Holocene appear to record the most frequent and largest events. Actual event ages await 210Pb dating of the historic parts of the cores and further 14C dating of coarse layers in the prehistoric parts of the sediment cores.

BTH 76 Nichols, Kyle K.

LANDSLIDE INITIATION AFTER DROUGHT

NICHOLS, Kyle K., Geology and School of Natural Resources, Univ of Vermont, Burlington, VT 05405, kknichol@zoo.uvm.edu, BIERMAN, Paul, Geology, Univ of Vermont, Burlington, VT 05405, KLEPEIS, Keith, Geology, Univ of Vermont, Burlington, VT 05405, and WRIGHT, Stephen F., Geology, Univ Vermont, Burlington, VT 05405

One of the largest landslides to affect Vermont in decades (>27,000 m³), occurred in the spring of 1999 after 6 months of below normal precipitation. Landslides after drought are unusual in Vermont, where many hillslopes (especially those underlain by clay and silt deposited in glacial lakes) require extended wet periods to fail.

Summer, 1998 was the wettest on record, followed by 6 months where precipitation was 24% less than normal with no long duration/heavy rainfall events. A 46 m high bank of the Brewster River in Jeffersonville, VT failed 3 times between April and July 1999, after the dry spell. The slide ran over a coherent bench of glacial silt ~5 m above the river and traveled ~290 m across the adjacent floodplain. The top of the bench had higher cohesions (direct shear test) (17 kPa) than below (5.6 kPa) and above the bench (8.2 kPa). The intact bench suggests bank undercutting was not the immediate initiation mechanism.

The debris (≤ 4 m thick) consisted mostly of blocks (≤ 10 m³) of clay/silt. Excavation of the debris during removal revealed a basal 20-cm thick saturated shear zone, consisting of rare 1–3 cm cohesive clay clasts in a homogenized gray silt matrix. This zone allowed debris mobilization, and was in sharp contact with the underlying, uneroded grass. Results from a RI/Φ test suggest that landslide movement over the shear zone aligned and rotated the clay clasts. The shear zone dewatered through spectacular fields of mud volcanoes (0.5 to 2 m wide) on the surface of the debris. At the margin of the runout zone, houses were splashed with mud and steep snouts of fine-grained material suggested debris-flow like behavior and a finite yield strength of the flowing mass.

The Jeffersonville slides have implications for the timing and run out potential of landslides in glaciated areas. Timing of these mass movements suggests that landslide hazards may lag heavy or prolonged rainfall by months. The saturated basal shear zone allowed the slide to travel much farther than other similar-sized landslides.

SESSION NO. 181, 1:30 PM
Thursday, November 8, 2001
Quaternary Geology/Geomorphology IV
Hynes Convention Center, 306

1:30 PM Evenson, Edward B.

GLACIOHYDRAULIC SUPERCOOLING AND BASAL ICE IN TEMPERATE GLACIERS OF ICELAND

EVENSON, Edward B., Lehigh University, Bethlehem, PA, ebe0@lehigh.edu, LAWSON, Daniel E., CRREL, Fort Richardson, AK, LARSON, Grahame, Michigan State University, East Lansing, MI, ROBERTS, Matthew, Staffordshire University, United Kingdom, KNUDSEN, Óskar, Klettur Consulting Engineers, Reykjavik, Iceland, RUSSELL, Andrew J., Keele University, United Kingdom, ALLEY, Richard B., Pennsylvania State University, University Park, PA, and BURKHART, Patrick, Slippery Rock University, Slippery Rock, PA

Glaciohydraulic supercooling has been demonstrated within the subglacial environment of Matanuska Glacier in Alaska, and hypothesized to be the predominant mechanism entraining debris in the glacier's basal zone. Although supercooling has been recognized in subglacial conduits at other large glaciers such as the Malaspina and Bering glaciers in Alaska, its occurrence in the presence of a debris-rich basal zone has not been demonstrated anywhere except Matanuska Glacier until now. We report here on recent observations documenting supercooling within subglacial discharges of warm temperate glaciers in Iceland that have debris-rich basal ice similar in characteristic to that of the Matanuska Glacier.

Summer observations, when air temperatures are always above freezing, at Skeidararjokull, Skaftafellsjokull and Kviarjokull - outlet glaciers from Vatnajokull, Iceland's largest ice cap - show abundant ice growth in and around discharge vents of subglacial waters, producing free frazil crystals, frazil aggregates and actively growing anchor ice terraces. These features demonstrate that glaciohydraulic supercooling is occurring. Winter observations of up-thrusted segments along the ice margin also reveal porous masses of debris-rich secondary ice developed around these vents, as well as 0.5 to 2 m thick sequences of stratified, debris-rich basal ice that is extremely similar to that observed at the Matanuska Glacier.

The sedimentary characteristics of Icelandic stratified basal ice sequences vary only in texture from those at Matanuska, while the frazil ice features are virtually identical to those at Matanuska, Bering and Malaspina glacier. These observations are consistent with theory that supercooling and basal-ice accretion occur wherever sufficient basal water flows out of a sufficiently steep overdeepening (adverse bed slope >1.2-1.7 times the magnitude of the surface slope). We therefore also infer that supercooling, ice growth, and debris entrainment similarly occurred along appropriately overdeepened margins of the former Laurentide and Scandinavian ice sheets, contributing to formation of the sedimentary deposits of those ice sheets. Our initial observations are the starting point for a more quantitative analysis. We anticipate that analysis of dD, d180, and 3H in basal ice of Icelandic glaciers will support our hypothesis that supercooling is responsible for its origin.

1:45 PM Oakes, Melanie

LATE WISCONSINIAN GLACIOLACUSTRINE SEDIMENTS DEPOSITED IN FRONT OF A SUBMERGED GLACIER FRONT, LAKE ERIE BLUFFS, CANADA

OAKES, Melanie and MARTINI, I. P., Land Resource Science, Univ of Guelph, Guelph, ON N1G 2W1, Canada, mel_oakes@hotmail.com

A detailed study was conducted to understand late Wisconsinian glaciolacustrine sediments deposited in front of a submerged end moraine. The Jacksonburg delta developed with its sediments exposed along the north shore of Lake Erie. Regionally a coarsening upward succession of four facies associations characterizes the delta. Clay rhythmites overly a till substrate, followed successively by silt rhythmites, sand rhythmites, and upper trough and low-angle cross-bedded and plane bedded sand.

Within 400 m of the submerged end moraine, the delta lacks clay and silt rhythmites. Sandy units deposited laterally in juxtaposed diachronous sequences infill shallow wide valley cuts. Two lower sequences exist: (1) ripple cross-laminated sand near the moraine is locally interrupted by apparently massive to cross-laminated sandy silt deposited by hyperpycnal flows. Sands near the moraine contain lenses of subaqueously slumped diamicton. These deposits represent glaciolacustrine delta facies. (2) Approximately 500 m from the moraine edge, a more distal sequence is characterized by plane bedded sand with heavy mineral concentrations along laminae alternating with thin (<1 cm) massive beds and minor ripple cross-laminations. These beach-like deposits constitute the transgressive filling of a wide (~450 m) shallow (<15 m) valley cut into the more proximal lower sequence 1

Both lower sequences are overlain by a coarser sand sequence characterized primarily by shallow dipping cross-beds alternating with plane beds and locally by ripple cross-laminated units. This upper sequence represents a complex frontal distributary bar of a braided delta. Periodical subaerial exposure allowed development of local beach deposits and some aeolian sands A well-developed soil unit formed after the last lake level drop and was later buried under a field of sand dunes.

2:00 PM Beske-Diehl, Sue

EVIDENCE FOR ICE RAFTING IN LAKE SUPERIOR FROM 10,600 TO 8,200 YEARS B.P

BESKE-DIEHL, Sue, Geological Engineering & Sciences, Michigan Tech Univ, 1400 Townsend Dr, Houghton, MI 49931, sbeske-d@mtu.edu and KERFOOT, Charles, Biological Sciences Department, Michigan Tech Univ, 1400 Townsend Dr, Houghton, MI 49931

Intervals of strongly bimodal grain size distributions exist in early Holocene sediments 21 km off the south shore of Lake Superior near the mouth of the Ontonagon River. The most prominent mode contains clay and fine-silt while the secondary mode includes medium to coarse-grained sand. The sediment count drops to zero between modes (fine sand to very coarse silt). We identified at least six layers with bimodal size distributions over an 80 cm sedimentary interval. Interlayered sediments exhibit a unimodal size distribution containing only fine-silt and clay. Removal of the coarse-grained size fraction from the bimodal distributions gives a sediment distribution remarkably similar to the unimodal sediment. These results suggest that the clay and fine silt was deposited steadily throughout the early Holocene, while the medium to coarse-grained sand was deposited episodically by an entirely different sedimentary process. The middle and late Holocene sediments do not show this bimodal size distribution. Since Lake Agassiz drained into Lake Superior during the early Holocene (about 10,6 to 9,500 calendar years BP), the most likely explanation for the influx of medium to coarse sand is through ice rafting during catastrophic flood events. Such floods occurred when progressively lower outlets opened between Lake Agassiz and the Superior Basin during recession of the glacier. In areas of more rapid sedimentation, the coarse-grained layers may be identified using seismic reflection methods enabling them to be used for correlation as has been done in Lake Huron.

The youngest sediment exhibiting bimodal distribution occurs immediately above an unconformity identified by a discontinuity in paleomagnetic inclination. The magnetic inclination data suggests erosion of 500 to 1,000 years of sediment circa 8,200 B.P. Such a date younger than most dates for drainage of Lake Agassiz into the Lake Superior Basin, howe light oxygen isotope ratios at 8,600 BP suggest glacially derived waters entered the Huron basin at about this time.

2:15 PM LaBlanc, K. J.

SEDIMENT FLUXES OF THE LAKE MICHIGAN AND THE GREEN BAY LOBES OF THE LAURENTIDE ICE SHEET

LABLANC, K. J.[1], MICKELSON, D. M.[1], CUTLER, P. M.[2], and COLGAN, P. M.[3], (1) Geology and Geophysics, Univ of Wisconsin-Madison, 1215 W. Dayton St, Madison WI 53706, klablanc@geology.wisc.edu, (2) National Rsch Council, 2101 Constitution Avenue NW (HA-372), Washington, DC 20418, (3) Department of Geology, Northeastern Univ, 14 Holmes Hall, Boston, MA 02115

Accurate estimates of sediment flux and sedimentation rates are important when trying to understand and contrast processes under former ice sheets. By combining volume estimates generated using GIS with bounding radiocarbon age estimates, we have calculated the average sediment flux and sedimentation rate under the southern part of the Lake Michigan Lobe and the Green Bay Lobe of the Laurentide Ice Sheet. Water well and geologic logs were collected in eight-km-wide bands along each flow line and used to create triangular irregular networks that represent the top and bottom of each major lithostratigraphic unit. Only diamicton currently present was quantified, therefore data represent a minimum estimate of the glacial sediment transported The calculated sediment flux ranges from 150 and 890 m³ per radiocarbon year per meter width for different members of the Wedron Group on the Lake Michigan Lobe flow line. These fluxes are comparable with those estimated in other studies (Johnson et al., 1991; Alley, 1991). The sediment flux for the Green Bay Lobe was 185 a 360 m³ per radiocarbon year per meter width of ice lobe for the Holy Hill and Kewaunee Formations respectively. The sedimentation rates for the Lake Michigan Lobe range betw 3 and 8 mm per radiocarbon year. The sedimentation rates for the Green Bay Lobe are and 4 mm per radiocarbon year. The sediment fluxes and sedimentation rates of the Gre Bay Lobe prior to 13,000 radiocarbon years B.P. (Holy Hill Formation) are lower than the Lake Michigan Lobe and later advances of the Green Bay Lobe. The presence of pe malfrost and a cold-based ice margin in the Green Bay Lobe prior to 13,000 radiocarbon years B.P. may explain this lower sedimentation rates. It may also be that the southern L Michigan Lobe and later advances of the Green Bay Lobe advanced directly out of a lat basin that would trap sediment.

2:30 PM Munroe, Jeffrey S.

RECONSTRUCTED LATE PLEISTOCENE GLACIER EQUILIBRIUM LINE ALTITUDES PROVIDE EVIDENCE FOR LAKE-EFFECT SNOW FROM LAKE BONNEVILLE

MUNROE, Jeffrey S., Geology Department, Middlebury College, Bicentennial Hall, Middlebury, VT 05753, jmunroe@middlebury.edu

Nineteen valley glaciers that existed in the northern Uinta Mountains during the late Pleistocene "Smiths Fork" Glaciation (local "Pinedale"/MIS Stage 2 equivalent) were reconstructed from geomorphic features that delineate their former margins, including terminal lateral moraines, heads of outwash, ice-marginal channels, and cirque headwalls. Paleoequilibrium line altitudes (ELAs) were determined for each of the 19 through a weighted average of independent estimates obtained from four methods: accumulation area ratio (AAR of 0.65), toe-headwall altitude ratio (THAR of 0.40), uppermost elevation of continuous lateral moraines, and elevation of the lowest northeast-facing cirque floor. The Smiths Fork-age ELAs average 3100 m above sea level (standard deviation of 100 m), and descend at