classified by land use (reference, light urban, and dense urban) and the three groups tested separately, the results were similar. The number of lakes for which the probable effect concentration was exceeded varied by metal, from just 2 percent of lakes for Cd to 42 percent of lakes for Pb. Concentrations of individual metals increased greatly with urban land use and most often exceeded the probable effect concentration at dense urban sites. These results indicate that overall contamination of United States streams and lakes by metals is decreasing, but even so, current concentrations continue to be at levels that could pose a threat to aquatic biota.

H51C-1083 0830h POSTER

Calcium Carbonate Effects On U(VI) Sorption To Soils

Zuoping Zheng (510-486-6472; zzuoping@lbl.gov)

Tetsu K Tokunaga (510-486-7176; ttokunaga@lbl.gov)

Jiamin Wan (510-486-6004; jwan@lbl.gov)

Uranium contamination of the subsurface resulting from past radioactive waste disposal and storage practices represents a serious environmental contamination problem at a number of sites. Under oxidizing geochemical conditions, sorption is one of the primarily controlling factors on U(VI) mobility in subsurface. In many soil systems, calcium carbonate represents an important mineral phase which likely affects U(VI) sorption behavior. To quantify this influence, sorption of U(VI) to soils in the presence of naturally occurring calcium carbonate was investigated by conducting batch experiments in which either U(VI) concentration or solution pH was varied. Two soils containing different calcite concentrations were selected, one from Oak Ridge, Tennessee, and another from Altamont Pass, California. The results show that the presence of calcium carbonate in soils strongly affects U(VI) sorption. Higher concentrations of soil calcium carbonate lead to a pronounced suppression of the pH-dependent sorption curve in neutral pH range, because of the formation of a very stable neutral complex of calcium uranyl carbonate (Ca2UO2(CO3)3) in solution. A surface complexation model considering both strong and weak sites for ferrihydrite and ionizable hydroxyl sites for clay minerals was compared with experimental results, and U(VI) binding parameters were reasonably estimated. Fair agreement was found between the model predictions and sorption data, which span a wide range of U(VI) concentrations and pH. The results also show that selection of appropriate solution-to-solid ratios is important when measuring distribution coefficients in calcareous soils because the impact of calcium carbonate on U(VI) sorption in natural systems can be artificially diminished by dilution.

H51C-1084 0830h POSTER

Cs-137 Distribution and Retention in Savannah, Georgia (USA) Estuarine, Marsh and Riverine Environments

Ashanti J Pyrtle[1] (727.553.1301; apyrtle@marine.usf.edu)

Ursula S Wilborn[1] (727.553.1301; uwilborn@marine.usf.edu)

Ellery D Ingall[2] (404.894.3883; ingall@eas.gatech.edu)

Meg Grantham[2] (404.894.3883; grantham@eas.gatech.edu)

W Crawford Elliott[3] (404.463.9548; geowce@panther.gsu.edu)

[1]University of South Florida College of Marine Science, 140 Seventh Avenue South, St. Petersburg, FL 33701, United States

[2]Georgia Institute of Technology School of Earth and Atmospheric Sciences, 311 Ferst Drive, Atlanta, GA 30332-0340, United States

[3]Georgia State University Department of Geology, 340 Kell Hall, Atlanta, GA 30302, United States

The Savannah River drainage basin spans parts of North Carolina, South Carolina and Georgia (USA). For those radionuclides that are not permanently sequestered at their introduction sites, the aquatic system often becomes the major mechanism by which the radionuclides are transported. Riverine, marsh and estuarine sediments were examined in order to identify processes affecting the distribution of Cs-137 and excess Pb-210 in the Savannah area. Results indicate that Cs-137 activities range from below detection limits to 3.42 dpm/g. Radiogeochemistry patterns suggest that in the marsh, steady-state particle mixing and burial processes primarily controls downcore particulate Cs-137 distribution, whereas in the local riverine and estuarine environments, non-steady state processes govern post-depositional Cs-137 distribution. In addition to physical processes, clay mineralogy and grain-size differences may also influence the Cs-137 retention ability of the Savannah area aquatic sediments. This research is apart of a larger on-going investigation of Savannah area aquatic radiogeochemistry.

H51C-1085 0830h POSTER

Water Quality Assessment: Statistical Versus Classification Approach

Ahmed Said[1] (813-974-5902; asaid@eng.usf.edu)

Mark A Ross[1] (813-974-5838; mross@eng.usf.edu)

David K Stevens[2] (435-797-3229; david.stevens@usu.edu)

[1]Department of Civil and Environmental Engineering, University of South Florida, Tampa, FL 33620, United States

[2]Civil and Environmental Engineering, Utah State University, Logan, UT 84321, United States

Water quality assessment requires the acquisition and analysis of data. An efficient assessment involves the use of statistics and other methods such as data classifications. Statistical techniques range from developing plots of data to iterative model building and parameter estimation. Water quality assessment based on data classifications such as water quality indices has some limitations. Water quality indices formulas are not used as absolute measures of the degree of pollution or the actual water quality in a stream. These formulas result in inherent loss of information. However, in statistical approaches, comparisons and analysis of data demonstrate complications that arise if the assessment results obtained from one data set are used to compare with the results from a different data set, unless all data sets are evaluated together simultaneously and have the same types of data. Thus, a statistical approach to evaluate the water quality is less applicable than the water quality index classification approach, which is considered as more objective and repeatable. Because of the requirements from some international or regional directives on critical issues related to water pollution, most countries need to report the status of their water quality based on a classification scheme. Although different countries are applying different classification schemes and the assessment approach in the index classification schemes differs greatly, they can be combined together into a single assessment technique that can be represented as index class value. In this study, a comparison between the classification and statistical approaches will be given through sufficient case studies to judge which method is better to understand and design systems for environmental protection.

H51C-1086 0830h POSTER

Modeling linkages between groundwater, surface water and perhiphyton-driven oxygen dynamics in the lower Truckee River, Nevada

W. Alan McKay[1] (775-673-7384; alan@dri.edu)

John J Warwick[1] (775-673-7300; warwick@dri.edu)

Suzanne Kish[2] (skish@uf.edu)

Christian F Fritsen[3] (775-673-7487; cfritsen@dri.edu)

[1]Desert Research Institute, Division of Hydrological Sciences, Reno, NV 89506, United States

[2]University of Florida, Dept of Environmental Engineering Sciences, Gainesville, FL 32611, United States

[3]Desert Research Institute, Division of Earth and Ecosystem Sciences, Reno, NV 89506, United States

Long-term water quality monitoring in the lower Truckee River, Nevada (U.S.) reveals increases in several constituents [e.g., total dissolved solids (TDS) and nitrogen (N)] not easily explained by simple solute and hydrologic budgets of surface inputs (i.e., suburban runoff; agricultural surface return flow; etc). Regional and sub-regional hydrologic investigations focusing on groundwater indicate that much of the solute increase is attributable to subsurface non-point source (NPS) returns driven by a complex combination of agricultural activities (e.g., flood irrigation of field crops) juxtaposed upon naturally occurring regional groundwater flow. A two-year monitoring program focusing on periphyton within the same river reach further reveals local maxima in biomass corresponding to gaining river reaches. A long-term dynamic surface water quality model provides the unifying element for these data, and helps support earlier theses suggesting a link between NPS groundwater returns, nutrient enrichment and periphyton-driven oxygen dynamics in the lower river.

H51D MCC: Level 2 Friday 0830h

Hillslope and Basin Geomorphology Posters

Presiding: **E B Safran,** Lewis and Clark College**; E Wohl,** Colorado State University

H51D-1087 0830h POSTER

Constraining Passive Margin Escarpment Evolution by Low-Temperature Thermochronology

Peter vanderBeek[1] (pvdbeek@ujf-grenoble.fr)

Jean Braun[2] (Jean.Braun@anu.edu.au)

[1]Universite Joseph Fourier de Grenoble, Laboratoire de Geodynamique des Chaines Alpines, Grenoble 38041, France

[2]The Australian National University, Research School of Earth Sciences, Canberra, ACT 0200, Australia

Passive margin escarpments are major geomorphic features that separate low-relief, high elevation plateaux from near sea-level coastal plains. Their initial development is often linked to a base level drop associated with the episode of continental rifting that leads to the opening of an adjacent oceanic basin. How they migrate from their original coastal position to their present-day location sometimes several hundred kilometers inland, remains a matter of debate. Do escarpments retreat while maintaining their shape, or do they evolve from their original position to the location of a pre-existing inland divide by downwearing of the continental plateau. Recent thermo-chronological studies across the Great Escarpment of Southeastern Australia and the escarpment flanking the southern margins of the African continent have provided some constraints on the rate and nature of escarpment migration. Here, we use a complex three-dimensional thermal model of the crust coupled to a surface processes model to demonstrate under which circumstances thermochronological data can be used to provide meaningful information on the evolution of the escarpment. Furthermore, we define specific sampling strategies to optimize the information that can be extracted from thermochronological datasets on the rate of escarpment migration, the nature of its retreat as well as the value of poorly constrained parameters such as the local geothermal gradient and the flexural thickness of the lithosphere. In this context, we re-analyze published datasets on the Great Escarpment of Southeastern Australia and demonstrate that they contain incomplete information on the evolution of the escarpment. We define new potential targets that might provide more constraining information.

H51D-1088 0830h POSTER

Transverse drainage development along a tectonically active transform plate boundary (San Lorenzo River and Pancho Rico Creek, Monterey County, California)

Antonio F. Garcia[1] ((805)756-2430; afgarcia@calpoly.edu)

Martin Stokes[2] (mstokes@plymouth.ac.uk)

[1]Physics Department, California Polytechnic State University, San Luis Obispo, CA 93407, United States

[2]University of Plymouth, School of Earth, Ocean and Environment, University of Plymouth, Plymouth PL4 8AA, United Kingdom

Transverse drainage is often assumed to form as a result of either antecedence or superposition. Drainage-basin geomorphology in the Diablo Range of central California suggests that Pancho Rico Creek established transverse drainage as result of headward erosion, and drainage diversion caused by a landslide. Stream piracy may have also played a significant role. Mesoscale stream catchments within the Diablo Range of central California are elongate parallel to the NW trending San Andreas Fault zone (SAFZ). Principal streams draining these catchments ultimately flow to the west and form transverse drainages across the western ridges of the Diablo Range. Examples include the San Lorenzo River (SLR), which flows into the Salinas Valley at King City, and Pancho Rico Creek (PRC), which flows into the Salinas Valley at San Ardo. Incision patterns, fluvial stratigraphy, wind gaps, and beheaded, SW-flowing piedmont streams suggest that southeastward expansion of the SLR catchment occurred via headward erosion parallel to the SAFZ. Expansion occurred at the expense of SW-flowing piedmont streams, which were separated from the upland parts of their catchment by

headward expansion of the SLR catchment. Preliminary results suggest that the upper PRC catchment was captured by the SLR after Qf2 time, but before Qt3 time. PRC recaptured its upper catchment when a Quaternary landslide (Qls) diverted both PRC and the SLR, an event that probably occurred after Qt3 time. Upper PRC drainage basin morphology also suggests recent stream capture. Thus, since Qls time, PRC has been a southeastward expanding transverse drainage.

H51D-1089 0830h POSTER

Relationships Between GIS-Based Erosion Indices and Relief Production in the Karakoram Himalaya

Michael P. Bishop[1] (402 554-4808; bishop@data.unomaha.edu)

John F. Shroder[1] (402 554-2770; jshroder@mail.unomaha.edu)

Andrew B. G. Bush[2] (780 492-0351; andrew.bush@ualberta.ca)

Luke Copland[3] (+64 3 364 3166; luke.copland@canterbury.ac.nz)

Lewis A. Owen[4] (909 787-3106; lewis.owen@ucr.edu)

[1]Univ. of Nebraska at Omaha, Dept. of Geography & Geology, Omaha, NE 68182, United States

[2]Univ. of Alberta, Dept. of Earth & Atm. Science, Edmonton, AL T6G 2E3, Canada

[3]Univ. of Canterbury, Gateway Antarctica, Christchurch 8020, New Zealand

[4]Univ. of California-Riverside, Dept. of Earth Sciences, Riverside, CA 92521, United States

Mountain topography is the result of highly scale-dependent interactions involving climatic, tectonic, and surface processes. Alpine glaciers are known to be effective erosional agents that alter landscape relief-structure differently with altitude, although considerable uncertainty and debate exists concerning their effectiveness relative to fluvial activity. Furthermore, from a geodynamic systems perspective, the role of surface processes and relief production, and the spatio-temporal relationships between erosion and rock uplift are enigmatic. The Karakoram Himalaya represents an excellent location to study such relationships, given the extreme relief and reported values of sediment flux and exhumation rates. Consequently, we utilized GIS-based terrain modeling, global climate model simulations, geochronology, and satellite remote sensing to depict areas of rapid erosion in relation to mountain peaks and zones of rapid uplift, and assess the influence of alpine glaciation and other surface processes on landscape relief-structure. Three-dimensional, scale-dependent analysis and modeling of GTOPO30 data reveals that the maximum Airy isostatic response to landscape dissection ranges from $\sim$ 2 - 3 km for the highest peaks. GIS-based erosion indices depict high-erosion patterns that are spatially coincident with known and suspected zones of rapid uplift and erosion, such as Nanga Parbat, K2 and the Hunza region. The spatial variations depict differences in the coupling of glacier and fluvial erosion, although high-erosion areas exhibit a significant glacier erosion component. Topographic analysis reveals a non-linear relationship between slope angles and altitude, and high-resolution satellite imagery provides evidence of glacier erosion surfaces at high altitude. Although these surfaces have not yet been dated in the K2 region, geochronologic evidence from similar terraces in Hunza support an age of $>$ 100 K BP. If we assume this to be the case, our preliminary maximum estimates of valley incision near K2 average $>$ 1.5 cm / yr. Paleoclimate simulations and glaciological parameter estimates support the interpretation of periodic monsoon-enhanced, high-magnitude glacial erosion in these zones. We conclude that climate forcing and glacier positive-feedback mechanisms can generate significant relief at high altitudes, as deep glacier erosion removes lithospheric mass, whereas high peaks and ridge-lines are protected by permafrost and cold-based ice.

H51D-1090 0830h POSTER

Himalayan Sackung and Associations to Regional Structure

John F. Shroder[1] (402 554-2770; jshroder@mail.unomaha.edu)

Michael P. Bishop[1] (402 554-4808; bishop@data.unomaha.edu)

Jeffrey Olsenholler[1] (402 554-2725; jolsenho@cosmos.unomaha.edu)

[1]Univ. of Nebraska at Omaha, Dept. of Geography & Geology, Omaha, NE 68182, United States

Recognition of sackung slope failure or deep-seated, rock-slope deformation in the Himalaya has been rather limited, in part because: (1) many geoscientists do not recognize its characteristics; (2) large-scale aerial photographs and topographic maps used to identify the characteristic surficial, topographic manifestations of the failure type are commonly low-level state secrets in that region; and (3) no systematic survey for sackung has ever been made in the Himalaya. In the Pakistani-controlled, western Himalaya, some unconventional access to aerial photographs in the Kaghan and Nanga Parbat areas allowed first recognition of several characteristic ridge-top grabens and anti-slope scarps. Later release of declassified, stereo imagery from the CORONA and KEYHOLE satellite series enabled discovery of other examples in the K2 region. Comparison of mapped sackung failures with geologic base maps has demonstrated some coincidence of sackung with various structural trends, including synformal structures in upper thrust plates or along the traces of high-angle faults. In all probability these structural trends have provided plentiful ancillary planes of weakness along which gravitationally driven sackung is facilitated. Sackung failure in the Himalaya appears to be a spatially scale-dependent manifestation of a gravitational-collapse continuum of the brittle, upper crust, mainly involving mountain ridges. In contrast, gravitational collapse of the whole range may involve some similar failures but also include listric faulting, as well as subsidence movement into zones of ductility at depth. Temporal scale dependence of sackung may also be threshold dominated, wherein initial long-continued, slow failure ultimately leads to the commonly catastrophic rock-slope collapses recently recognized throughout the western Himalaya and now differentiated from their original mismapping as glacial moraines. Such sackung in Himalayan terrain undergoing active deglaciation from global warming may increase catastrophic slope-failure hazard.

H51D-1091 0830h POSTER

Constraining the Erosion History of Ancient Mountain Belts by Thermochronology: the Effect of Flexural Isostasy

Xavier Robert[1] (xrobert@ens-lyon.fr)

Jean Braun[2] (Jean.Braun@anu.edu.au)

[1]Ecole Normale Superieure de Lyon, Laboratoire de Sciences de la Terre, 46 Allee d'Italie, Lyon 69364, France

[2]Australian National University, Research School of Earth Sciences, Canberra, ACT 0200, Australia

Much work has recently been done to understand the coupling between tectonic and erosion. Regions characterized by a finite amplitude relief are subject to erosion, leading to rock exhumation and cooling. We can therefore obtain information about rock exhumation and the evolution of the relief from thermochronological data, especially when considering the relationship between age and elevation at a range of length-scales. In post-orogenic settings, exhumation is driven by the isostatic response to erosion. Using a coupled thermo-isostatic model, we demonstrate that the distribution of cooling ages at the surface of an ancient mountain belt is not only determined by the rate at which the ancient topography has evolved through time but also by the nature of the isostatic rebound which is, in turn, controlled by the flexural strength of the underlying lithosphere. Using published low-temperature thermochronological data from the Dabie Shan in eastern China, we demonstrate that a careful quantitative analysis of the age distribution and its relationship to present-day surface topography provide information on the rate at which the surface topography of the mountain belt has evolved through time to reach its present-day morphology but also on the elastic thickness of the underlying lithosphere. The data suggest that, over the last 60 to 70 Myr, relief has decreased almost linearly by a factor of 4 to 5 and that the lithosphere is characterized by an effective elastic thickness of 20 km. The data also provide constraints on the thermal structure of the crust beneath the Dabie Shan.

H51D-1092 0830h POSTER

Tectono-morphic scenarios for the Southern Alps of New Zealand.

Jean Braun[1] (61261255512; jean.braun@anu.edu.au)

Frederic Herman[1] (61261254227; frederic.herman@anu.edu.au)

William Jim Dunlap[1] (612612553247; jim.dunlap@anu.edu.au)

[1]australian national university, Research School of Earth Sciences, Canberra, ACT 0200, Australia

Temperature-time histories of rocks can be used to constrain tectonic and/or geomorphic scenarios of tectonically active areas. However, this inference is not always straightforward and relies on several interdependent mechanisms such as heat conduction, horizontal and vertical heat advection, tectonic kinematics, transient topography, etc, that must be taken into account while interpreting thermochronological datasets. Using a 3D finite element code (Pecube) that solves the transient heat transfer equation with an evolving topography, one can define accurate Temperature-time histories to interpret thermochronological datasets. Proper inversion methods (Monte Carlo type, e.g. Neighborhood Algorithm) can in turn be used to constrain the tectono-morphic development of a tectonically active area. This approach is applied to the continental collision that occurs in the South Island in New Zealand. Existing thermochronological datasets (K-Ar in Biotite and Muscovite, Fission tracks in apatite and zircon) complemented by recent low-T termochronometer data ((U-Th)/He in apatite and zircon) are used to derive information on the tectono-morphic development of the orogen: changes in tectonic regime, apparition of relief, geometry of major oblique-thrust and influence of glaciations.

H51D-1093 0830h POSTER

Effects of Drainage basin property and geological dip - strike angle on Landslide

Daisaku Kawabata (d-kawabata@aist.go.jp)

The recent spread of GIS and high-precision DEM has been making rapid and extensive topographical measurements feasible. GIS is helpful tool to analysis of landslide probability and make landslide hazard map. We have investigated that the altitude-slope relationship for each geological unit (e.g. sandstone-dominant, mudstone-dominant, sandstone-mudstone alternation) in the Southern Japanese Alps. This result shows that terrains underlain by some specific rocks, however, are highly susceptible to landslides and thus have markedly reduced slope angles than other terrains with similar altitudes. It is another result of our investigation that the characteristics slope failures like toppling is difference from landslides. In our study, it is not clear of the relationship of dip angle of the geology and aspect in landslide area. In addition to this subject, the problem which we consider next is what the other factor decides landslide distribution. Relationship drainage basin and landslide is focused in this study. The results of morphometric measurement, over 70% landslides are on the geological boundary. The slope angle of landslide area is 10-15% lower than dip angle of geological unit. The dip angle direction of geological unit shows similar trend of aspect of landslide. Many Landslides are on the low drainage density and high slope angle area. Drainage density is low and it has large area in geological unit include many landslides. These results show that landslides are easy to cause in a place like similar dip direction and dip angle of the geological unit. It is likely that landslides tend to cause in the place where material is different. Large drainage basin and high slope angle effects on landslide distribution.

H51D-1094 0830h POSTER

Process-Modulated Contrasts in Slope Exposure of Landslides in the San Francisco Bay Area

Richard J. Pike[1] (650-329-4947; rpike@usgs.gov)

Steven Sobieszczyk[2] (503-251-3464; ssobie@usgs.gov)

[1]U.S. Geological Survey, 345 Middlefield Road MS 973, Menlo Park, CA 94025, United States

[2]U.S. Geological Survey, 10615 S.E. Cherry Blossom Drive, MS 975, Portland, OR 97216, United States

Beaty (1956) first quantified the relation between slope exposure (aspect), the compass direction faced by a hillside normal to its contours, and landsliding in the Bay Area; he found that 78 of 112 recent small landslides east of the city of Oakland occupied NW to NE slopes. Frequency distributions of DEM-calculated aspect revisit this relation for two large sets of landslides in seven 1:24,000 quadrangles centered on Oakland: 30-m source areas of the 1,943 debris flows that formed during the severe 3-5 January 1982 storm *(Wieczorek et al., 1988)*, and 116,360 30-m grid cells on 6714 pre-1970 deep-seated landslides of various types exclusive of debris flows *(Nilsen, 1975; Pike et al., 2001)*. Normalizing each distribution of landslide aspect (in percent, in 10° intervals) by the aspect of all slopes in the study area above 75 m in elevation and steeper than 3° corrects for the excess of NE and SW slopes imparted by the NW-SE grain of local topography. Both resulting distributions are skewed, but in directions that reflect contrasting processes of landsliding. The differences suggest that any incorporation of slope aspect into landslide susceptibility in the Bay area must reflect specific types of failure. The deep-seated landslides favor ENE slopes and are deficient on southerly slopes. The prevailing explanation for this observation was first proposed in the study area by *Beaty (1956)*. Compared to steep S-SW slopes, exposed to afternoon sun at near-normal angles of incidence (northern hemisphere), N-NE slopes are more shaded, sustain less evapo-transpiration, and thus accumulate more and deeper moisture over extended periodsconditions favoring deep-seated failure triggered

by prolonged rainfall or seismic shaking. Such conditions are unlikely to have controlled location of the 1982 debris flows, which are conspicuously deficient on NE slopes but strongly favor S-SSE slopes. One explanation is wind-driven rainfall, which may have delivered moisture preferentially to steep southerly slopes. This hypothesis is consistent with the 155° median of 33 hourly measurements of wind direction during the January 1982 rainstorm at nearby Oakland International Airport, where recorded wind speed averaged 19 kts. Alternative explanations and other Bay Area locations remain to be explored.

H51D-1095 0830h POSTER

Landslide Sediment Production in the Middle Fork Eel River: 1940-2002

Juan A. de la Fuente[1] (530-841-4413; jdelafuente@fs.fed.us)

William P. Snavely[1] (530-841-4403; wsnavely@fs.fed.us)

Alisha R. Miller[2] (530-242-2254; alishamiller@fs.fed.us)

Don Elder[1] (530-841-4414; delder@fs.fed.us)

[1]Klamath National Forest, 1312 Fairlane Road, Yreka, CA 96097, United States

[2]Shasta Trinity National Forest, 2400 Washington Avenue, Redding, CA 96001, United States

A sequential air photo analysis was conducted by the U.S. Forest Service (USFS) and North State Resources in the 753 square mile Middle Fork Eel River basin, under contract to US Environmental Protection Agency as part of a Total Maximum Daily Load (TMDL) assessment. All landslides visible on air photos which appeared to deliver sediment to the stream system were mapped, and the delivered volume estimated. Landslides on undisturbed hillslopes were classified as natural, those within recently burned areas as fire-related, those in harvest units as harvest-related, and those adjacent to roads as road-related. About 5% of the landslides were field verified. Data were then summed for three air photo intervals, spanning the period 1940-2002. A total of 4,122 landslides were inventoried, delivering a total of 24,969,836 cubic yards of sediment to the stream system, and occupying 13,526 acres. The photo interval 1940-1969 accounted for 79% of the delivered volume, 1970-1984 for 8%, and 1985-2002 for 13%. This pattern is similar to that observed in many NW California watersheds where the storms of 1955 and 1964 generated large volumes of landslide sediment. Landslide volume per unit area delivered to streams from 1940-2002 averaged 0.84 cubic yards/acre/year for the Middle Fork Eel, and was highest in the Black Butte River, and Williams-Thatcher subwatersheds which exhibited rates of 1.55 and 1.31 cubic yards/acre/year respectively. The lowest delivery rates were in Upper Middle Fork (0.29), and Round Valley (0.44). Natural landslides accounted for 89.9% of the total, fire-related for 1.9%, harvest-related for 0.4%, road-related for 3.4%, and undetermined 4.4%. A large proportion of the total delivered sediment originated from the toes of large deep seated landslides adjacent to streams. Many of these landslides exhibited multiple years of activity, shedding debris slides of varying sizes at different times. The mapped active landslides are concentrated near streams, but do not display any obvious affinity with specific bedrock units. The landslide sediment delivery rate in the Middle Fork Eel basin determined by this study (0.84 cuyd/ac/yr) compares to published values for other parts of the Eel basin as follows: North Fork Eel 0.16 (USFS, 2003); Middle Fork Eel 5.93 (USGS, 1986, total sediment); South Fork Eel 2.26 (Tetra Tech, 1998). Different techniques were used in each study, making direct comparison problematic. A model employed by the USFS in 2001 predicted landslide rates (cubic yards/acre/year) very similar to those measured by this study: Black Butte River 1.55 measured versus 1.33 predicted; Elk/Dos Rios 0.45 vs 0.96; Upper Middle Fork 0.29 versus 0.62; Williams Thatcher 1.31 vs 1.17.

H51D-1096 0830h POSTER

Investigating Effects of Resolution on Landslide Identification and Landscape Attributes in the Queen Charlotte Islands, B.C.

Darren Sjogren[1] (403-220-2575; sjogren@ucalgary.ca)

Yvonne Martin[2] (403-220-6197; ymartin@ucalgary.ca)

[1]Earth Sciences Program, University of Calgary, 2500 University Dr. NW, Calgary, AB T2N 1N4, Canada

[2]Department of Geography, University of Calgary, 2500 University Dr. NW, Calgary, AB T2N 1N4, Canada

Two exceptional mass wasting inventories (Rood, 1984; Gimbarzevsky, 1988) have been collected and analyzed for the Queen Charlotte Islands, British Columbia. These islands are located about 80 km off the coast of British Columbia, have a mild, wet climate and are seismically active. These factors contribute to a high frequency of landsliding. The Gimbarzevsky database consists of about 8000 debris slides, debris avalanches and debris flows over the entire 10,000 km^2 of the Queen Charlotte Islands. Events were identified from 1:50,000 panchromatic aerial photographs. Large grid cells (1 km^2) were used to classify landslide attributes, such as gradient and aspect. The Rood database consists of about a thousand events covering a total area of 350 km^2 in both logged and unlogged terrain. Failures were identified from 1:11,000 and 1:13,000 aerial photographs. Terrain attributes, such as initiation gradient, were obtained using photogrammetric techniques. The present study explores the effects of topographic data (DEM) resolution and air photo resolution on landsliding analysis. For the former, landscape attributes associated with mass movements, such as initiation gradient and aspect, are compared for the original Gimbarzevsky results (based on 1-km grid cells) and new results for this database derived from 100-m DEM data. For the latter, we explore the effects of aerial photograph scale on landslide identification for the Rood and Gimbarzevsky databases. In addition, we explore the benefits in deriving initiation gradients from detailed, yet time-consuming, photogrammetric techniques versus more automated approaches using existing DEM data. References: Gimbarzevsky, P. (1988) Mass Wasting on the Queen Charlotte Islands: A Regional Inventory, B.C. Ministry of Forests, Land Management Report 29; Rood, K. (1984) An Aerial Photograph Inventory of the Frequency and Yield of Mass Wasting on the Queen Charlotte Islands, B.C., B.C. Ministry of Forests, Land Management Report 34

H51D-1097 0830h POSTER

Landslide Rates in the Eastern Cascade Mountain Range

Kristian J. Bergen[1] (kbergen@fas.harvard.edu)

Colleen O. Doten[2] (206-685-1796; colleen@hydro.washington.edu)

Dennis P. Lettenmaier[2] (206-543-2532; dennisl@u.washington.edu)

[1]Harvard College, University Hall, Cambridge, MA 02138, United States

[2]University of Washington, Department of Civil and Environmental Engineering, Box 352700, Seattle, WA 98195, United States

Assessing landslide rates is an important factor in quantifying sediment generation in mountainous watersheds. Prediction of the role of land cover change, especially forest harvest and fires, on sediment generation is currently a problem of particular interest to forest management agencies. Traditional aerial photograph interpretation techniques have long been used for estimation of failure rates, however to date such data has rarely been used in a predictive modeling context. Furthermore, relatively little quantitative data exist that are applicable to the east slopes of the Cascade Mountains, where recent fires have created an interest in improved prediction techniques that might help better understand the implications of post-fire sediment generation for the health of streams. Using aerial stereo photographs from the years 1970, 1975, 1979, 1985, and 1992, provided by the U.S. Forest Service, landslides were mapped in the Rainy Creek tributary of the Little Wenatchee basin of the northeastern Washington Cascades. The slides were mapped onto digital orthophotos and were categorized by a confidence scheme based on the visible features of a landslide. Slides were further categorized by the land type (forested, harvested, unforested, burned, and road-related) they occurred in, and stream and forest road intersections were also noted. Landslide rates and slide densities were calculated based on the photo record intervals. The volume of removed sediment was also estimated. These rates were compared to precipitation records over the same time period to evaluate the effect of large storms on mass wasting in this region. Estimated slide number and area densities are compared with similar studies elsewhere in the western U.S. Also, predicted and estimated number and area of slides from a numerical model described in a companion paper (Doten et al) are compared with the orthophoto estimates for the 22-years period 1970-92.

H51D-1098 0830h POSTER

A Mechanical Explanation for the Shape of Landslides on Maps

Stephen J Martel (808 956-7797; smartel@hawaii.edu)

Department of Geology and Geophysics, University of Hawaii, 2525 Correa Road, Honolulu, HI 96822, United States

Landslides in rock or consolidated sediments commonly have roughly elliptical shapes in map view and a width: length ratio between 0.5 and 1. A fracture mechanics analysis that treats the landslide slip surface as a shear fracture (slip patch) provides an explanation for these observations. The slip patch is parallel to the surface of an elastic half-space, simulating sliding at depth along a pre-existing weakness (e.g., a geologic contact or bedding plane). The slip patch propagation tendency is inferred from the fracture energy release rate G at its perimeter; G is essentially a measure of the energy available to drive propagation a unit distance. The energy consumed per unit amount of patch advance (G*) is considered as a constant around the patch perimeter. The tendency for a slip patch to propagate in plane is inferred to be greatest where G is highest. A "preferred" patch shape is assumed to occur if G is uniform around the fracture perimeter. For a slip patch with a length that is small relative to its depth (i.e., during slip nucleation) a uniform value of G is obtained for elliptical patches with width: length ratios of 1, ∼0.75 and ∼0.5 for Poisson's ratios of 0, 0.25 and 0.5, respectively. Boundary element analyses reveal that as a slip patch spreads in a material with a Poisson's ratio of 0.25, the patch would tend to maintain a width: length ratio between 0.5 and 1. I interpret these results as predicting that the distribution of width: length ratios for a large sample of landslides would peak between 0.5 and 1. Data from about 350 landslides in Hokkaido, Japan (Yamagishi and Ito, 1994) show that ∼ 60% of the slides have a ratio between 0.4 and 1, consistent with the prediction. The presence of landslides with width: length ratios less than 0.5 or greater than 1 indicates that factors other than the fracture energy release rate come into play in real slopes. Structural, stratigraphic, topographic, and hydrologic heterogeneity probably account for some of this variation, as could variation in the energy required for patch propagation (G*) as a function of position on the patch perimeter. Nonetheless, the consistency of the model predictions with the observations suggests that the simple model here captures at least some of the essential physics of the sliding process.

URL: http://www.soest.hawaii.edu/martel/Stevem.html

H51D-1099 0830h POSTER

Links between erosion, runoff variability, and seismicity in the Taiwan orogen

Niels Hovius[1] (nhovius@esc.cam.ac.uk); Simon J Dadson[1] (sdadson@esc.cam.ac.uk); Hongey Chen[2] (hchen@ntu.edu.tw); W Brian Dade[3] (william.b.dade@dartmouth.edu); Meng-Long Hsieh[2] (hsiehml@pchome.com.tw); Sean D Willett[4] (swillett@u.washington.edu); Jyr-Ching Hu[2] (jchu@ccms.ntu.edu.tw); Ming-Jame Horng[5] (mjhorng@wra.gov.tw); Meng-Chiang Chen[6] (cmorgan@taroko.gov.tw); Colin P Stark[7] (cstark@ldeo.columbia.edu); Dimitri Lague[1] (dlag02@esc.cam.ac.uk); Jiun-Chuan Lin[8] (jclin@ccms.ntu.edu.tw)

[1]Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge CB2 3EQ, United Kingdom

[2]Department of Geosciences, National Taiwan University, No. 1, Sec. 4, Roosevelt Road, Taipei ROC, Taiwan

[3]Department of Earth Sciences, Dartmouth College, Hanover, NH 03755, United States

[4]Department of Earth and Space Sciences, University of Washington, Seattle, WA 98195, United States

[5]Water Resources Agency, Ministry of Economic Affairs, Hsin-Yi Road, Taipei ROC, Taiwan

[6]Taroko National Park Headquarters, Fu-Su Village, Hualien ROC, Taiwan

[7]Lamont-Doherty Earth Observatory of Columbia University, Palisades, New York, NY 10964, United States

[8]Department of Geography, National Taiwan University, No. 1, Sec. 4, Roosevelt Road, Taipei ROC, Taiwan

Erosion of mountain belts controls their topographic and structural evolution and is the main source of sediment delivered to the oceans. While mountain erosion rates have been estimated from relief and precipitation, full evaluation of controls on erosion rates and patterns is challenging and requires detailed measurements across multiple time-scales. We report erosion rates in the Taiwan mountains estimated from modern river sediment loads, Holocene river incision, and million-year time-scale thermochronometry. Estimated erosion rates are high, 3–6 mm yr^{-1}, on all time-scales, but the pattern of erosion has changed over time in response to localized tectonic deformation. Modern erosion corresponds with historical seismicity and runoff variability, while the topographic expression of tectonic and erosional forcing is modulated by substrate erodibility.

URL: http://www.esc.cam.ac.uk/∼simon00/

H51D-1100 0830h POSTER

Overlandflow generation and surface erosion in Mongolia

Yuichi Onda[1] (81-29-853-4226; onda@atm.geo.tsukuba.ac.jp); Tomoyuki Nishikawa[1] (s023557@icho.ipe.tsukuba.ac.jp); Hiroaki Kato[1] (hiros980@zae.att.ne.jp); Yukiya Tanaka[2] (ytanaka@khu.ac.kr); Maki Tsujimura[1] (mktsuji@atm.geo.tsukuba.ac.jp); Gombo Davaa[3] (gdavaa@yahoo.com); Dambaravjaa Oyunbaatar[3] (oytetuar@yahoo.com)

[1]Institute of Geoscience, University of Tsukuba, 1-1-1 Tenno-dai, Tsukuba 305-8571, Japan

[2]Department of Geography, Kyung Hee University, 1Heogi-dong, Dongdaemun-gu, Seoul 130-701, Korea, Democratic People's Republic of

[3]Institute of Meteorology and Hydrology Mongolia, P.O. Box 150, Ulaanbaatar-36, Ulaanbaatar 36, Mongolia

In Mongolia, significant soil erosion is thought to be caused by overgrazing and unsuitable management. Soil erosion also make desertification, a key issue of environmental concern. However, very few field data are available on overland flow mechanism, soil erosion processes and amount and the desertification processes. The purpose of our research project (2001-2006) is to study and assess the state and the causes of soil erosion through the monitoring of overlandflow flow and soil erosion. The study site locate 60-100 km east of Ulanbaatar. One site is Kherlen Bayaan Ulaan (KBU), and the other site is Baganuur (BG). The drainage area of the watershed is 7.1 ha and 8.0 ha, and relative height is 105 m and 160 m, respectively. Parshall flumes and sediment traps were installed at the outlet of the catchments. Also we established 2 hillslope plots (50m x 50 m) in each area in which one is surrounded by fens. Discharge flow plots were monitored by Parshall flumes, and tensiomters, raindrop impact sensors, wind velocities were also recorded. About 50 Soil cores were sampled in each catchments and Cs-137 analysis were conducted. The runoff peak in 2003 in KBU is greater than BG. Through the Cs-137 analysis, long term soil erosion is very significant throughout the catchment is KBU, but deposition area were detected downslope of the catchment and lower overall erosion rate in BG. These data suggest the overlandflow erosion is significant in the study area, but importance of surface erosion varied between place to place.

H51D-1101 0830h POSTER

Investigation of Human Impacts on Surficial Geomorphology in Mountain Parks Using MASTER Data: Preliminary Results

William L. Stefanov[1,2] (480-965-5507; will.stefanov@asu.edu)

[1]Department of Geological Sciences, Arizona State University, Tempe, AZ 85287-6305, United States

[2]Center for Environmental Studies, Arizona State University, Tempe, AZ 85287-3211, United States

The role of humans as active agents of geomorphic change is obvious at large scales (i.e. urbanization), but is also important at smaller temporal and spatial scales due to activities such as hiking and mountain biking. The effect of these activities on soil disturbance, sediment transport, surface hydrology, and vegetation growth are not well understood in arid regions where the majority of projected population growth is expected to occur. The Phoenix, AZ metropolitan area includes several public mountain parks comprising a wide range of bedrock, structure, soils, and geomorphology. The region includes ideal sites for study as there are parks completely surrounded by urbanization (with a high degree of constant use) as well as parks more removed from the metropolitan core that experience less overall human presence. A primarily field-based approach to this study is impractical due to the large total area of investigation (approximately 1000 square kilometers). Use of high spatial and spectral resolution remotely sensed data represents a useful alternative (or complementary) approach. Airborne MODIS/ASTER Simulator (MASTER) data were obtained at a ground resolution of 5 meters/pixel over Phoenix urban and peri-urban mountain parks during April 2003. This sensor acquires data in 50 bands in the visible through mid-infrared wavelengths and captures primary rock-forming mineral (quartz, feldspar, pyroxene, amphibole, etc.); weathering and pedogenetic mineral (clays, oxides, carbonates); and vegetation spectral features useful for compositional analysis. Preliminary results presented here use MASTER spectral data and band ratios to assess the degree of disturbance of surficial soils (as defined by presence of clay minerals and lack of surface crusts/pavements) associated with high- and low-use areas of mountain parks. These initial results are being used to assess the degree to which lithology, structure, vegetation, soil type, and landscape position modulate the effects of human disturbance of surficial materials.

H51D-1102 0830h POSTER

THE EVOLUATION IMPACT OF THE GEOLOGICAL ENVIRONMENT IN EXPANSION OF ANCIENT CIVILIZATION AT BUTRINT - FOENIKE REGION, SOUTHERN ALBANIA.

Vladimir S Kavaja[1] (35-5-54-23-9885; kavajav@yahoo.com)

Çerçiz S Durmishi[1] (35-5-54-23-3758)

Fatbardha Nazmi Vinçani[1] (35-5-54-36-9284)

[1]Albanian Geological Survey, Qendra Gjeofizike, Blloku Vasil Shanto, Tirana, Al 000000, Albania

The rise, creation and decline of the ancient civilization depended on paleo-geographic development changing at the geological environmental.This region is a worldknown archaeological site protected by UNESCO. The area under investigation occupies about 80 km2 and encompassing a large expanse of land at southern and northern side of the Butrinti lake, which is with oval shape and 21.5 depth. Throughout its long history, Butrint had an interactive relationship with its hinterland and the even-changing coastline. Preliminary research suggests that in the Holocene the Lake of Butrint was a sea inlet that stretched 20 km to north of Butrint, as far as the city of Foenike, later Epirot capital. Today the Butrint Lake is just 7.5 km long, being the result of gradual silting up this inlet with soils brought down by Bistrica River in the north side and Pavllo River in the South from surrounding mountain ranges. The goal of this study is investigation of the link between the evolution of Butrinti lake and hydrologicacal systems of the lake, its silting history and how this has impacted and interacted with land and human activity. Histories of terrestrial erosion, nearshore sediment redistribution, times, subsidence and compaction, land-sea interaction are obvious now. Geophysical observation consist of vertical electric soundings (V.E.S.) and magnetic measurements inside a layout of 80 km2. The soundings data, particularly resistivity variations are the base for sedimentologic studies due to the lack of boreholes. For a gravel deposition, in addition to the usual parameter maps as resistivity and thickness maps, combined multiparametric characterization maps have been plotted. Based on the sedimentologic and structural factors studied and geophysical maps and cross-sections , plenty of geomorphic problems are resolve. The evaluations of the regional water bearing are estimated, separating salty waters area.

H51D-1103 0830h POSTER

Sediment Production from Forest Roads in the Central Sierra Nevada, California

Drew B.R. Coe[1] (360-592-5176; dcoe@nooksack-tribe.org)

Lee H. MacDonald[2] (970-491-6109; leemac@cnr.colostate.edu)

[1]Nooksack Indian Tribe, 5016 Deming Road, Deming, WA 98244, United States

[2]Dept. of Forest, Rangeland and Watershed Stewardship, Colorado State University, Fort Collins, CO 80523, United States

Unpaved roads are a major source of sediment in many forested landscapes. For the Sierra Nevada of California there are few data on road erosion rates or the factors that control road sediment production. This information is urgently needed to establish TMDLs and evaluate cumulative effects. Annual sediment production from 139 road segments was measured over three wet seasons using sediment fences. The first wet season had 1290 mm of precipitation as compared to 890 and 1057 mm in the second and third wet seasons, respectively. More importantly, the second and third wet seasons were dominated by colder storms with much of the precipitation falling as snow. Hence the annual erosivity (EA) in the first wet season was 847 MJ mm ha-1 hr-1, which was nearly twice the values from the second and third wet seasons. The mean sediment production rate from native surface roads in the first wet season was 0.64 kg m-2 as compared to 0.17 and 0.20 kg m-2 in the second and third wet seasons, respectively. Rocked roads produced only 0.01-0.03 kg m-2 yr-1. Recently-graded native surface roads produced twice as much sediment per unit storm energy as ungraded roads. The product of road surface area and road slope explained 40% of the variability in sediment production from native surface roads. Adding EA and a dummy variable for grading increased the overall R2 to 0.54. Road segments draining soils with rock outcrops or particularly shallow soils produced more than twice as much sediment as roads on or adjacent to all other soil types, and this difference is attributed to the higher runoff rates associated with the interception of shallow subsurface stormflow. The much lower erosion rates in the second and third wet seasons can be attributed to the lower annual erosivities and the role of the snow cover in reducing rainsplash and overland flow velocities, and possibly attenuating high-intensity bursts of rainfall. The results emphasize the variability of road erosion rates, the sensitivity of road erosion rates to site and climatic factors, and the difficulty of accurately predicting sediment production rates.

H51D-1104 0830h POSTER

Predicting the Surface Redistribution of Possibly Contaminated Tephra Deposits at the Yucca Mountain Repository Using Cesium-137

Charles D Harrington[1] (505-667-1855; charrington@lanl.gov)

John W Whitney[2] (303-236-7803; jwhitney@usgs.gov)

K. Teryn Ebert[1] (505-667-0791; teryne@hotmail.com)

[1]Los Alamos National Laboratory, EES-9 MS J521, Los Alamos, NM 87545-0001, United States

[2]U.S. Geological Survey, Federal Center MS 980, Denver, CO 80225, United States

In the event a volcanic eruption occurred through the proposed Yucca Mountain repository, Nevada, radioactive waste particles could be incorporated into the eruption products and deposited with the volcanic ash. The objective of this study was to predict the surface redistribution of the contaminated tephra deposits in order to evaluate how the critical group (located 20 km south of the repository within the Fortymile Wash drainage area) might be affected. We calculated the volume of material that has been eroded or deposited within the past 50 years using cesium (Cs)-137. Radioactive Cs-137 was distributed worldwide as a result of atmospheric nuclear weapons tests during the 1950's, and has been used as an anthropogenic tracer. In most earlier cesium-137 studies, the investigated sites were either along several transects or on plots of a few dozen km2, whereas this study covers an area of >1500 km2. Fortymile Wash is an 800-km2 drainage basin that includes the entire eastern slope of Yucca Mountain and the Fortymile Wash alluvial fan; therefore, understanding the surface processes along Fortymile Wash are important to the volcanic-eruption consequence. To assess erosion rates on the Fortymile Wash fan, alluvium samples were analyzed for Cs-137 concentrations, for the vertical cesium profile down to 10 cm depth, and for particle-size composition of the upper 3-5 cm. The results of Cs-137 concentrations in the samples from the upper fan indicate that the upper fan interstream divide areas have been eroding over the last 50+ years and have lost 1 cm to 2 cm of the upper soil horizon, mainly as the result of eolian processes.

H51D-1105 0830h POSTER

Factors Associated With Post-fire Sediment Yields From Hillslope Plots in the Colorado Front Range

Juan de Dios Benavides-Solorio[1] (52-33-3641-2248; jdedios@cirpac.inifap.conacyt.mx)

Lee H. MacDonald[2] (970-491-6109; leemac@cnr.colostate.edu)

[1]INIFAP-Centro de Investigacion Regional del Pacifico Centro, Parque Los Colomos s/n Col. Providencia, Guadalajara, Jal 44600, Mexico

[2]Colorado State University, Department of Forest, Rangeland and Watershed Stewardship, Fort Collins, CO 80523, United States

In recent years there has been a large increase in the number and size of wildfires in the mid-elevation zones of the Colorado Front Range. High-intensity rainstorms after these fires have increased erosion rates by several orders of magnitude and severely affected downstream aquatic resources. The objective of this study was to measure sediment production rates at the hillslope scale and determine the key controlling variables. To this end 48 sediment fences have been continuously monitored in three wildfires and three prescribed fires at elevations ranging from 1670 to 3050 m. The most intensively-studied area is the Bobcat fire, which burned 43 km^2 in June 2000. Within this fire sediment production rates exceeded 10 Mg ha^{-1} yr^{-1} for areas burned at high severity. Prescribed fires produced substantially less sediment than the corresponding wildfires. Sediment production rates from sites burned at high severity were nearly 200 times higher than sites burned at moderate severity. Nearly all of the erosion occurred as a result of summer rainstorms rather than winter snowmelt. Sediment production rates per unit area were 2-3 times higher in swales or small drainages than from planar hillslopes. Data from the older fires indicate that sediment production

rates remain elevated for sites burned at high severity for at least three years after burning. When the data from all fires were combined, 77% of the variability in sediment production rates could be explained by fire severity, percent bare soil, rainfall erosivity, soil water repellency, and soil texture. A simpler model using only percent cover and rainfall erosivity had a R^2 of 0.62. Various models were tested against an independent data set from the Bobcat fire, and this showed that fire severity, percent bare soil, and rainfall erosivity could successfully predict post-fire erosion rates. The understanding and models developed in this project can help land managers predict the likely impacts from future wildfires and assist in the design of more effective post-fire rehabilitation techniques.

H51D-1106 0830h POSTER

Hillslope Erosion Processes after High Severity Wildfires, Colorado Front Range

Joseph H Pietraszek (jpietrzk@cnr.colostate.edu)

Lee H MacDonald (leemac@cnr.colostate.edu)

High severity forest fires can increase soil erosion rates by two or more orders of magnitude, with potentially severe consequences to downstream water resources. The objectives of this study were to contrast hillslope and rill erosion in severely burned areas, and quantify the effects of different controlling variables. Sediment yields are being monitored from 34 sites that burned at high severity in early summer 2002 in the central Colorado Front Range. Twenty-three of these sites are in topographically convergent swales with contributing areas of 100 to 7000 m^2. The other 11 sites are on planar hillslopes with contributing areas ranging from 30 to 150 m^2. Rill formation is being measured at 117 cross-sections in 14 of the 23 swales. Tipping bucket rain gages are measuring rainfall intensities within 0.5 km of each site. For individual storms the sediment yields per unit area vary by an order of magnitude, and this is largely due to the spatial variability in the amounts and intensity of rainfall. In the swales storm sediment yields can exceed 1.0 kg m^{-2}, and on average the swales produce approximately 2-3 times more sediment per unit area than the planar hillslopes. The greater topographic convergence in the swales results in more concentrated overland flow, and this is evidenced by the rapid rill incision in the swale axes. The cross-sectional area of these rills ranges up to 0.05 m^2, and the cross-sectional area of these rills has been increasing in the second summer after burning despite the gradual increase in ground cover. Data from a storm of 8 mm shows that rill erosion in the swale axes can account for nearly 80% of the measured sediment yields. A better understanding of rill erosion is needed to accurately predict post-fire erosion rates and design effective rehabilitation treatments.

H51D-1107 0830h POSTER

Effectiveness of Emergency Rehabilitation Treatments in Reducing Post-fire Erosion, Colorado Front Range

Daniella T.M. Rough (drough@lamar.colostate.edu)

Lee H MacDonald (leemac@cnr.colostate.edu)

Daniella T.M. Rough Department of Forest, Rangeland, and Watershed Stewardship, Colorado State University, Fort Collins, CO Lee H. MacDonald Department of Forest, Rangeland, and Watershed Stewardship, Colorado State University, Fort Collins, CO Burned area emergency rehabilitation (BAER) treatments are often applied to reduce post-fire flooding and erosion, but few studies have quantified their efficacy. The effectiveness of different BAER treatments in reducing post-fire erosion rates is being studied for three different wildfires in the Colorado Front Range. The treatments being monitored include seeding, contour felling, mulching, scarification with seeding, and a polyacrylamide (PAM). Sediment production rates are being measured at the hillslope scale using sediment fences installed immediately after the June 2000 Bobcat fire and the 2002 Hayman and Schoonover fires. Neither aerial- nor ground-based seeding significantly reduced erosion rates in the first three years after the Bobcat fire. In contrast, 4.5 t ha^{-1} of straw mulch consistently reduced sediment yields by more than 90%. Contour felling initially reduced erosion rates for small and moderate storms, but was less effective following the largest storms, presumably due to overwhelmed sediment storage capacity. A pairedswale design is being used for the 2002 Hayman and Schoonover fires, as this provides a more sensitive evaluation of BAER treatment effectiveness. The ground-based application of straw mulch and the aerial application of hydromulch each reduced sediment yields by more than 95% in both 2002 and 2003. However, the ground-based application of hydromulch in fall 2002 did not significantly reduce sediment yields in 2003. In 2002 the application of 11 kg ha^{-1} of PAM in an ammonium sulfate solution reduced sediment yields by 66%. In 2003 neither these sites nor three newly treated sites showed a significant reduction in sediment yields. A dry application of 5.6 kg ha^{-1} PAM had no detectable effect on sediment yields, nor did scarification and seeding in 2002 or 2003. These data suggest that treatment effectiveness varies with time since application, storm intensity, and amount of ground cover. Studies on these and other fires indicate that percent ground cover is the primary control on post-fire erosion rates because this reduces rainsplash, sheetwash, and rill erosion. Mulching has been the most effective BAER treatment because this immediately provides ground cover. Treatments that do not immediately increase ground cover (e.g., seeding, contour felling, and PAM) have shown more limited effectiveness in reducing post-fire erosion rates.

H51D-1108 0830h POSTER

Climate Change Imprint in Spatial Patterns of Dune Fields

BT Werner[1] (bwerner@ucsd.edu)

G Kocurek[2] (garyk@mail.utexas.edu)

[1]Complex Systems Laboratory, Cecil and Ida Green Institute of Geophysics and Planetary Physics, University of California-San Diego, La Jolla, CA 92093-0225

[2]Department of Geology and Geophysics, University of Texas, Austin, TX 78712

Although many techniques for probing the history of a dune field, such as statigraphic reconstruction and dating, are available, the information contained within the spatial pattern of dunes rarely has been utilized. Here we present a model study aimed at identifying characteristic signals of climate change in the spatially varying properties of a dune field. In the model, a dune field is characterized by spacing, orientation and density of defects (ends of crestlines), properties that vary continuously in both space and time. The model is forced with transport direction and magnitude that change with time. Defects migrate through the dune field at a speed greater than dunes. As a defect passes through a dune crestline, crest length decreases because of merger, resulting in an increase in spacing. Defect density decreases as oppositely facing defects annihilate. Orientation changes when oppositely facing defects migrate at different speeds. Defect density increases and spacing decreases on boundaries when sand is supplied from upwind, resulting in the creation of numerous small dunes. Spacing, defect density and orientation both advect and diffuse. The resulting set of coupled nonlinear partial differential equations is solved using a finite difference technique. Climate changes result in changes in properties of dune fields at the boundaries; these changes then propagate into the dune field and dissipate. For example, dune constructional episodes cause the development of a shock wave in defect density, originating at the upwind end of the field, that results in a permanent increase in spacing. The prospects for determining the occurrence and characteristics of past climate change from snapshots of modern dune fields will be assessed. Supported by National Science Foundation, Geology and Paleontology Program.

H51D-1109 0830h POSTER

Microclimatic Influences on Hillslope Geomorphology, Northeastern Arizona

Benjamin N. Burnett[1] (burnett@unm.edu)

Grant A. Meyer[1] (gmeyer@unm.edu)

Leslie D. McFadden[1] (lmcfadnm@unm.edu)

[1]Department of Earth & Planetary Sciences, University of New Mexico, Albuquerque, NM 87131, United States

Climate is commonly assumed to be an important factor influencing weathering, erosion and landscape evolution, but few studies have quantitatively assessed differences in geomorphology associated with minor but persistently different moisture and temperature conditions. In northeastern Arizona, we have studied several small (~0.5 km^2), semi-arid eastward-draining basins where topography has induced different microclimates on north- and south-facing canyon slopes. These 60-100 m deep canyons expose lenticular silty sandstones and mudstones of the Jurassic Morrison formation; sandstones, shales, and coals of the Cretaceous Dakota formation; and shales of the Mancos formation. Over one annual cycle (beginning 17 August 2002), we monitored air, surface, and subsurface temperatures as well as soil moisture at four locations at 0.5 h intervals. The annual average air temperature (at ~10 cm above the surface) was 1.3°C warmer on a south-facing colluvial slope and 2.1°C warmer on a south-facing exposure of weathered sandstone than on north-facing slopes of the same type. Annual average surface temperature was 3.0-3.8°C warmer on south-facing slopes and the temperature at ~10 cm depth in the sandstone was 5.7°C warmer on the south-facing slope. Soil moisture tension averaged at least 78-100 kPa lower on north-facing slopes at 10 cm depth but only 36 kPa lower at 30 cm depth. Morrison formation sandstones weather primarily by granular disintegration and form a disaggregated mantle on some slopes where weathering exceeds erosion, but also form little-weathered vertical cliffs (dominantly on southerly aspects). Rock strength was estimated at over 400 sites using a Schmidt hammer. Slope angle and aspect, as well as vegetation type and % cover were also recorded at each location. Vegetation covers about 4 times as much area on northeast-facing slopes as on southwest facing slopes. Young's modulus values derived from Schmidt hammer rebound for southwest-facing points averaged 3.1 GPa, whereas northeast-facing slopes averaged 1.3 GPa indicating significantly greater weathering on north-facing slopes. Detailed mapping of weathered, unweathered, and debris-covered slopes shows that weathered exposures cover about half of the north-facing slopes and a third of south-facing slopes. Unweathered slopes comprise only 9-12% of north-facing slopes but 25-30% of south-facing slopes. Slope angles on southeast-facing slopes average 47° whereas northeast-facing slopes average 36°. The lower-angle slopes (<20°) are dominated by weathered bedrock exposure and minimal erosion whereas on steeper slopes (>40°) the weathered mantle has been stripped off leaving unweathered bedrock. Debris covers are most common on slopes between 20° and 40° and represent areas that are dominated by transport processes. These trends in slope cover, rock weathering, and slope angle suggest that over longer timescales, subtle temperature and moisture differences are sufficient to produce significant aspect-related changes in hillslope geomorphology.

H51D-1110 0830h POSTER

Dynamical Interactions Between Human Populations and Landscapes in Barrier Island Environments

Dylan E McNamara[1] (dmcnamara@ucsd.edu)

B T Werner[1] (bwerner@ucsd.edu)

[1]Complex Systems Laboratory, Cecil and Ida Green Institute of Geophysics and Planetary Physics, University of California-San Diego, La Jolla, CA 92093-0225, United States

Although much research has focused on how humans affect landscapes or how landform processes affect humans, little attention has been paid to dynamical interactions between the two. Based on the hypothesis that landscape and human dynamics both self-organize into a temporal hierarchy of scale-separated behaviors, we model the evolution of a coupled human population and barrier island system. Barrier islands are represented as a series of alongshore nodes, with each node specifying the width, height, cross-shore position, and profile of the island and the beach width, dune position and dune height. These characteristics evolve according to rules governing sediment transport during acretionary phases, erosion from storms, dune growth and migration, tidal delta formation, overwash, inlet formation, alongshore sediment transport, and dune and backbarrier vegetation growth. At each of these nodes, human populations and their cultural accoutrements are represented by mean property value, fraction of land used for tourist accommodations and tourist population. The dynamics of these variables is determined by simulating the competition for economic resources amongst the local population and the desire of the tourist population for adequate recreational beaches. The human and barrier subsystems are coupled through beach replenishment and a dependence of tourist population on beach width. Model results fall into three general categories of dynamical behavior, as classified by the (linearized) time scale of recovery from perturbations for the uncoupled systems. When the time scale for barrier islands is much less than that of the human population, the long-time-scale evolution of the barrier island follows human dynamics. In the reverse case, the long-time-scale evolution of the human population follows barrier dynamics. When the time scales are similar, new long-time-scale, spatially varying behavior of the coupled system emerges. Implications for prediction and optimization strategies will be discussed.

H51D-1111 0830h POSTER

Dramatic Changes in Sediment Discharge and Runoff From a Rapidly Urbanizing Coastal Watershed

Jonathan A Warrick[1] (650-329-5376; jwarrick@usgs.gov)

Kevin M Orzech[1] (650-329-5401; korzech@usgs.gov)

[1]Coastal and Marine Geology, USGS, 345 Middlefield Rd., MS 999, Menlo Park, CA 94025, United States

The southern California landscape has undergone dramatic urbanization and population growth during

the past 60 years and currently supports almost 20 million inhabitants. Here we show that these landscape changes have imparted significant decreases in suspended sediment concentrations for the region's largest river, the Santa Ana (over 10 fold decreases in sediment rating curves between 1967 and 2001). These decreases do not, however, represent alteration of the total sediment flux to the ocean (a common interpretation of sediment rating curves), but rather a dilution of sediment by increases in runoff from the urban impervious surfaces. We hypothesize that the observed decreases in sediment concentrations have changed the buoyancy of river discharge into the ocean from negative (i.e. hyperpycnal) to positive (i.e. hypopycnal). Thus, not only is landscape urbanization responsible for altering runoff patterns, but it may have also been responsible for changing the dispersal mechanisms and fate of sediment on the continental shelf.

H51D-1112 0830h POSTER

A 3D Ecomorphodynamic Model of Tidal Marsh Development

Matthew L Kirwan[1] ((919) 684-6258; mlk13@duke.edu)

Allen B. Murray[1] (abmurray@duke.edu)

James T Morris[2] (morris@biol.sc.edu)

Lincoln F Pratson[1] (lincoln.pratson@duke.edu)

[1]Duke University, Div. Earth and Ocean Sciences Duke University Box 90229, Durham, NC 27708, United States

[2]University of South Carolina, Dept. of Biological Sciences University of South Carolina, Columbia, SC 29208, United States

Extensive loss of global marshlands has been attributed to a combination of sea level rise, subsidence, erosion, and reduced sediment supply. Field and laboratory measurements indicate that in many marshes, vertical accretion rates are in equilibrium with sea level rise. Because vertical accretion rates appear to keep pace with sea level rise even in areas of widespread lateral marsh loss, previous modeling efforts which have been restricted to zero and one dimensional models of vertical accretion are inadequate to characterize the response of marshes to environmental change. Furthermore, interactions between biological and physical processes, although recognized as essential components of marsh evolution, have been ignored in previous models, greatly limiting an understanding of marsh morphodynamics. We have developed a three dimensional model of tidal marsh development that integrates ecological relationships between marsh productivity, relative sea level, and sediment accretion with a spatially explicit, physical model of the geomorphological evolution of the marsh that is applicable to large spatial and temporal scales. The model consists of a cellular topographic surface initially flooded to high tide water depth. Parcels of water in each cell drain according to a parametrically represented water-surface elevation. Discharge is the cumulative volume of the parcels passing through divided by a typical period of high flow during a tidal cycle, 3 hrs. Velocities, based on Chezy-Manning equations and the cumulative discharge, are calculated in each cell. The local deposition rate is proportional to the local depth of the bed below high tide level, up to a threshold depth above which deposition is constant. The constant of proportionality between deposition rate and water depth is a function of biomass production and suspended sediment concentration. Local erosion rates are proportional to bed shear stress when a critical shear stress is exceeded. Bed shear stress is estimated by $\tau_b = \rho f_c v^2$, where v represents a typical velocity during the period of high flow during a tidal cycle. The model explicitly runs over a single ebb tide drainage. If flow fields are assumed to be similar during the flood tide, the results from the single ebb flow can be extrapolated in time steps ranging from days to years. With a constant sea level and sediment supply, the model has been used to build a marsh platform dissected by tidal creeks that is everywhere in steady state. Model experiments on geological time scales featuring variation in sea level and suspended sediment concentration will allow the simulation of marsh response to changing environmental conditions.

H51D-1113 0830h POSTER

A numerical landscape-evolution model that simulates river width dynamics and consequent geomorphological features (braided river dynamics, terrace formation,...)

Philippe Davy[1] (Philippe.Davy@univ-rennes1.fr)

Sebastien Castelltort[1] (Sebastien.Castelltort@univ-rennes1.fr)

Jean VandenDriessche[1] (Jean.Van-Den-Driessche@univ-rennes1.fr)

[1]Geosciences Rennes, Campus de Beaulieu, Rennes 35042, France

We present a landscape evolution model that explicitly considered lateral stream erosion to simulate river width dynamics. The numerical code (€ros) is a walker-based method which solves the tectonic/erosion/deposition mass balance for a stochastic distribution of climatic events. The erosion flux is assumed to depend only on water flow and on topographic slope. According to the recent literature, we use the stream power-law model with threshold. The deposition flux is assumed to be proportional to suspended-sediment concentration; the proportionality factor is a sediment-transport distance ξ whose value fixes the nature of mass balance equation: transport-limited if $\xi << 1$, detachment-limited if $\xi >> 1$, and even any intermediate case. Lateral erosion is applied to domains (pixels) at the immediate vicinity of the walker route. As a first approximation, we assume that lateral erosion is proportional to basal erosion flux and to the height of river bank. €ros well reproduces the observed downslope widening of rivers. Clearly the river width is not a univocal function of discharge area as stated by most of the existing landscape evolution models; it has its own dynamics which mainly depends on erosion flux, and so on topographic disequilibrium. €ros also reproduces the classical river typology, braided, straight or sinuous, but not meandering whose physics is not yet included in the model (no dependency of lateral flux with river curvature). Braided rivers form during aggradation phases while a sinuous river mark the equilibrium stage. It is worth noting that lateral erosion favors river instability either in response to an external change of the hydraulic or tectonic conditions, or as a purely internal chaotic process. For instance autocyclic transitions between braided and sinuous shapes are observed in the simulations although no external parameter is modified. This instability is also responsible of terrace formations with also both deterministic causes (climatic or tectonic perturbations) and chaotic ones.

H51D-1114 0830h POSTER

Late Quaternary alluvial fan response to climatic and tectonic base-level changes: Jakes Valley, Central Great Basin, USA

Martin Stokes[1] (mstokes@plymouth.ac.uk)

Antonio F. Garcia[2] ((805)756-2430; afgarcia@calpoly.edu)

[1]School of Earth, Ocean and Environment, University of Plymouth, Plymouth PL4 8AA, United Kingdom

[2]Physics Department, California Polytechnic State University, San Luis Obispo, CA 93407, United States

Late Quaternary alluvial fans within the Jakes Valley region (White Pine County, Central Great Basin) are typically composed of up to 4 inset morphostratigraphic units. These units, Qf0 (oldest) through to Qf3 (youngest), are based upon field relationships (mapping & fan topographic profiles) and soil properties. Distal fan areas contain pluvial lake shoreline features (erosional benches and beach ridges) that record lake-level lowering since the last glacial maximum. Integration of the fan morphostratigraphy and pluvial lake shoreline features allows for the alluvial fan response to climate induced base-level lowering to be investigated. Geochronology is established by AMS C14 dating of gastropod shells sampled from a range of high-stand (dates pending) through to lowstand (12,080 +/- 50 rcybp) beach ridges. Detailed analysis of two alluvial fans from the western (Cottonwood Fan) and eastern (Yamaha Fan) basin margins reveals some interesting differences in fan morphostratigraphy. The Cottonwood fan is characterised by a complete suite of morphostratigraphic units (Qf0-Qf3), whilst the Yamaha fan comprises only Qf0 and Qf3. The presence of a pronounced 17 m high scarp feature, some several hundreds of metres in length, within close proximity to the mountain front on the Cottonwood fan, suggests the occurrence of neotectonic activity. This extensional (?) faulting appears to be post QF0 and may have been responsible for influencing the observed stratigraphic differences between the Cottonwood and Yamaha fans via a tectonic lowering of base-level. Within this poster we explore the relative roles of climate and tectonic base-level lowering for alluvial fan development.

H51D-1115 0830h POSTER

Numerical modelling of drainage basin evolution and alluvial fan stratigraphy

Maarten Wachter[1] (Maarten.Wachter@Wintershall.com)

Quintijn Clevis[2] (quintus.clevis@geog.ox.ac.uk)

Poppe L de Boer[1] (pdeboer@geo.uu.nl)

[1]Sedimentology Group, Faculty of Earth Sciences, Utrecht University, Budapestlaan 4, Utrecht 3584 CD, Netherlands

[2]School of Geography and the Environment, University of Oxford, Mansfield Road, Oxford OX1 3TB, United Kingdom

A 3D forward numerical model is presented to study the effects of bedrock erodability, thrust displacement rate, pulsating tectonic activity and sea-level fluctuations on drainage basin morphology and stratigraphy of large alluvial fan systems. A low value of the bedrock erodability coefficient (Kb = 0.5 x 10-4 yr-2/3) versus thrust rate (Rthrust = 2.0 m/kyr) is associated with a time lag between cessation of tectonic activity and maximum sedimentation rates observed on the alluvial fans. Applying higher Kb values, ranging between 1.0 and 8.0 x 10-4 yr-2/3, results in higher sediment yields due to more rapid headward catchment erosion and elaborate sideways branching of drainage networks. Pulsating tectonic activity is reflected in a stratigraphic alternation of prograding and retrograding alluvial fan gravels. During tectonic activity fan gravel fronts and coastlines retreat because catchment yields are insufficient to fill the accommodation space created by the flexural response due to thrust loading. Phases of tectonic quiescence and cessation of flexural subsidence are indicated by progradation of the gravel front. Depending on the position in the basin, the lag time for arrival of the gravel associated with tectonic cessation is several tens to hundred kyrs. A combination of pulsed tectonic activity with sinuous sea-level fluctuation leads to a more complex stratigraphic pattern. In that case stratigraphic response to tectonic pulses is masked by a similar but higher-order frequency-stacking pattern, especially in the more distal parts.

URL: http://www.library.uu.nl/digiarchief/dip/diss/2003-0708-104559/inhoud.htm

H51D-1116 0830h POSTER

Knickpoint Propagation and Sediment Yield in an Experimental Steady State Drainage Basin: Size Matters

Leslie E. Hasbargen (1-219-980-7124; lhasbarg@iun.edu)

Dept. of Geosciences, Indiana University Northwest, 236 Marram Hall 3400 Broadway, Gary, IN 46408, United States

Can we detect knickpoint propagation in sediment yield records from eroding drainage basins? Knickpoint development and migration are common in experimental drainage basins experiencing constant rainfall and base level fall conditions, and such experiments offer a way of addressing this question. Previous experimental work has documented an increase in sediment flux following an abrupt drop in base level (Parker, 1977; Hancock, 1997). These experiments documented increase and exponential decay in sediment yield as the knickpoint propagated through the drainage basin. In the physical experiments presented here, a constantly dropping base level (equivalent to a continuous block uplift condition) forced the entire landscape to erode, and a balance between erosional flux and tectonic flux was maintained over longer times. Here, streams incised both by steady entrainment of bed material and by spontaneous knickpoint development and propagation. Imposed on the long term eroding landscape were self-generated epicycles of valley aggradation followed by knickpoint generation and stream incision. An automated measurement device recorded a detailed record of sediment flux leaving the basin. Time lapse video monitored knickpoint propagation. An analysis of the sediment flux record during several cycles of knickpoint propagation through the drainage network reveals that normal sediment flux oscillations mask the contribution of sediment flux due to knickpoint migration. Curiously, valley aggradation was not obvious in the sediment flux record either. Knickpoint heights for these experiments were about 0.5 cm. When scaled to maximum relief in the drainage basin, this height corresponds to a few percent of total relief in the basin. Some smearing of the knickpoint contribution occurs as sediment derived from knickpoint retreat is redeposited locally. Hence, no clear signal will be visible at downstream reaches. Only very large base level drops (greater than 1 cm, or about 5-10% of the basin relief) developed clear sediment flux signals. These results demonstrate that eroding stream networks exhibit significant short term variations in sediment transport and incision under steady forcing conditions, and such oscillations can hide the contribution from knickpoint migration.

H51D-1117 0830h POSTER

Anchor Ice Formation and Fluvial Ice Rafting

Edward W. Kempema (307-742-8637; kempema@uwyo.edu)

Edward W. Kempema, Geology and Geophysics University of Wyoming, Laramie, WY 82071, United States

The Laramie River in southeastern Wyoming is a small, low gradient, meandering, riffle and pool river with a winter discharge of about 1 m^3 s^{-1}. During late winter sections of the river surface are ice free. These river sections are subject to anchor ice formation during periods of cold weather. The diurnal formation of anchor ice at night, along with the subsequent release of anchor ice with entrained sediment from the streambed on following mornings results in downstream ice rafting of bed sediment. In February 2002, we placed 31 marked gravel clasts on the bed of the Laramie River in two areas where anchor ice was likely to form. These clasts, which were similar in size to the largest naturally occurring sedimentary particles on the riverbed, had masses ranging from 84 to 949 g. Over the next three weeks, we monitored anchor ice formation and ice rafting of the marked gravel. During this period 21 of the marked clasts moved. Four of the clasts that moved were never recovered. The remaining 17 clasts were ice rafted distances ranging from ∼20 cm to 85 m. An unexpected result of this study is that the lightest clast did not move, while the heaviest clast moved a total of 65 m downstream in three separate ice-rafting events. This result illustrates the apparently capricious nature of ice rafting: for the gravel used in this study there is no simple relationship between particle size and the probability that the particle will be ice rafted. This study also shows that coarse bed material is mobile during winter low-flow conditions. During anchor ice events, any size bed material may be buoyed to the surface by released anchor ice and ice rafted long distances downstream. Anchor ice events are sediment transport events in fluvial systems.

H51D-1118 0830h POSTER

Oil Seepage in the Upper Ojai Valley, CA

Marlene F Duffy[1] (marlene_duffy@umail.ucsb.edu)

Edward Keller[1] (805-893-4207; keller@geol.ucsb.edu)

[1]University of California, Department of Geological Sciences Building 526, Santa Barbara, CA 93106

Hydrocarbons naturally seep to the surface of the earth in hundreds of locations around the world, usually through the sea floor or on land. Although marine underwater seeps have been studied to some extent, little work has been done on land. Terrestrial hydrocarbon seeps associated with active faulting in the Upper Ojai Valley, CA present an opportunity to characterize the nature of liquid tar seepage. Geomorphic forms produced by emission of tar at the study area include emission pits, layered tar flows, tar mounds, terraces, and tar patties. We measured surface velocities on tar flows at 56 locations in the study area, ranging from 0 cm/hour to nearly 2 cm/hour .We have topographically and morphologically mapped three prominent areas of seeps to characterize: geology; morphometry and morphology of landforms produced by seepage of tar; flow pattern and rate of movement of tar; and possible relationships between size and distribution of geomorphic form and process of tar emission features to seepage rate.

H51D-1119 0830h POSTER

Supervised Classification of Surficial Geology Units Using Local Statistics from Digital Orthophoto Quadrangles as Input into an Artificial Neural Network

Geoffrey A Phelps[1] (gphelps@usgs.gov)

David M Miller[1] (dmiller@usgs.gov)

[1]U.S. Geological Survey, 345 Middlefield Rd MS 989, Menlo Park, CA 94025, United States

In the arid southwestern United States a U.S. Geological Survey project is underway to create 100,000 scale surficial geologic maps. Surficial geologic deposits are classified according to process of deposition using geomorphic and sedimentologic features. Geomorphic position, surface roughness, pavement maturity, pedogenesis, and inset relations are used to establish relative deposit ages. Geologic mapping is conducted using field methods and interpretation of remote-sensing images, primarily stereo-pair aerial photographs viewed through a stereoscope. Recently the project has been investigating methods of classification based on remote sensing data to improve the mapping process. A supervised classification method has been developed to distinguish alluvial geomorphic units ranging in age from active to Pleistocene. The remote sensing technique makes use of spatially autocorrelated information contained in digital orthophoto quadrangles (DOQs) and the classification power of a multilayer feedforward artificial neural network. The DOQs are processed by examining local statistics of the DOQ gray-scale values in moving-window neighborhoods across the image (mean, median, range, and standard deviation) as a function of distance for each point on the image. For example, at a given point the mean is examined in a 3x3 square neighborhood, a 5x5 square neighborhood, and so on. An empirical function of the mean vs. the window length is then generated. The shapes of the resulting functions for points within a given geomorphic unit, when considered together, are distinct for each generalized geomorphic unit. Each unit is represented not by a single function, however, but rather by a family of functions. The family of functions generated is complex, yet almost every function belonging to a given geomorphic unit is at least 5% different, most much more so, than those belonging to any other unit. A sample set of functions, 1000 for each of three geomorphic units, was used to train a three-layer multilayer feedforward network. Multilayer feedforward networks are reasonably immune to noise and correlation of input variables, and so are ideal for distinguishing inputs that interact in complex ways. The method produced results consistent with recent mapping. The method was further tested by applying it to a test area, roughly 20 km southwest of the training area. This test also produced results consistent with recent mapping. The method has several advantages compared to training using other common remote sensing data sets: (1) it uses 1-m resolution DOQs, so classifies at higher resolution than possible with many data sets; (2) it examines neighbors to classify pixels, thus honoring spatial patterns, an advantage for mapping spatially-dependent features such as geomorphology and vegetation, and (3) it allows for both mixed classification and rejection of classification of the given classes on an individual pixel level, which allows for the identification of mixed geomorphic units and new (unclassified) geomorphic units.

H51E MCC: Level 2 Friday 0830h

Quantifying Rates of Geomorphic Processes I Posters *(joint with T, V)*

Presiding: **A M Heimsath,** Dartmouth College**; T Ehlers,** University of Michigan**; L Reinhardt,** University of Glasgow

H51E-1120 0830h INVITED POSTER

Fluvial Bedrock Incision Rates in Taroko Gorge (Taiwan) From in Situ-Produced Cosmogenic Nuclides

Mirjam Schaller[1] (734 615 4286; mirjam@umich.edu)

Niels Hovius[1] (nhovius@esc.cam.ac.uk)

Sean Willett[2] (swillett@u.washington.edu)

Susan Ivy-Ochs[3] (ivy@particle.phys.ethz.ch)

Hans-Arno Synal[4] (synal@particle.phys.ethz.ch)

[1]Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ, United Kingdom

[2]Department of Earth and Space Sciences, University of Washington, Seattle, WA 98195, United States

[3]Institute of Particle Physics, ETH Hoenggerberg, Zuerich 8093, Switzerland

[4]Paul Scherrer Institut, c/o Institute of Particle Physics, Zuerich 8093, Switzerland

Climate, through its influence on erosion, plays a key role in the tectonic evolution of the continental crust. Tectonics may in turn moderate both local and global climate, for example through the construction of mountain belts. Geodynamic modeling has yielded testable hypotheses concerning the feedbacks between climate, erosion and tectonics. The models, however, are not matched by an observational data base to test their predictions. This is primarily because erosion, the key parameter linking cause and consequence, has proved difficult to measure. Cosmogenic nuclide concentrations can be used to determine present and past rates of river incision, a key erosional process, and thus establish how bedrock rivers have responded to recent change of climate. The effects of such changes are recorded in fluvially sculpted landforms in mountain valleys. The age of these fluvially sculpted surfaces can be dated by cosmogenic nuclides. The concentration of cosmogenic nuclides in rocks exposed at the Earth's surface is proportional to the total duration of their exposure. The age of the surface and their absolute altitude above the active river channel is used to constrain valley lowering rates. We applied this approach in the Taroko gorge of the Liwu Chi river, Taiwan, an ideal natural laboratory for fluvial erosion studies because of its extreme, monsoonal climate and steady tectonic forcing, absence of significant glaciation, and availability of high-quality measurements of present day erosion. Fluvial incision rates between February 2000 and May 2002 are around 5 mm/yr (Hartshorn et al., 2002). Similar to these short-term incision rates are the long-term exhumation rates estimated from apatite fission tracks. However, 2.4 kyr old terrace deposits upstream of the Taroko gorge imply higher intermediate-term incision rates of 11 mm/yr (Liew, 1988). Minimum surface exposure ages derived from the concentration of in situ-produced ^{36}Cl in marble, and corrected for topographic shielding range between 0.3 kyr and 5.8 kyr. Ages increase from 0.3 kyr 3 m above the modern river channel to an age of 3.6 kyr at an elevation of 55 m above the channel. Incision rates for these lowermost samples were calculated using the sample altitude above the river channel divided by the exposure age of the sample. The incision rates are high for the time period between 0.3 kyr and 1.0 kyr (43 mm/yr). Rates are lower for the time period between 1 kyr and 3.6 kyr (8 mm/yr). Samples collected at elevations between 55 m and 165 m show highly variable surface exposure ages. Simple age-elevation interpretation yields a high incision rate of 28 mm/yr. Above 165 m the ages decrease again to 1.0 kyr. This pattern can be explained by multiple exposure histories (e.g. exposure, burial by landslide material and re-exposure) or may be the result of complex weathering processes (e.g. preferential leaching of ^{36}Cl over time).

H51E-1121 0830h POSTER

Using Fill Terraces and Multiple Dating Techniques to Calculate Incision Rates for Grand Canyon

Joel L Pederson[1] (435-797-7097; bolo@cc.usu.edu); Matt D Anders[1] (matt.anders@nau.edu); Tammy M Rittenour[2] (tammyr@unlserve.unl.edu); Warren D Sharp[3] (wsharp@bgc.org); John C Gosse[4] (jcgosse@dal.ca); Karl E Karlstrom[5] (kek1@unm.edu)

[1]Geology Department, Utah State University, Logan, UT 84321, United States

[2]Department of Geosciences, University of Nebraska-Lincoln, Lincoln, NE 68588, United States

[3]Berkeley Geochronology Center, 2455 Ridge Road, Berkeley, CA 94709, United States

[4]Earth Sciences Department, Dalhousie University, Halifax, NS B3H 4R2, Canada

[5]Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131, United States

OSL, U-series, and terrestrial-cosmogenic-nucleid dating applied to the impressive fill-terrace record of eastern Grand Canyon provide a relatively complete reconstruction of fluvial history, including long-term bedrock incision rates. Despite how common and information-rich fill terraces like these are, the cyclic alluviation and incision they record complicates their use for calculating incision rates relative to strath terraces. This has frequently resulted in overestimates of true bedrock incision that are exacerbated in shorter records. Multiple dating techniques applied to the well-exposed eastern Grand Canyon Quaternary stratigraphy allow us to date the timing of aggradation, the abandonment of terraces, and even incision. We use this record to illustrate a widely applicable methodology of extracting high quality bedrock incision rates by linking episodes when the river is on bedrock. Our long-term bedrock incision rate for eastern Grand Canyon of 155 m/my is greater than rates from near the hangingwall of the Hurricane and Toroweap faults in western Grand Canyon, but less than long-term incision rates reported upstream in and near western Colorado. This increase in rate upstream could be due either to differential uplift in Colorado, to a knickzone passing through the system from faulting or the major drainage capture 6 Ma at the southwestern edge of the Colorado Plateau, or to different timescales and methods of rate calculation. More, consistent data are needed about bedrock incision along the profile of this major river to investigate the role of these factors in the erosion of the Colorado Plateau.

H51E-1122 0830h POSTER

Bedrock Incision Rates Through A Knickpoint Reach

Jong-Yeon Kim[1] (44-141-330-4445; jkim@geog.gla.ac.uk)

Trevor Hoey[1] (thoey@geog.gla.ac.uk)

Paul Bishop[1] (pbishop@geog.gla.ac.uk)

Keith Fifield[2] (keith.fifield@anu.edu.au)

Vladmir Levchenko[2] (vladmir.levchenko@anu.edu.au)

[1]Department of Geography & Geomatics, University of Glasgow, Scotland, Glasgow G12 8QQ, United Kingdom

[2]Department of Nuclear Physics,The Australian National University, Canberra, ACT, Canberra 0200, Australia