KECK GEOLOGY CONSORTIUM

PROCEEDINGS OF THE TWENTY-FOURTH ANNUAL KECK RESEARCH SYMPOSIUM IN GEOLOGY

April 2011
Union College, Schenectady, NY

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2010-2011 PROJECTS

FORMATION OF BASEMENT-INVOLVED FORELAND ARCHES: INTEGRATED STRUCTURAL AND SEISMOLOGICAL RESEARCH IN THE BIGHORN MOUNTAINS, WYOMING
Faculty: *CHRISTINE SIDDOWAY, MEGAN ANDERSON*, Colorado College, *ERIC ERSLEV*, University of Wyoming
Students: *MOLLY CHAMBERLIN*, Texas A&M University, *ELIZABETH DALLEY*, Oberlin College, JOHN *SPENCE HORNBUCKLE III*, Washington and Lee University, *BRYAN MCATEE*, Lafayette College, *DAVID OAKLEY*, Williams College, *DREW C. THAYER*, Colorado College, *CHAD TREXLER*, Whitman College, *TRIANA N. UFRET*, University of Puerto Rico, *BRENNAN YOUNG*, Utah State University.

EXPLORING THE PROTEROZOIC BIG SKY OROGENY IN SOUTHWEST MONTANA
Faculty: *TEKLA A. HARMS, JOHN T. CHENEY*, Amherst College, *JOHN BRADY*, Smith College
Students: *JESSE DAVENPORT*, College of Wooster, *KRISTINA DOYLE*, Amherst College, *B. PARKER HAYNES*, University of North Carolina - Chapel Hill, *DANIELLE LERNER*, Mount Holyoke College, *CALEB O. LUCY*, Williams College, *ALIANORA WALKER*, Smith College.

INTERDISCIPLINARY STUDIES IN THE CRITICAL ZONE, BOULDER CREEK CATCHMENT, FRONT RANGE, COLORADO
Faculty: *DAVID P. DETHIER*, Williams College, *WILL OUIMET*. University of Connecticut
Students: *ERIN CAMP*, Amherst College, *EVAN N. DETHIER*, Williams College, *HAYLEY CORSON-RIKERT*, Wesleyan University, *KEITH M. KANTACK*, Williams College, *ELLEN M. MALEY*, Smith College, *JAMES A. MCCARTHY*, Williams College, *COREY SHIRCLIFF*, Beloit College, *KATHLEEN WARRELL*, Georgia Tech University, *CIANNA E. WYSHNYSZKY*, Amherst College.

SEDIMENT DYNAMICS & ENVIRONMENTS IN THE LOWER CONNECTICUT RIVER
Faculty: *SUZANNE O'CONNELL*, Wesleyan University
Students: LYNN M. GEIGER, Wellesley College, KARA JACOBACCI, University of Massachusetts (Amherst), GABRIEL ROMERO, Pomona College.

GEOMORPHIC AND PALEOENVIRONMENTAL CHANGE IN GLACIER NATIONAL PARK, MONTANA, U.S.A.
Faculty: *KELLY MACGREGOR*, Macalester College, *CATHERINE RIIHIMAKI*, Drew University, *AMY MYRBO*, LacCore Lab, University of Minnesota, *KRISTINA BRADY*, LacCore Lab, University of Minnesota

Students: *HANNAH BOURNE*, Wesleyan University, *JONATHAN GRIFFITH*, Union College, *JACQUELINE KUTVIRT*, Macalester College, *EMMA LOCATELLI*, Macalester College, *SARAH MATTESON*, Bryn Mawr College, *PERRY ODDO*, Franklin and Marshall College, *CLARK BRUNSON SIMCOE*, Washington and Lee University.

GEOLOGIC, GEOMORPHIC, AND ENVIRONMENTAL CHANGE AT THE NORTHERN TERMINATION OF THE LAKE HÖVSGÖL RIFT, MONGOLIA
Faculty: *KARL W. WEGMANN*, North Carolina State University, *TSALMAN AMGAA*, Mongolian University of Science and Technology, *KURT L. FRANKEL*, Georgia Institute of Technology, *ANDREW P. deWET*, Franklin & Marshall College, *AMGALAN BAYASAGALN*, Mongolian University of Science and Technology.
Students: *BRIANA BERKOWITZ*, Beloit College, *DAENA CHARLES*, Union College, *MELLISSA CROSS*, Colgate University, *JOHN MICHAELS*, North Carolina State University, *ERDENEBAYAR TSAGAANNARAN*, Mongolian University of Science and Technology, *BATTOGTOH DAMDINSUREN*, Mongolian University of Science and Technology, *DANIEL ROTHBERG*, Colorado College, *ESUGEI GANBOLD*, *ARANZAL ERDENE*, Mongolian University of Science and Technology, *AFSHAN SHAIKH*, Georgia Institute of Technology, *KRISTIN TADDEI*, Franklin and Marshall College, *GABRIELLE VANCE*, Whitman College, *ANDREW ZUZA*, Cornell University.

LATE PLEISTOCENE EDIFICE FAILURE AND SECTOR COLLAPSE OF VOLCÁN BARÚ, PANAMA
Faculty: *THOMAS GARDNER*, Trinity University, *KRISTIN MORELL*, Penn State University
Students*: SHANNON BRADY*, Union College. *LOGAN SCHUMACHER*, Pomona College, *HANNAH ZELLNER*, Trinity University.

KECK SIERRA: MAGMA-WALLROCK INTERACTIONS IN THE SEQUOIA REGION
Faculty: *JADE STAR LACKEY*, Pomona College, *STACI L. LOEWY*, California State University-Bakersfield
Students: *MARY BADAME*, Oberlin College, *MEGAN D'ERRICO*, Trinity University, *STANLEY HENSLEY*, California State University, Bakersfield, *JULIA HOLLAND*, Trinity University, *JESSLYN STARNES*, Denison University, *JULIANNE M. WALLAN*, Colgate University.

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Keck Geology Consortium: Projects 2010-2011
Short Contributions— Glacier National Park

GEOMORPHIC AND PALEOENVIRONMENTAL CHANGE IN GLACIER NATIONAL PARK, MONTANA, U.S.A.
Project Faculty: KELLY MACGREGOR, Macalester College, CATHERINE RIIHIMAKI, Drew University, AMY MYRBO, KRISTINA BRADY LacCore Lab, University of Minnesota

LINKAGES BETWEEN CLIMATE CHANGE, VOLCANISM, AND DIATOM PRODUCTIVITY OVER THE PAST 12,900 YEARS IN SWIFTCURRENT LAKE, GLACIER NATIONAL PARK, MONTANA
HANNAH BOURNE, Wesleyan University
Research Advisor: Tim Ku

A CONTINUOUS LATE HOLOCENE RECORD OF PALEOCLIMATE CHANGE FROM GRINNELL LAKE SEDIMENT CORES, GLACIER NATIONAL PARK, MONTANA
JONATHAN GRIFFITH, Union College
Research Advisor: Donald Rodbell

HOLOCENE FIRE HISTORY OF THE SOUTHERN SWIFTCURRENT BASIN: A PALEOENVIRONMENTAL STUDY OF GLACIER NATIONAL PARK
JACQUELINE KUTVIRT, Macalester College
Research Advisor: Kelly MacGregor

VEGETATION HISTORY OF THE LATE HOLOCENE IN EAST GLACIER NATIONAL PARK, MONTANA: A PALEOENVIRONMENTAL STUDY
EMMA LOCATELLI, Macalester College
Research Advisor: Louisa Bradtmiller

CARBON SIGNAL IN ALPINE LAKE SEDIMENT DURING THE HOLOCENE IN GLACIER NATIONAL PARK, MONTANA
SARAH MATTESON, Bryn Mawr College
Research Advisor: Don Barber

GEOCHEMICAL EVIDENCE OF ANTHROPOGENIC IMPACTS ON SWIFTCURRENT LAKE, GLACIER NATIONAL PARK, MT
PERRY ODDO, Franklin and Marshall College
Research Advisor: Christopher J. Williams

SUBSURFACE SEISMIC REFRACTION IMAGING OF GLACIAL TILL/BEDROCK INTERFACE IN GRINNELL VALLEY, GLACIER NATIONAL PARK, MONTANA
CLARK BRUNSON SIMCOE, Washington and Lee University
Research Advisor: Romain Meyer

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Periods SWF-3 (2100-1000 ybp) and SWF-4 (1000 ybp-present) show moderate fire activity with lower frequency and strength than SWF-2. Percent TOC levels and C/N rations are also lower than SWF-2 (MacGregor et al., 2011). There seems to be a general local cooling trend through this period reflected by this decrease in %TOC, C/N and lower fire activity. The temporally constrained changes in %TOC, C/N and fire activity over the entire record demonstrate that fire activity shows a strong correlation with climate proxies discussed in MacGregor et al. (2011). This allows for confidence in the fire record as supportive evidence of local environmental changes that seem to be partially driven by climate variability. With this confidence in the local record, the Swiftcurrent fire record can be compared with other NRM records in effort to further constrain different temporal and spatial environmental and climate variability in the region.

Swiftcurrent and NRM Fire Records

Here we compare the well-constrained local Swiftcurrent fire history to records from accross the NRM region. We hypothesize that Swiftcurrent Lake will yield a significantly different fire history than records from the opposite side of the Continental Divide. Brunelle et al. (2005) explore how changing precipitation regimes, dictated by topography, affect NRM fire frequency patterns. This comparison is made in effort to constrain the differing effect of climate changes in "summer-wet" and "summer-dry" environments. The Swiftcurrent Lake basin receives most of its precipitation during the summer months, making it a "summer-wet" climate (Fig. 4). Brunelle et al. (2005) show that records from "summer-dry" lakes show fire frequency decreasing over the mid-late Holocene, whereas at the "summer-wet" lakes, show fire frequency increasing over the mid-late Holocene. The Swiftcurrent Lake record seems to be consistent with this hypothesis as the fire frequency has generally increased over the entire mid-late Holocene record. This comparison highlights the importance of site-specific topography and elevation on climatic variation in the NRM.

The influence of regional topography is highlighted in a comparison of Foy Lake and Swiftcurrent Lake environmental proxies. Foy Lake is located just ~90 km southwest of Swiftcurrent Lake, in a "summer-dry" climate (Fig. 4). The Continental Divide runs between the two lakes. The 3800 yr Foy Lake study provides a very high resolution pollen and charcoal record that shows an overall decrease in fire frequency over the late-Holocene, again consistent with the Brunelle et al. (2005) hypothesis that "summer-dry", NRM lakes record decreased fire frequency over the mid-late Holocene. Patterns seen in the "summer-wet" Swifcurrent record are generally contrary to those seen in the Foy record.

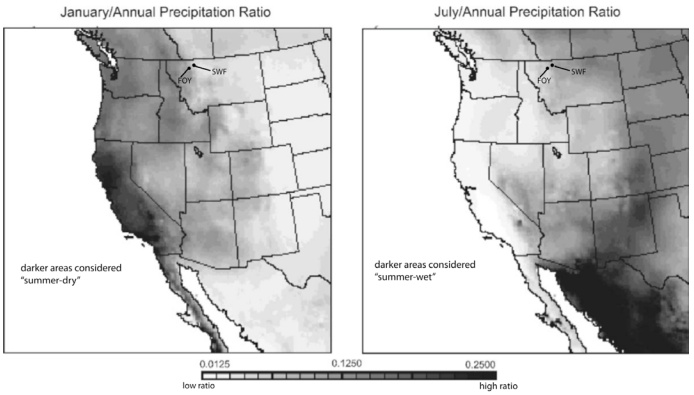

Figure 4: Distribution of precipitation in the western US shown using ratios of January and July to annual precipitation. Darker shades indicate high ratio and lighter indicates a low ratio. Notice SWF is located on the boundary of the high and low precipitation ratios. Figure published in Brunelle et al., (2005).

CONCLUSIONS

The ~7630 yr fire history record of Swifcurrent Lake does show differing trends than similar records from across the Continental Divide. The record is also consistent with the hypothesis proposed by Brunelle et al. (2005) that increasingly strong seasonal variations in precipitation patterns in the NRM cause higher regional variability in fire records over the mid-to late-Holocene. The Continental Divide is not the only factor controlling paleoenvironmental trends, and more localized effects of NRM topographic complexity will be explored. The apparent variability in Holocene fire histories from the NRM proves that the most recent fire trends seem to be part of the normal variable cycle in fire frequency. A broad spatial and temporal perspective must be taken in exploring NRM fire fre-

quency today in order to account for the interactions between local environments and climatic variability.

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