strain the timing of aggradation and incision in the lower Colorado River corridor and can be used to test these hypotheses. Our exposure ages can also be used to develop a regional correlation of coarse-grained sediments deposited during periods of climate change.

87-2 BTH 2 Matmon, Ari

COSMOGENIC AND OSL DATING OF THE LATE PLEISTOCENE SHORELINES OF LAKE LISAN, SOUTHERN ISRAEL: TWO DIFFERENT HISTORIES

MATMON, Ari[1], CROUVI, Onn[2], ENZEL, Yehouda[2], BIERMAN, Paul[3], LARSEN, Jennifer[4], AMIT, Rivka[5], PORAT, Naomi[3], and CAFFEE, Marc[6], (1) U.S. Geol Survey, 345 Middlefield Rd, Menlo Park, CA 94025, amatmon@usgs.gov, (2) Geology, Earth Science Institute, Hebrew Univ, Gival Ram, Jerusalem, 91904, Israel, (3) Geology Department, Univ of Vermont, Burlington, VT 05405, (4) Geology, Univ of Vermont, Burlington, VT 05405, (5) Israel Geol Survey, 30 Malkhe Yisrael St, Jerusalem, 95501, Israel, (6) Prime Laboratory, Physics Department Physics Department, Purdue Univ, West Lafeyette, IN 47907

A series of beach ridges, along the southern end of the Dead Sea, southern Israel, 160-177 meters below sea level were studied in order to establish their relationship to the late Pleistocene Lake Lisan, precursor of the Dead Sea. Optically stimulated luminescence dating of sandy sediments from these ridges yielded ages of 20.0± 1.4 ka and 36.1± 3.3 ka. These ages are supported by the degree of soil development on the beach ridges and correspond well with previously determined ages of Lake Lisan, which suggest that the lake reached its highest stand ~27,000 cal yr B.P.

Five chert clasts from two of these beach ridges were sampled for ^{26}Al and ^{10}Be measurements. The measured activities indicate low rates of chert bedrock erosion and complex exposure, burial, and by inference, transport histories. The chert clasts were derived from the Senonian Mishash Formation, a chert-bearing chalk, which is widely exposed in the Nahal Zin drainage basin, the drainage system that supplied most of the material to the beach ridges.

By assuming only exposure at the sampling sites, ^{26}Al and ^{10}Be activities suggest exposure ages that range from 35 to 354 ky. These ages do not correspond with the OSL and soil ages of the beach ridges. Furthermore, using the ratio ^{26}Al/ ^{10}Be, total clast histories range from 460 to 4300 ky, unrelated to the clasts' current position and exposure period on the late Pleistocene beach ridges. If the clasts were exposed only once and than buried beyond the range of significant cosmogenic nuclide production, the minimum initial exposure and total burial times before delivery to the beach ridges range from 50 to 1300 ky and 390 to 3130 ky, respectively. Alternatively, the initial cosmogenic dosing could have occurred during steady erosion of the source bedrock. Calculating such rates of rock erosion suggests very low erosion rates between 0.4 and 12 m My^{-1}.

The relatively long burial periods indicate extended sediment storage as colluvium on slopes and/or as alluvial deposits in Plio-Pleistocene Nahal Zin river terraces and only washed on to the shores of Lake Lisan during the late Pleistocene. The results suggest that using cosmogenic nuclides to date arid-region, terminal lake shorelines is problematic because nuclides are inherited and accumulate from prior periods of exposure.

87-3 BTH 3 Marchetti, David

COSMOGENIC EXPOSURE AGES OF DESERT PAVEMENTS: WHAT ARE THEY REALLY TELLING US?

MARCHETTI, David[1], FENTON, Cassandra[2], and CERLING, Thure[1], (1) Geology and Geophysics, Univ of Utah, 135 S 1460 E Room 719, Salt Lake City, UT 84112, dwmarche@mines.utah.edu, (2) U.S. Geological Survey, 520 N. Park Avenue, Tucson, AZ 85719

Desert pavements are common surface features in arid environments. Their origin has been long debated, but in the past two decades a prevailing hypothesis has emerged of stone clast surfaces that are formed and maintained at the air-earth interface and inflated through time via air fall accretionary pedogenesis. Evidence for this mechanism stemmed from both soil studies and exposure age dating. Exposure ages of desert pavement samples on several lava flows in southern California were nearly identical to radiometric ages of the flows, suggesting uninterrupted exposure at the surface. Other research has shown that pavement continuity is closely tied to vegetative abundance and that vegetation shifts due to climate change play a pivotal role in pavement destruction and formation. This research argues that all but the lowest elevation pavements were disrupted by down slope vegetative shifts during the LGM. 3He exposure ages of desert pavements from two locations having differing elevations and source materials (Whitmore Cascade-basalt flow, 750-1120m, Western Grand Canyon National Park, USA and Johnson Mesa-debris flow deposit, 1710-1780m, Capitol Reef National Park, USA) demonstrate two end members of pavement exposure age interpretations. In the Grand Canyon, exposure ages of desert pavements on the Whitmore Cascade appear to be slightly older than exposure ages of primary flow surfaces. This suggest that the flow surfaces have been eroded and that in this case, desert pavements were likely not disrupted by vegetation during the LGM and may be the best indicator of the "true" exposure age of this surface. On Johnson Mesa, however, desert pavement exposure ages are all 30-98ka younger than exposure ages of large boulder clasts within the debris flow deposit which have an average 3He exposure age of 190±12ka (zero erosion, n=3). The average desert pavement 3He exposure age on Johnson Mesa is 127±9ka (zero erosion, n=9), which coincides with the penultimate interglacial period, suggesting a link between pavement formation and climate. This data demonstrates that not all pavements record the exposure age of the surface they are forming on and suggests that climate strongly controls the timing of pavement inception at higher elevations.

87-4 BTH 4 Gosse, J.

COSMOGENIC NUCLIDE DATING OF ARID REGION ALLUVIAL FANS

GOSSE, J., Department of Earth Sciences, Dalhousie Univ, Halifax, NS B3H 3J5, Canada, john.gosse@dal.ca, MCDONALD, E., Desert Rsch Institute, Reno, and FINKEL, R., CAMS, LLNL, Livermore

Cosmogenic nuclide exposure ages have been used to infer rates and styles of surface and tectonic processes responsible in evolving arid region landscapes. Precise Pliocene-Quaternary fan chronologies in arid regions are necessary for calculating strain rates and seismicity recurrence intervals. Soils geomorphology and cosmogenic 10Be in quartz on alluvium in the U.S. southwest (Providence Mtns., Fish Lake Valley, and Amargosa Valley) reveal that it is not always possible to attain high precision fan chronologies. Examination of alluvial fan sediments and surfaces from four lithologically distinct catchments in the Providence Mtns (eastern California) indicates that although fan aggradation is approximately synchronous around 75±10 ka (QF3 fans), older and younger fans correlated along the same range front do not show this synchronicity. Instead of invoking geomorphological explanations of the exposure age disparities among correlative fans, we turned to the assumptions of the dating method. For the Mojave region, the 75-kyr aggradation event may be the most optimally suited for exposure dating. Older fans have significantly and variably disturbed surfaces (erosion, mixing, and burial also vary with elevation), so exposure ages (from surface boulders and subsurface and pavement pebbles) of correlated fans will vary. Large changes in bulk densities during pedogenesis also need to be considered. For younger fans, inheritance is the dominating control on the ages. In the Providence Mtns. and Amargosa Valley (western Nevada), modern wash sediment has as much as 70-kyr worth of inherited 10Be. Even with concentration-depth profiles using amalgamated pebble samples it is not possible to estimate this amount of inheritance with sufficient accuracy to correct a Holocene fan exposure age. The influence of inheritance diminishes with depositional age of a fan. Furthermore, when the option exists, we suggest choosing fans from rapidly eroding or previously glaciated catchments for dating, and correlating other fans along a range front with soils. Ages on a Holocene fan emanating from a glaciated catchment in Fish Lake Valley show lower standard deviations and are closer to radiocarbon ages than ages on a correlated radiocarbon-dated fan from a non-glaciated adjacent catchment.

87-5 BTH 5 Hill, Christopher L.

LUMINESCENCE DATING OF GLACIAL LAKE GREAT FALLS, MONTANA, U.S.A

FEATHERS, James K., Department of Anthropology, Univ of Washington, Box 353100, Seattle, WA 98195-3100, jimf@u.washington.edu and HILL, Christopher L., Department of Anthropology, Boise State Univ, 1910 University Drive, Boise, ID 83725-1950, chill2@boisestate.edu

Stratigraphic sequences related to glacial Lake Great Falls are exposed along the Missouri River valley. They help to determine the timing and extent of continental glaciation on the Great Plains of North America. Near Holter Lake, Montana, laminated silts of glacial Lake Great Falls are buried by sands. An infrared-stimulated luminescence (IRSL) age of 13.2±0.9 ka was obtained for the lake silts (sample UW355). Anomalous fading, or loss of thermally stable signal through time, is evident. Thus, this age can only be taken as a minimum; correction for fading provides an age with a large standard deviation (35.4±18.3 ka). Optically-stimulated luminescence (OSL), using the single aliquot SAR method, gave an age of 17.1±1.4 ka for the lake silts. Multi-aliquot OSL analysis gave an age of 14.7±1.1 ka for the overlying sand (sample UW356), while single aliquot analysis gave an age of 13.1±0.5 ka. Based on these measurements, a Late Wisconsinan (oxygen isotope stage 2) assignment does not seem unreasonable for the Holter Lake sequence. A stratigraphic sequence near Hower Coulee, Montana, contains fluvial gravels and sands that are buried by silts (the "lower lake") of glacial Lake Great Falls. The lower lake silts lie below till of the Laurentide Ice Sheet (LIS). The till is overlain by a set of deposits collectively referred to as the "upper lake." Luminescence measurements of the lower lake suggest the sediments were deposited during the early part of oxygen isotope stage 2. Single-aliquot OSL ages range from 24.6±4.39 ka (UW469) to 14.5±2.03 ka (UW468), while multi-aliquot IRSL ages after correction for fading range from 24.7±6.78 ka (UW468) to 17.6±2.24 ka (UW469). There are two ages on sandy and silty lithofacies of the upper lake sequence, using the single-grain leading edge technique: 10.5±3.33 ka (UW454) and 14.3±3.66 ka (UW467). These ages imply that the deposits of the upper lake sequence likely date to the last part of oxygen isotope stage 2. Sediments of glacial Lake Great Falls were deposited in a lake formed when the Missouri River was blocked by a lobe of the LIS. Direct dating of sediments using luminescence measurements appears to support a late Wisconsin age for these stratigraphic sequences. This implies that a lobe of the LIS advanced into northern Montana and reached the present-day location of the Missouri Valley during oxygen isotope 2.

87-6 BTH 6 Hill, Christopher L.

PLEISTOCENE STRATIGRAPHY AND CHRONOLOGY OF THE LOWER YELLOWSTONE BASIN, NORTH AMERICA

HILL, Christopher L., Department of Anthropology, Boise State Univ, 1910 University Drive, Boise, ID 83725-1950, chill2@boisestate.edu.

The Pleistocene stratigraphic record in the Lower Yellowstone basin, in eastern Montana, consists of a variety of lithofacies associated with geomorphic features and vertebrate fossils. Middle Pleistocene or possibly Sangamonian age gravels form high terraces in the Yellowstone River Valley. Some of these deposits, such as the Doeden gravels, contain Illinoian/Sangamonian(?) age fossil vertebrates, including ground sloths, mammoth, mastodon, horses, musk ox, and giant short-faced bear. Dates on tephra and calcrete from within the Yellowstone River and Tongue River valleys indicate that these high terraces were formed in the Middle Pleistocene or early Late Pleistocene. Lower terrace gravels at Glendive, Montana, contain mammoth fossils dated to 20,470 +/-80 RCYBP (Beta-155642), while gravels along Beaver Creek, near Wibaux, Montana, contain tusk fragments dated to 26,000 +/- 120 RCYBP (SR-6086). Upland settings within the lower Yellowstone drainage indicate that Late Glacial environments were associated with intervals of aeolian deposition interrupted by periods of increased landscape stability and soil formation. Pedogenic features consist of secondary carbonates perhaps linked to arid climates as well as well-developed A-horizons possibly connected to wetter or cooler climates. Upland silts within the South Fork of Deer Creek overlie bedrock and contain buried A-horizons and secondary carbonates. The silts contain the remains of a mammoth, with dates on collagen of 11,500 +/- 80 RCYBP (Beta-102031) and 12,330 +/- 50 RCYBP (SR-5576). Stratigraphic sequences south of the Yellowstone River, at OTL ridge (south of Glendive, Montana), contain buried A-horizons developed within aeolian silts dated to between 9,330 +/- 80 RCYBP (Beta-155708) and 11,415 +/- 35 RCYBP (SR-6089). These upland lithostratigraphic sequences can be correlated with the Aggie Brown Member of the Oahe Formation. The lower Yellowstone Valley contains fluvial gravels that form Middle and Late Pleistocene-age terraces. Vertebrate fossils recovered from the lower terraces provide dates of about 26,000-20,000 RCYBP. Upland silts contain mammoth remains dated to about 12,000 RCYBP. Soil forming episodes occurred close to the Pleistocene-Holocene transition, generally within the interval of 11,000-9,000 RCYBP.

87-7 BTH 7 Smith, Larry N.

GLACIAL LAKE MISSOULA DEPOSITS ALONG THE CLARK FORK RIVER DOWNSTREAM FROM MISSOULA, MONTANA: STRATIGRAPHIC CONTEXT OF THE NINEMILE SECTION

SMITH, Larry N., Montana Bureau Mines & Geology, Montana Tech of The Univ of Montana, 1300 W Park St, Butte, MT 59701-8997, lsmith@mtech.edu.

Ice dams created by the Purcell lobe of the Cordilleran ice sheet near the current Idaho/Montana border impounded Glacial Lake Missoula, which inundated valleys of NW Montana to altitudes of 1265 m. Varved, cyclic, and silt-dominant glacial-lake deposits along the Clark Fork River valley, such as the Ninemile section, have been argued to represent one or more lake stands. Recent mapping of unconsolidated deposits from Missoula, downstream to the confluence of the Clark Fork and Flathead Rivers, revealed a variety of deposits that are interpreted to be products of glacial-lake impoundment and catastrophic drainage. The stratigraphic relations between the glacial-lake silt and older and younger gravelly deposits, and erosional and depositional landforms in the valleys suggests that some lake stands reached vastly different altitudes.

Where exposed, the alluvium is stratified, with a few <50 cm-thick interbeds of laminated silty clay. However one exposed paleovalley contains a basal diamicton of cobble- to very coarse boulder-sized clasts, possibly a debris flow deposit. Imbricated boulder-sized clasts and planar cross-stratified gravel, with set heights of 2 to >35 m, display down-river, and up-tributary paleocurrents, indicating a high-energy, high-volume alluvial environment. In limited exposures, the contact between underlying alluvium and overlying glacial-lake silt shows soft-sedi-