

trends during the Holocene, is limited. During 1998, glaciological and meteorological studies were conducted at two high-elevation (5300-6000 meter) sites in the Central Asian/Asian Subcontinent region. Records from these sites provide information on two critical components of the Asian monsoon, namely the Siberian high pressure system (Tien Shan site, eastern Kyrghyzstan) and the Indian/Arabian low pressure system (Khumbu Himal site, eastern Nepal). We are currently developing multivariate ice core records that yield information on changes in atmospheric chemistry and circulation, precipitation rate and moisture transport, site temperatures, and atmospheric dust loading in the region. Preliminary results from chemical (major ion and trace element) and isotopic (δ^{18} O) measurements will be discussed in the context of recent (1990 - present) meteorological data.

LATE GLACIAL CLIMATE STUDY IN A COMPLICATED SETTING WEST OF EQUATORIAL AFRICA

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A currently debated scientific question is the global synchrony or asynchrony of climatic events. To examine the relationship between tropical climate records and a previous North Atlantic study (Lagerklint, 1995), a deep-sea core from the continental slope west of equatorial Africa is examined for the late glacial and Holocene time frame. Conditions at the core location are complicated by seasonal upwelling and outflow from the Congo River, factors that influence surface water characteristics and sediment preservation.

To achieve reliable records of climate change, a multivariate method of analysis is applied. The core is dated by accelerator mass spectrometry (AMS) ^{14}C-dating on bulk sediment. Sea surface temperature variations are determined by alkenone analysis of marine organic material and oxygen isotope analysis of planktonic foraminifera. Temperature decreases caused by increased upwelling of cold deep water will be identified by analyzing species that live at different water depths, providing information about the vertical temperature structure. Sedigraph analyses of the sediment s fine fraction will indicate variations in the river discharge which affects the δ^{18}O of the surface water and the foraminiferal shells. Records of river discharge and upwelling may also indicate changes in atmospheric patterns and oceanic circulation.

Initial ^{14}C-dating gave ages of 475 $\pm$ 70 years BP at 98 cm and 12,675 $\pm$ 300 years BP at 298 cm, showing that the core has high sedimentation rate and a long Holocene record. Levels immediately below 300 cm that are barren of foraminifera suggest increased dissolution of $CaCO_3$ in the sediment during the glacial/late glacial transition. This indicates either an increased river outflow and deposition of organic material or increased upwelling of acidic deep water. As chemical dissolution of the foraminiferal shells may distort the isotopic signals, analyses of radiolarian and diatom assemblages may in addition become necessary for the detection of upwelling events.

DOES MASSIVE BURIED ICE IN BEACON VALLEY, ANTARCTICA, HAVE PALEOCLIMATIC SIGNIFICANCE?

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The central portion of Beacon Valley, Antarctica, contains massive ground ice beneath 10 to 100 cm of diamicton and volcanic ash deposits up to 8.1 million years old. Two hypotheses have been put forth to explain the existence of the ice in one of the coldest and driest polar deserts on Earth. One hypothesis, based on models from the Arctic, explains the ice as an accumulating lens segregated from active sand wedges in the overlying soil. This explanation implies the continuous formation of relatively young ice beneath soil that may be much older. The ice would therefore have little paleoclimatic significance.

The second hypothesis explains the ice as a remnant of a glacier preserved beneath ablation till and eolian sediments. This requires the ice to be of the same age or older than the covering volcanic ash deposits. The existence of ice 8.1 million years old would argue strongly for the stability of the Antarctic ice-sheet and climate system since the formation of the Antarctic circumpolar current (ACC) in the early Miocene. The stability of antarctic climate within an ACC dominated regime has ramifications for the studies of global sea level, ocean and atmospheric circulation, and computer modeling of the Earth's climate system.

To test these hypotheses, I am conducting a sedimentological study comparing the covering deposits and ice-cemented wedge deposits to sediment contained within the ice. The sediment will be examined on the basis of grain size, sorting, lithology, and weathering characteristics. Stratigraphic relationships were established in the field in hand-dug excavations exposing the buried ice surface and the diamicton, volcanic ash and ice-wedge deposits. The ice was sampled and will be analyzed for chemical properties and ice crystal orientation fabrics.

Preliminary field observations suggest that the ice was derived from a source outside of Beacon Valley prior to the emplacement of the volcanic ash deposits. Glacially striated granite clasts are common in and overlying the ice, while no granite bedrock occurs in Beacon Valley. Furthermore, although sand wedges overlying and penetrating the ice may be active, they do not appear to be associated with the formation of the ice. The wedges often display cross cutting relationships with ice foliation and do not produce the raised polygon edges or upturned beds commonly associated with growing ice or sand wedges.

DEDUCING BASAL CONDITIONS ALONG BYRD GLACIER FROM ICE HARDNESS VARIATIONS

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Byrd Glacier is the largest outlet glacier delivering East Antarctic ice to the Ross Ice Shelf. It occupies a fjord through the Transantarctic Mountains at 157°E, 80°30'S. The fjord is 100 km long and Byrd Glacier becomes afloat about halfway through. The north fjord wall is granite and the south fjord wall is marble, so the fjord follows a bedrock fault. Velocities and elevations were measured photogrammetrically on the ice surface of Byrd Glacier using control targets placed on the fjord walls and the ice surface during the 1978-1979 Antarctic field season. The velocity gradients were used to measure surface strain rates, which were then used with measurements of surface slope and glacier width to compute variations in ice hardness from the "flow law" of glacier ice. Transverse ice hardness variations were computed at 10 km intervals for the 100 km long fjord. Ice becomes soft in the lateral shear zones of Byrd Glacier, due to thermal and strain softening, as expected. Down the axis of Byrd Glacier, however, ice hardness has an asymmetry that may reflect different basal conditions on opposite sides of the fault. Possible conditions and their-implications for ice-stream dynamics are discussed, notably colder ice on the south side due to a colder source area or due to thinner ice because of dip-slip motion on the fault.

LANDSCAPE EVOLUTION AND POLYGON DEVELOPMENT ON A DEBRIS-COVERED GLACIER SURFACE, BEACON VALLEY, ANTARCTICA.

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The question pertaining to the stability of the East Antarctic Ice Sheet (EAIS) during the Cenozoic can perhaps be answered with the aid of stratigraphic information contained in the surficial deposits of the Dry Valleys region. Beacon Valley may hold stratigraphic clues that can be used to support or refute the notion of a collapsed or stable EAIS during the Pliocene. Debris-covered glaciers are prominent features in Beacon Valley, and the large polygon array that covers them is intriguing. Previously reported $^{40}Ar/^{39}Ar$ ages of ashes in Beacon Valley are of Miocene age, which implies that the buried ice is quite old. Questions arising from this discovery have been numerous- How can ice exist for such a long time in an polar desert environment? How can a landscape covered with patterned ground be considered stable? These questions may be successfully answered through an analysis of the geomorphology and stratigraphy in Beacon Valley.

Surveys and excavations of many polygons in Beacon Valley yielded information pertinent to both patterned ground formation and landscape stability of this region. Mapping the physical dimensions and characteristics of these polygons provides data which can be used to compare the morphology of these features along the long axis of the debris-covered glacier. Some down-glacier trends observed included increases in polygon size, polygon relief, steepness of polygon trenches, width of polygon trenches, and thickness of sedimentary cover. The preservation of delicate stratigraphic and sedimentologic features, such as aeolian bedding, intact volcanic ash wedges,

textural immaturities of ash grains as well as buried desert pavements suggest that this particular area of patterned ground may not have been formed by typical cryoturbative processes. The process by which these polygons form may actually be the preservation mechanism for the buried glacial ice in Beacon Valley.

The buried Miocene ice in this valley, as well as the stratigraphy contained in this particular polygon complex would have likely been destroyed in a temperate glacial climate. This evidence contradicts the hypothesis of a meltdown of the EAIS during the Pliocene, and supports a stable polar climate in the Dry Valleys region since Miocene time.

INITIAL INVESTIGATIONS OF A PREHISTORIC VILLAGE AT THE MOUTH OF THE SACO RIVER

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In the fall of 1998 ARC Inc. conducted phase I archaeological investigations of proposed building sites for the University of New England's marine center. This testing determined the extent and significance of Site 5.06, previously identified in 1985. Site 5.06 covers approximately 17,400 m2 at the mouth of the Saco River extending into the backshore at the western end of Hills Beach. The portion of the site located on the riverbank is shallow (less than 40 cm thick) and varies in age from the Early to Late Ceramic period. No evidence of alluvial deposition was observed in the area. Stratified shell and non-shell, Late Ceramic period, midden deposits were discovered in the backshore area associated with Hills Beach. Midden deposits are in excess of 1.5 m deep in some areas and capped by a layer of fine-medium light colored sand. This sand deposit contains no prehistoric cultural material.

The location of this midden corresponds with the location of a Native American village visited by Samuel de Champlain in 1605. Champlain traveling down the coast from Nova Scotia reached the village at the mouth of the Saco ("Chouacoit") River on July 9th. He mapped the area and recorded descriptions of Native Americans, the village, and farming practices. Interestingly, Champlain's map of the area does not depict Hills Beach or Biddeford Pool, both prominent landforms in the area today. Previous paleogeologic reconstructions of the area done by Hulmes (1980, 1981) concluded that Hills Beach and Biddeford Pool had formed by 1,000 B.P. due to erosion and landward migration of glacial sediments. Understanding the geologic evolution of this area is critical to understanding not only the past environments available to prehistoric occupants but also factors that have affected the preservation of the archaeological record.

KEYNOTE ADDRESS:

HOLOCENE CLIMATIC FLUCTUATIONS IN AMAZONIA AND THEIR IMPACT ON HUMAN GROUPS

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Since the 1970's, when biogeographers inferred the existence of periods of fragmentation of the rainforest during and since the Pleistocene based on distributions of animals and plants not congruent with existing geographical barriers to dispersal, the validity of the refugia model has been contested by palynologists. A variety of studies are now available, ranging from hydrology, limnology, and sedimentology to paleoclimatology and ecology, which strongly support the existence of periods of aridity of varying duration and intensity. Their impact on human groups is documented in archeological evidence for discontinuity in local sequences throughout the lowlands, as well as in the heterogeneity of linguistic and genetic distributions. Repeated exposure to severe subsistence stress from infrequent catastrophic drought explains both the prominence of risk- avoidance behavior among contemporary indigenous Amazonians and the absence of archeological evidence for permanent settlements and associated sociopolitical complexity.

TECHNOLOGICAL CONTINUITY AMONG PALEOINDIAN LITHIC ASSEMBLAGES

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Preliminary analysis of three lithic assemblages attributed to the Paleoindian cultural period suggest potential continuity with respect to strategies in the procurement of raw material, reduction of lithic materials, and the production of tool forms. Two of the assemblages were recovered from single component sites located in the Little Androscoggin River drainage and are dominated by materials transported a considerable distance from their sources. The location of these sources are tentatively identified as Mt. Jasper in Berlin, N.H. and the Munsungun Formation in northern Maine. The production of tool forms from biface as well as block or polyhedral cores is evident in each of these assemblages. Preferential selection of lithic material is suggested between uniface and biface tools with Munsungun Formation chert primarily restricted to the production of unifaces. The third assemblage, recovered near the confluence of the Piscatiquis River and Sebois Stream, exhibits attributes of both the Paleoindian and Archaic cultural periods and may represent a transitional assemblage between the two periods. These attributes include a diverse suite of lithic materials derived from local as well as probable long distance sources and tool types that are characteristic of both periods. Continuing research aims at identifying general trends in the technologies employed to produce the assemblages. This research will involve detailed lithic analysis of the assemblages from a technological perspective as opposed to morphological.

MIDDLE ARCHAIC PERIOD SUBSISTENCE IN NORTHERN NEW ENGLAND: A COMPARISON BETWEEN THE GULF OF MAINE ARCHAIC TRADITION AND THE STARK/NEVILLE COMPLEXES

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Two archaeological traditions are recognized in northern New England during the Middle Archaic period (8000-5900 ^{14}C BP). The first is identified on the basis of diagnostic flaked-stone bifaces (Stark/Neville Complexes of the Atlantic Slope Macrotradition), the other by a diagnostic flake, core, and batter nodule industry (Gulf of Maine Archaic tradition). Little is known about the relationship between the two traditions, and even less is known about Middle Archaic period subsistence. Archaeological investigations in northern New England in the last 10 years have resulted in the recovery of calcined faunal remains from Middle Archaic period sites attributable to either the Stark/Neville complex or to the Gulf of Maine Archaic tradition. These calcined assemblages provide subsistence information that can be used to examine the relationship between the Gulf of Maine Archaic tradition and the Stark and Neville Complexes.

ICE-CONTACT DEPOSITS AND FLUVIAL OUTWASH TILL IN THE UPPER SANDY RIVER VALLEY, WESTERN MAINE.

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Rapid recession of glacial ice margins combined with isostatic crustal depression resulted in marine submergence extending far inland of today's coastal limits. Glacial marine deposits typically grade into estuarine sediments, which, in turn, grade into fluvial outwash sands and gravel. The Sandy River drains a large area southeast of Saddleback Mountain and southwest of Mt. Abraham. Presumpscot formation marine sediments outcrop along the river embankment in Farmington. The valley floor rises in elevation from 113 meters above sea level in Farmington to 152 meters above sea level in Avon. In the town of Avon, river-incised outwash terraces line both sides of the valley. Stoss-and-lee formations, limited striations, and stratified moraine deposit suggest localized southwestern ice flow through the study area during late Wisconsin stage glaciation.

CALCULATING CONSTRAINTS ON ICE ALONG THE CENTRAL FLOWBAND OF BYRD GLACIER

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Byrd Glacier is the largest and fastest East Antarctic ice stream that enters the Ross Ice Shelf. It becomes an outlet glacier as it passes through a fjord in the Transantarctic Mountains at 157°E, 80°30'S. The constraints on ice flowing through the fjord are basal shear due to ice-bed coupling, side shear against the fjord sidewalls, and forward buttressing by the Ross Ice Shelf. The effect of side shear is minimized for the central flowband of Byrd Glacier, so the dominant constraints are the basal traction as measured by the ratio of the basal water pressure P_W to the ice overburden pressure P_I, and the ice-shelf back stress σ_B measured as a ratio with the gravitational pulling stress σ_P. Byrd Glacier becomes afloat about halfway through the fjord. Using a formula that relates the surface slope to the ice thickness, ratio P_W/P_I for the grounded part, and ratio σ_B/σ_P for the floating part, we were able to calculate these two ratios along Byrd Glacier for the respective grounded and floating portions. Ice hardness parameter A in the flow law of ice was chosen to constrain these ratios to vary between zero and unity. Peaks in P_W/P_I coincided with maxima in the surface slope, at which the gradient of ice-bed uncoupling was greatest, but not the uncoupling itself. There was no obvious relationship to bed slope or ice thickness. Peaks in σ_B/σ_P correlated with maxima in floating ice thickness, suggesting that compressive flow thickened ice. The maximum $P_W/P_I = 0.9$ occurred in the grounding zone, indicating some influence of side shear on the ice surface slope. The minimum $\sigma_B/\sigma_P = 0$ occurred at the fjord entrance, where lateral rifts in the Ross Ice Shelf reduce side shear to nearly zero, and beyond which the rifts heal and increase coupling of Byrd Glacier with the Ross Ice Shelf.

CULTURAL AND ENVIRONMENTAL BOUNDARIES IN THE GULF OF MAINE REGION: ARCHAIC PERIOD BURIAL CEREMONIALISM, 8500-3400 B.P.

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The Gulf of Maine region encompasses important cultural and environmental boundaries that persisted for thousands of years. One of the boundary areas corresponds to widespread vegetation differences betwen western and eastern Maine, and another distinguishes the maritime and coastal zone from interior riverine and wetland areas. This cross-cutting set of environmental conditions corresponds to artifact styles and assemblages, suggesting that at least three recognizably different populations may have coexisted in proximity to each other during most periods of prehistory. The numerous cemetaries of the Moorehead burial tradition provide perspective on both core areas and boundaries within what appears to have been a particularly stable cultural quadrant of this environmental grid, on the central Maine coast.

EL NIÑO AND PERU'S CULTURAL PATRIMONY

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After 1997-98, most consumers of mass media are aware that El Niño means unusual--often bad--weather throughout much of the world. Along the coast of Peru, El Niño's heartland, the negative effects on fisheries, irrigation systems, transport networks, and public health are well known. Though less publicized, especially in the northern hemisphere, El Niño also impacts archaeological sites. In August of 1997, with El Niño forecasts in hand, the Peruvian government made funds available for protection of north coast sites of touristic importance. In July of 1998, I visited several north coast sites and interviewed archaeologists, government officials, and U.S. Embassy personnel about the just-ended event. In this talk, I discuss the impact of El Niño on Peruvian archaeological sites, with special reference to the 1997-98 event and government-sponsored mitigation attempts.

ZOOGEOGRAPHY OF MAINE: DATA FROM THE PREHISTORIC RECORD

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The objective of The Zoogeography Project is to consolidate all identified and published faunal data from Maine archaeological sites into a single, easily accessible database. When complete, this comprehensive database will be used to record and map animal species through time and across space, in essence, developing a zoogeographic map of extinct and extant species in Maine. This database will be useful to a wide audience including archaeologists, wildlife biologists, ecologists, and paleontologists. The Zoogeography Project will be conducted in four stages: 1) Archaeological faunal data entry; 2) Consolidation and reworking database; 3) Zoogeographic map generation of specific species; and 4) Dissemination of information to other scientists through publications, presentations, and possible internet website (i.e. Faunmap by the Illinois State Museum, www.museum.state.il.us/Oh/research/faunmap/aboutfaunmap.htm1). For this presentation, I discuss the status of The Zoogeography Project and potential important information.

SOME RECENT MIDDLE HOLOCENE DATES FROM ARCHAEOLOGICAL DEPOSITS LOCATED ALONG THE SACO RIVER

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Archaeological research conducted at three sites located in the Saco River valley has yielded a variety of prehistoric artifacts that relate to the Gulf of Maine Archaic technological tradition. These archaeological materials include a prevalence of chipping debris manufactured from local rock such as quartz, stone implements that are manufactured by pecking and grinding rather than chipping, and a low incidence of bifacially worked stone. A group of uncorrected ^{14}C dates places the age of these deposits between 8,400 and 6,400 B.P. The dated charcoal comes from hearth features as well as charcoal from buried soil horizons in which the archaeological materials were collected. More than 50 Early and Middle Holocene ^{14}C dates have been reported from archaeological sites situated in alluvial settings along most of Maine's major waterways. These dates and the carbonized flora on which they are based likely possess interpretive value for paleoenvironmental reconstructions.