9:30 AM Bilderback, Eric L.

A REGIONALLY SIGNIFICANT RECORD OF LATEST PLEISTOCENE AND HOLOCENE GLACIATION IN THE NORTH CASCADES, WA

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Lake cores collected from five lakes adjacent to two sets of post Wisconsin maximum moraines in the Alpine Lakes Wilderness, WA, preserve detailed records of the timing and extent of the glaciations. The Enchantments Lakes Basin in the Alpine Lakes Wilderness contains two well-preserved sets of moraines that record periods when regional climate was substantially colder and wetter than present. The absence of a 450-year-old Mount St. Helens tephra (Wn) on both the inner (Brynhild) moraines or the glacially scoured surface behind the moraines indicates they are Little Ice Age equivalent (Waitt et al., 1982). Waitt et al. (1982) argued that the outer marines (Brisingamen) are early Holocene rather than latest Pleistocene on the basis of qualitative weathering characteristics and the presence of the 6800 14C yr B.P. Mt Mazama ash. The distinction is important to paleoclimatic studies because the early Holocene has generally been thought to be a time of warmth and regional glacier retreat.

Magnetic susceptibility analyses of the multiple cores collected from the Enchantments Lakes outside the older moraines indicate the presence of multiple ash layers thought to be the Wn and Mazama tephras and show evidence of glacial sediments underlying the older tephra layer. The outwash in some cores is separated by a thick sequence of low-susceptibility, probably organic rich sediment. This pre-Mazama interval has a maximum thickness of about 92 cm in one of the collected cores, implying either a high organic sedimentation rate between an early Holocene glaciation and tephra deposition or a moderate organic sedimentation rate after a late-Pleistocene advance and before tephra deposition.

Ongoing detailed dating of the sediment cores (tephrochronologic, AMS-radiocarbon, paleomagnetic) and cosmogenic exposure dating of moraines and glaciated bedrock will enable us to establish a high-resolution, continuous, and regionally correlatable chronology of glaciation and sedimentation for the area.

9:45 AM Lundeen, Kari A.

AGE CONSTRAINTS ON LATE-GLACIAL ICE FLUCTUATIONS IN THE SAWTOOTH MOUNTAINS, CENTRAL IDAHO

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Basal dates from two lake cores in the eastern Sawtooth Mountains of central Idaho constrain glacial ice volume fluctuations during latest Pleistocene time. These dates, coupled with relative weathering data and equilibrium line altitude (ELA) estimations, indicate that near full-glacial ice volume was maintained into late glacial time.

Three AMS radiocarbon dates have been obtained from two cores taken from MacDonald Lake, located in the lower portion of Yellow Belly Lake Valley. A date of 10,590 ka was obtained from a detrital wood sample at a depth of 126 cm in the core. The wood was contained within a silty clay horizon, which grades downward into clay and basal fine sand.

Two samples of organic material from a second core yielded dates of 11,640 ka, at a depth of 132 cm, and 11,920 ka, at a depth of 140 cm. At 132 cm, the sediment is clayey silt, underlain by ca. 3.5 cm of interbedded sands and silts; a second clayey silt bed lies at 140 cm depth, overlying silt and 2.3 cm of basal sandy silty clay. All three dated horizons lie directly above basal inorganic glacial sediments, and thus provide minimum limiting dates for an associated moraine.

Moraine deposits in Yellow Belly Lake Valley and three other valleys in the Sawtooth Mountains have been split into three age groupings based on relative weathering criteria. MacDonald Lake is located directly upvalley of the second moraine group; therefore, the three dates provide minimum limiting ages for this moraine group. As all three moraine groups lie in a narrow elevational range in the low-gradient, lower portion of the valley, their estimated ELA's lie in a narrow range as well. Together, the radiocarbon dates, relative weathering data, and ELA estimates indicate that near full-glacial ice volume was maintained well into late-glacial time, possibly because of reinvigorated atmospheric transport of Pacific moisture.

10:15 AM Armour, Jake

A LATE PLEISTOCENE AND HOLOCENE HIGH-RESOLUTION GLACIAL AND PALEOCLIMATE RECORD FROM NORTHERN NEW MEXICO

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The Winsor Creek drainage in the southern Sangre de Cristo Mountains of New Mexico contains geomorphic evidence of both valley and cirque glacial activity ranging in age from the late Pleistocene to the late Holocene. Sediment cores recovered from alpine bogs trapped behind Pinedale moraines below Lake Katherine cirque contain a high-resolution record of climatic change spanning this interval. Analysis of the sedimentologic and magnetic mineral properties of these cores together with several radiocarbon dates allows the precise dating of both glacial and non-glacial climatic changes. The base of the deepest cores reached glacial till (confirmed by GPR data), which is overlain by a decimeter-thick interval of rock flour-rich clay. Above this is a ~3 meter thick sequence of laminated lake clays which become more massive towards the top. The lake clays grade up into ~2 meters of gyttja which is punctuated by three sand and/or organic rich layers.

This lake-bog transition is gradational, describing the life cycle of an alpine catchment; however, superimposed on this long-term cycle are a number of distinct sedimentary events marking times of dramatic environmental change. These include the final recession of Pinedale valley glaciers (basal age of 12,120 y.b.p. - all dates in radiocarbon years), a possible Younger Dryas cirque advance (ending just before 9,765 y.b.p.) and a mid-Holocene dry (and warm) period (~6,100 to 5,010 y.b.p.). The late Holocene is marked by an early Neoglacial cirque advance (~3,600 y.b.p.) and two periglacial events correlative with the middle Neoglacial (~2,800 y.b.p.) and the Little Ice Age (~120 y.b.p.). The age model from these cores indicates an increase in depositional rates immediately following the glacial events, as well as a prolonged period of reduced sedimentation rates during the mid-Holocene. Total organic carbon data lends support to these interpretations by indicating times of high and low biologic productivity correlative with periods of environmental change within the range.

10:30 AM Fawcett, Peter J.

REGIONAL ELEVATIONAL RESPONSE TO GLACIAL AND MID-HOLOCENE CLIMATE PERURBATIONS IN NEW MEXICO

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Two high-resolution paleoclimate records from different environments and elevations in New Mexico are compared to determine how synchronous the late Quaternary climate change events were in this region. The timing of late Pleistocene and Holocene valley and cirque moraines in the southern Sangre de Cristo Range of northern New Mexico has been constrained by a lake/bog record below Lake Katherine cirque. Three alpine glacial events occurred: the termination of a late Pinedale valley glaciation just prior to 12,120 yrs B.P. (all dates are radiocarbon years), a possible Younger Dryas equivalent cirque glaciation (ending before 9,765 yrs B.P.), and an early Neoglacial cirque glaciation (3,700 to 3,300 yrs B.P.).

Each of these high-elevation (> 3,200 m) glacial events is correlative with a relative highstand in pluvial (and playa) lakes 130 km to the south in the lower elevation Estancia Basin (~1,800 m). The final in a series of late Pleistocene highstands of pluvial Lake Estancia terminated at 12,490 yrs B.P., with a later, smaller highstand that terminated before 9,650 yrs B.P. During the mid-Holocene, Estancia basin dried out and winds cut nearly 100 playa basins into the Pleistocene lake floor. The blowout basins were reoccupied by water beginning around 4,220 yrs B.P. This early to mid-Holocene dry event is also reflected in the Sangre de Cristo record by markedly reduced sedimentation rates. The hydrologic balance in Estancia basin depends on winter groundwater recharge and runoff from the intermediate elevation Manzano Mountains (~2,400 m) and evaporation in the basin itself. The Sangre de Cristo glacial events also require cooler climates and enhanced winter precipitation. We suggest that the major control on the hydrology of both environments is the amount of winter precipitation, with summer precipitation (e.g. early Holocene) being of secondary importance. Comparison of these two records confirms that in the southernmost Rockies, regional responses to climate changes associated with the last glacial termination through the Holocene are expressed at all elevations and reflect large-scale changes in atmospheric circulation.

10:45 AM Dethier, David P.

THE COSMOGENIC ISOTOPE RECORD OF LATE PLEISTOCENE INCISION, BOULDER CANYON, COLORADO

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Geomorphic relations and cosmogenic 26Al, 10Be, and 14C dating link late Pleistocene terraces along Boulder Canyon, Colorado with Front Range moraines and surfaces on the adjacent High Plains. Bull Lake moraines along upper Boulder Creek have minimum average 10Be and 26Al ages of 101 ± 21 ka and 122 ± 26 ka and Pinedale moraines have average model ages of 16.9 ± 3.5 and 17.5 ± 3.6 ka. Isolated terrace remnants 20 to15 m above grade give a model age of 130 ± 27.5 ka. More extensive fill terraces 15 to 4 m above grade have average model ages from ~ 30 to 10.5 ka (early to late Pinedale). Low terraces and fans built from tributary catchments show that Boulder Creek has been within 4 m of grade throughout Holocene time. Inset, closely spaced Pinedale-age terraces record multiple pulses of local aggradation and incision 5 to 20 km downstream from Pinedale moraines, implying that glacial events controlled terrace formation. Relative soil development and sparse radiometric ages suggest that the Louviers, Broadway and Piney Creek Alluviums downstream on the High Plains correlate with the three groups of terraces along Boulder Creek. Louviers and Broadway surfaces are only 7 and 4 m, respectively, above grade, indicating downstream convergence of terrace profiles, and slower net incision in the High Plains in late Pleistocene time. Since ~ 600 ka, net incision rates on the High Plains near Boulder Creek have been ~0.04 m/ka, whereas rates in Boulder Canyon have averaged ~ 0.15 m/ka since about 130 ka. Extrapolating late Pleistocene rates to middle Pliocene time gives 375 m of net incision in Boulder Canyon, deeper than the modern canyon. Downcutting rates along Boulder Canyon must have increased since early Pleistocene time, perhaps as bedrock knickpoints migrated upstream in response to increases in snowmelt discharge.

11:00 AM Klein, Jeffrey

YOUNGER DRYAS IN THE ROCKY MOUNTAINS AND CALIBRATION OF 10BE/26AL PRODUCTION RATES

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Measurements of cosmogenic nuclides in boulders deposited on a moraine separating two lakes in the Titcomb Basin (3231 m asl) in the Wind River Range in Wyoming (109W 43.12N), known to have been deposited during the Younger Dryas from radiocarbon dates on core samples from the lower lake (c.f. abstract 25239 from GSA 1999, Denver, Co.) provide a means of calculating the production rates of 10Be and 26Al averaged over the past 12 ka.

Recent evidence (Braucher, R. et al., EPSL 163(1998)197-205) suggests that the contributions of muons to the production of 10Be and 26Al have been over estimated, and the new best estimates place the muon contribution at sea level and high latitude to be 3% (or less) instead of the formerly assumed 15-20%. Based on seven 10Be measurements and six 26Al measurements and an exposure age of 12.35 +/- 0.75 ka (middle of the Younger Dryas chron), the estimated 10Be and 26Al production rates at the site of measurement are 52.2 +/- 6.4% atoms/g of quartz/yr and 302 +/- 7.3% atoms/g of quartz/yr, respectively. Correcting these values for an estimated snow cover would increase them by between 1.4% and 4%. Scaling these values to high latitude (>60 degrees) and sea level using a scaling relationship based on the nucleonic scaling of Lal (EPSL 104(1991)424-39) but a 3% muonic contribution at sea level, the normalized production rates are 5.05 +/- 0.35and 29.0 +/- 2.2 atoms/g of quartz/yr, whereas based on the former scaling relations, the sea-level high-latitude production rates would have been 5.52 and 31.7 atoms/g of quartz, respectively.

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