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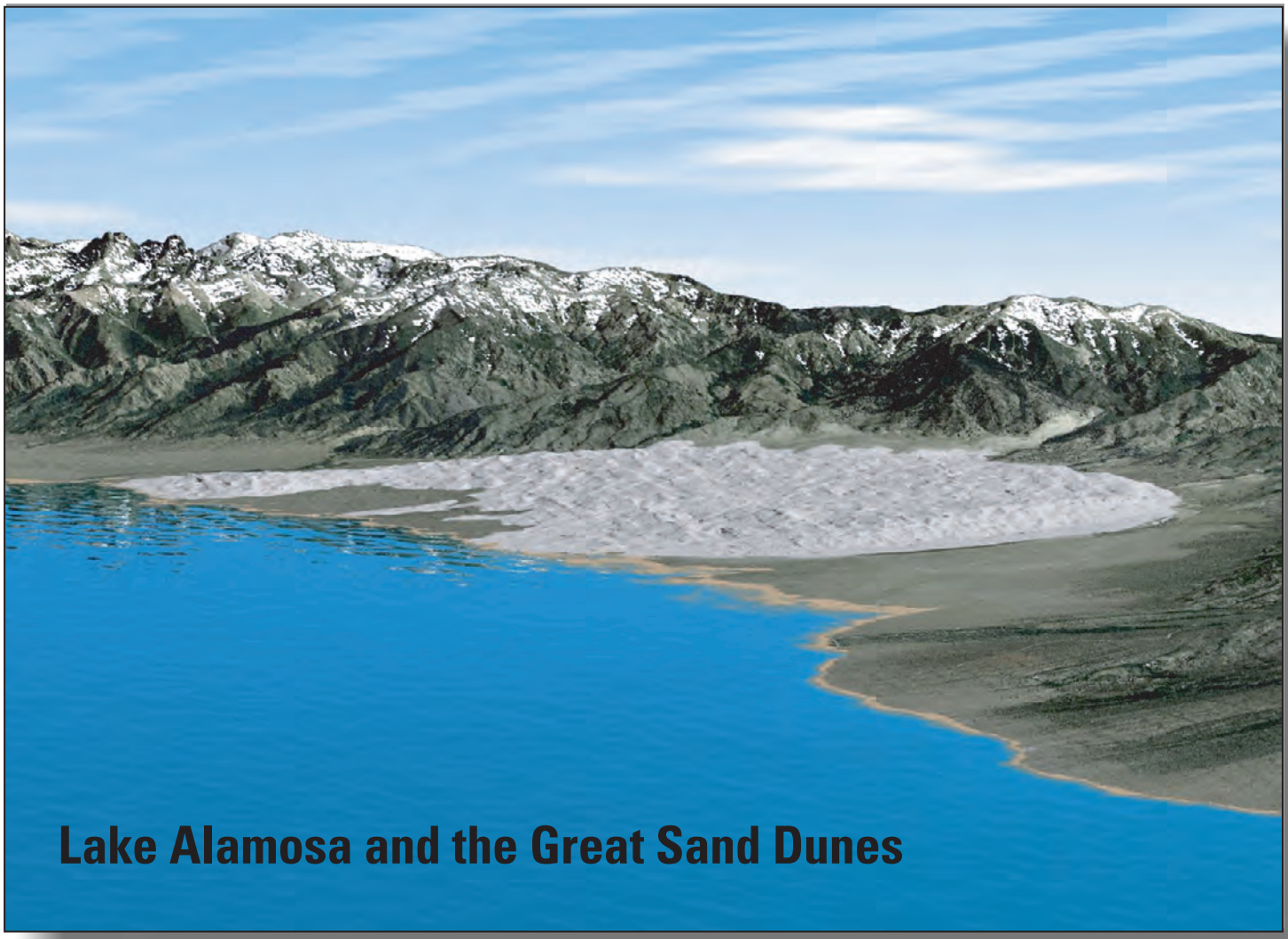
2007 Rocky Mountain Section Friends of the Pleistocene Field Trip—Quaternary Geology of the San Luis Basin of Colorado and New Mexico, September 7–9, 2007



Open-File Report 2007–1193

U.S. Department of the Interior
U.S. Geological Survey

2007 Rocky Mountain Section Friends of the Pleistocene Field Trip—Quaternary Geology of the San Luis Basin of Colorado and New Mexico, September 7–9, 2007

By Michael N. Machette, Mary-Margaret Coates, and Margo L. Johnson

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Cover
A modern restoration of Lake Alamosa. View to the northeast from above the San Luis Hills, southeast of Alamosa, Colo. Visualization created in Visual Nature Studio (v. 2.7, 3D Nature Co.) by Paco Van Sistine (USGS) using 30-m DEM and a lake elevation of 7,660 ft (2,335 m).

Contents

Conversion Factors

Units of measure

The U.S. Geological Survey uses international units of measure (meters, kilometers, kilograms, etc), so our normal policy is to use only these units. However, because this guidebook deals with distances that are always shown in miles on road signs and automobile odometers, and because all of the detailed topographic maps (1:24,000-scale) use feet as the measure of elevation, we feel compelled to provide both units. Thus, for this report our convention for reporting units of measure will be as follows:

For distances, we use kilometers (and miles)

For elevations, we use feet (and meters) asl (above sea level)

For thickness in measured section and heights above or below some datum (such as stream level or canyon rim), we use only metric (meters or kilometers).

For areas and volumes, we use only metric (cm^2, m^2, or km^2; cm^3, m^3, or km^3)

For weights, we use only metric (grams or kilograms)

The following table lists conversion factors useful for this report:

Multiply SI unit	By	To obtain English unit
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
	Area	
square centimeter (cm^2)	0.1550	square inch (ft^2)
square centimeter (cm^2)	0.001076	square foot (ft^2)
square meter (m^2)	10.76	square foot (ft^2)
square meter (m^2)	0.0002471	acre
square kilometer (km^2)	247.1	acre
square kilometer (km^2)	0.3861	square mile (mi^2)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:
°F=(1.8×°C)+32

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:
°C=(°F–32)/1.8

Vertical coordinate information is referenced to the insert datum name (and abbreviation) here, for instance, “North American Vertical Datum of 1988 (NAVD 88)”

Horizontal coordinate information is referenced to the insert datum name (and abbreviation) here, for instance, “North American Datum of 1983 (NAD 83)”

Altitude, as used in this report, refers to distance above the vertical datum.

Abbreviations Used in This Report

Units of measure	
^{14}C	carbon 14 (radiocarbon)
^{14}C yr	radiocarbon years
asl	above sea level
cal yr B.P.	calibrated years before present
cm	centimeter, centimeters
cm/yr	centimeters per year
ft	foot, feet
ft/mi	feet per mile
g	gram
g/cm^2	gram per square centimeter
Gy	Gray (a measure of absorbed dose for luminescence dating)
ka	thousands of years ago
km	kilometers
k.y.	thousands of years (duration of time)
m	meter, meters
m/s	meters per second
m/yr	meters per year
mGy/yr	milli-Grays per year
mi	miles
mm	millimeter, millimeters
mm/yr	millimeters per year
mW/cm^2	milliwatts per square centimeter
nm	nanometers
nT	nano-Tesla
s	second, seconds
torr	unit of pressure; 1 torr = 133.322368 pascals
wt percent	weight percent
yr	year

Initialisms	
AMS	accelerator mass spectrometry
BLM	Bureau of Land Management
B.P.	before present
DP	drift potential
EROS	Earth Resources Observation System
ETM	enhanced thematic mapper
FOP	Friends of the Pleistocene
GSDNPP	Great Sand Dunes National Park and Preserve
HF	hydrofluoric acid
ICP-MS	inductively coupled plasma–mass spectrometry
IRSL	infrared stimulated luminescence
M	moment magnitude
M_w	moment magnitude
M_s	moment magnitude
MAP	mean annual precipitation
MAT	mean annual temperature
NAD27	North American Datum of 1927
NOSAMS	National Ocean Sciences Accelerator Mass Spectrometry facility
NPS	U.S. National Park Service
OIS	oxygen-isotope stage
OSL	optically stimulated luminescence
PD	parabolic dune
PE	paleoevent
PDSI	Palmer Drought Severity Index
RDD	resultant drift direction
RDP	resultant drift potential
RDP/DP	ratio of resultant drift potential to resultant drift direction
RMMP	(private company)
SAR	single aliquot regeneration
SCS	Soil Conservation Service
TCN	terrestrial cosmogenic nuclide
U.S.A.	United States of America
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

Edited by Michael N. Machette, Mary-Margaret Coates, and Margo L. Johnson

Field-trip leaders:

Day 1—Andrew Valdez, Steve Forman, Richard Madole, Jim McCalpin, Michael Machette, Mike Rupert, Randy Schumann, Shannon Mahan, Pegi Jodry, and Fred Bunch

Day 2—Michael Machette, Ren Thompson, David Marchetti, and Robert Kirkham

Day 3—Cal Ruleman, Ren Thompson, Ralph Shroba, and David Marchetti

2007 Rocky Mountain Cell Friends of the Pleistocene Field Trip—Quaternary Geology of the San Luis Basin of Colorado and New Mexico, September 7–9, 2007

Prologue

Welcome to the 2007 Rocky Mountain Cell Friends of the Pleistocene Field Trip, which will concentrate on the Quaternary geology of the San Luis Basin of Colorado and New Mexico. To our best knowledge, Friends of the Pleistocene (FOP) has never run a trip through the San Luis Basin, although former trips in the region reviewed the "Northern Rio Grande rift" in 1987 and the "Landscape History and Processes on the Pajarito Plateau" in 1996. After nearly a decade, the FOP has returned to the Rio Grande rift, but to an area that has rarely hosted a trip with a Quaternary focus. The objective of FOP trips is to review—in the field—new and exciting research on Quaternary geoscience, typically research being conducted by graduate students. In our case, the research is more topically oriented around three areas of the San Luis Basin, and it is being conducted by a wide range of Federal, State, academic, and consulting geologists.

This year's trip is ambitious—we will spend our first day mainly on the Holocene record around Great Sand Dunes National Park and Preserve, the second day on the Quaternary stratigraphy around the San Luis Hills, including evidence for Lake Alamosa and the 1.0 Ma Mesita volcano, and wrap up the trip's third day in the Costilla Plain and Sunshine Valley reviewing alluvial stratigraphy, the history of the Rio Grande, and evidence for young movement on the Sangre de Cristo fault zone.

In the tradition of FOP trips, we will be camping along the field trip route for this meeting. On the night before our trip, we will be at the Great Sand Dunes National Park and Preserve's Pinyon Flats Campground, a group facility located about 2 miles north of the Visitors Center. After the first day's trip, we will dine and camp in the Bachus pit, about 3 miles southwest of Alamosa. For the final night (after day 2), we will bed down at La Junta Campground at the Bureau of Land Management (BLM) Wild and Scenic Rivers State Recreation Area, west of Questa, New Mexico, overlooking a majestic canyons of the Rio Grande and Red River.

This is the 48th meeting of the Rocky Mountain Section of FOP, which was initiated by Gerry Richmond (USGS-Denver, deceased) in 1952 (see the following table, which lists all the Rocky Mountain Section field trips). The Rocky Mountain Section has been inactive for three years owing to a series of problems, including an unfortunate cancellation of Dennis Dahms' trip to the southern Wind River Range in 2005. Hopefully, this year's trip will provide the logistical initiative and scientific momentum for future Friends of the Pleistocene trips in the Rocky Mountain region.

Michael Machette
Organizer and Editor

2007 FOP Rocky Mountain Section

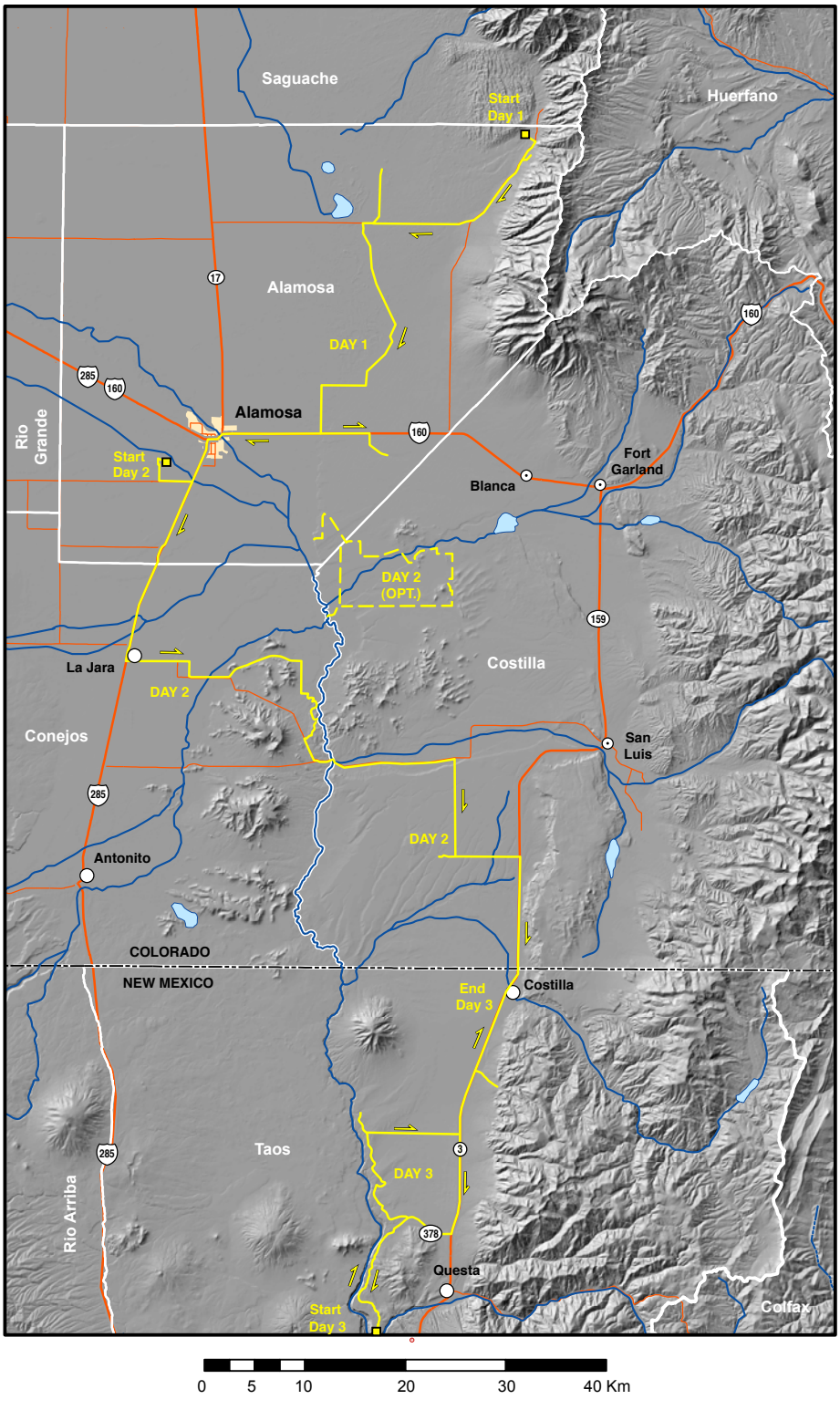

Figure 1. Route map for the FOP trip, days 1, 2, and 3. More detailed maps for each day are included in chapters A, B, and C (respectively) in this volume.

FRIENDS OF THE PLEISTOCENE ROCKY MOUNTAIN SECTION
LIST OF ANNUAL TRIPS

This section (or cell) was organized by Gerry Richmond in May 1952 at the Rocky Mountain Section meeting of the Geological Society of America at Salt Lake City, Utah

No.	Year	Date	Area or title and leaders
1	1952	Oct. 4–5	Rocky Mountain National Park, Colorado: Gerald Richmond
2	1953	Oct. 3–4	Twin Lakes area, Colorado: Gerald Richmond
3	1954	Oct. 9–10	Medicine Bow–Laramie area, Wyoming: S.H. Knight
---	1955–1957		No trip conducted
4	1958	Sept. 5–7	Jackson Hole area, Wyoming: J.D. Love, John Montagne
5	1959	Sept. 12–13	Pinedale and Lander areas, Wyoming: Gerald Richmond
6	1960	Sept. 10–11	Little Cottonwood Creek area, Salt Lake County, Utah: Henry Goode, Roger Morrison
7	1961	Aug. 25–26	Bear Lake Valley, Utah–Idaho, to American Falls, Idaho: J. Stewart Williams, Donald Trimble, Allan Willard, Verlyn Parker
8	1962	Aug. 24–26	Twin Falls to Glenns Ferry, Idaho (Snake River Canyon): Harold Malde, Howard Powers, Dwight Taylor
9	1963	Aug. 23–24	Madison River Valley and Yellowstone River Valley from Hayden Valley to Pine Creek, Montana: John Good, J.D. Love, John Montagne
10	1964	Aug. 28–30	Quaternary geology of the Duncan-Virden-Safford area, New Mexico: Roger Morrison
---	1965		No FOP trips, in light of the 1965 INQUA meeting in Boulder, Colo.
11	1966	Aug. 26–28	Landscape evolution and soil genesis in the Rio Grande region, southern New Mexico (Desert Project, Soil Investigations, Soil Conservation Service): John Hawley, Leland Gile
12	1967	Aug. 25–27	Western Snake River Plain, Idaho: Harold Malde
13	1968	Sept. 21–22	San Pedro Valley and Murray Springs archeological site, Arizona: Vance Haynes, Larry Aggenbroad, Peter Mehringer, Paul Martin, Everett Lindsay, William Wasley, Thomas Hemmings
14	1969	Oct. 4–5	Jordan Valley, Utah: Richard Van Horn, Edward Weakly
15	1970	Oct. 2–4	San Francisco Peaks (Flagstaff area): Troy Péwé, R.G. Updike
16	1971	Oct. 9–10	Bishop–Mono Lakes area, California: Michael Sheridan
17	1972	Sept. 9–10	Canon City–Westcliffe area (Wet Mountain Valley), Colorado: Glenn Scott, Richard Taylor, Rudy Epis
18	1973	Sept. 15–16	Mt. Sopris–Thomas Lakes area, Colorado: Peter Birkeland, Ralph Shroba, James Yount
19	1974	Sept. 6–7	West Yellowstone–Gallatin River–Three Forks area, Montana: John Montagne, Cliff Montagne, Ken Pierce, Leslie Davis
20	1975	Oct. 17–18	Southern High Plains, Texas: C.C. Reeves, Jr., James Goolsby, Charles Johnson, Eileen Johnson, John Hawley
21	1976	Aug. 27–28	Plains of southern Alberta (Canada): Chester Beaty, Rene Barendregt, John Dormaar, Stuart Harris, Archie Stalker
22	1977	Aug. 2–3	Natural Trap cave, Lovell, Wyoming: B. Miles Gilbert
23	1978	July 29–30	Hot Springs Mammoth site, South Dakota: L.D. Agenbroad
24	1979	July 9–10	Agate Basin archeological site, Wyoming: George Frison
---	1980		No trip conducted
25	1981	Sept. 19–20	Roaring Fork Valley and Twin Lakes and Chalk Creek areas, central Colorado: Alan Nelson, Lucy Piety, Ralph Shroba
26	1982	Sept. 17–19	Little Valley, Jordan Valley, and Beaver Basin, Utah: William Scott, Michael Machette, Ralph Shroba, William McCoy
27	1983	Aug. 26–28	Three trips—(1) Jokulhlaups in to the Sanpoil arm of glacial Lake Columbia, Washington: Brian Atwater; (2) Jokulhlaups near Spokane, Washington, and Lewiston, Idaho: Richard Waitt; (3) Glacial sequence near McCall, Idaho: Steven Colman, Ken Pierce, Richard Fosberg

28	1984	Aug. 10–11	Northern Bighorn Basin, Wyoming–Montana: Marith Reheis, Dale Ritter, Robert Palmquist
29	1985	Sept. 19–20	Animas Valley, Colorado–New Mexico: Mary Gillam, Robert Blair
30	1986	Sept. 6–7	Yellowstone National Park, Wyoming–Montana–Idaho: William Locke, Grant Meyer, Wayne Hamilton, John Montagne, David Nash, Steven Personius, Ken Pierce, Gerald Richmond
31	1987	Oct. 8–11	Northern Rio Grande rift, New Mexico: Dave Dethier, Chuck Harrington, Dave Love, Chris Menges, Steve Wells, John Wesling, Ralph Shroba
32	1988	Oct. 14–15	Tonto Basin, central Arizona: Larry Anderson, Lucy Piety, Dale Nations, Jim Faulds, Joel Sturm, Cathy Wellendorf
33	1989	Aug. 17–21	Wind River Mountains, Wyoming: Peter Birkeland, Curt Sorenson, Ralph Shroba, Dennis Dahm, Bob Hall
34	1990	Aug. 15–19	Quaternary geology of the western Madison Range, Madison Valley, Tobacco Root Range, and Jefferson Valley: Robert Hall, Ken Adams, Bill Locke, Scott Lundstrom, and ten others
35	1991	Oct. 11–13	Lake Bonneville stratigraphy and Quaternary volcanism in the Sevier and Black Rock Deserts, Utah: Charles (Jack) Oviatt (ed.), William McCoy, William Nash
36	1992	Sept. 11–13	Quaternary geology of Jackson Hole, Wyoming: Ken Pierce, John Good
37	1993	Sept. 10–12	Quaternary geology of the Mission Valley, Montana: Dan Levish, Dean Ostenaa, Ralph Klinger
38	1994	Aug. 13–14	Quaternary geology of the Wind River Basin, Wyoming: Oliver Chadwick, Bob Hall, Gene Kelley, Ronald Amundson, John Gosse, Fred Phillips, Cheryl Jaworoski
39	1995	Aug. 25–27	Late Pleistocene–Holocene evolution of the northeastern Yellowstone landscape: Grant Meyer (ed.), James Anderson, Matthew Bingham, Peter O'Hara, Eric Simpson, Kenneth Pierce
40	1996	Sept. 12–15	Landscape history and processes on the Pajarito Plateau, northern New Mexico: Steve Reneau, Eric McDonald, Craig Allen, David Broxton, Jamie Gardner, Rory Gauthier, Keith Kelson, William Phillips, Bradford Wilcox
41	1997	Oct. 12–14	The active geologic environment of central Colorado—Aspen–Glenwood Springs area, Colorado: Jim McCalpin (ed.), Bob Kirkham, Bruce Stover, Jim White
42	1998	Sept. 10–13	Soil, water, and earthquakes around Socorro, New Mexico: Bruce Harrison (ed.), Dave Love, Carol Treadwell-Stietz, Dennis McMahon, Michael Machette, Allen Gellis, Milan Pavih, Missy Eppes, Fred Phillips, John Hawley, Frank Pazzaglia, and Dan Koning. Included premeeting (Sept. 10) and postmeeting (Sept. 13) trips
43	1999	Sept. 10–12	Quaternary and environmental geology of the southwestern San Juan Mountains, Colorado: Mary Gillam, Robert Blair, Stanley Church, Scott Elias, Robert Kirkham, Thomas Perry, Fred Phillips, and others
44	2000	Sept. 22–24	Red Gate to Blue Gate–Lava-boulder diamicts and gravel, Aquarius Plateau through Waterpocket Fold (Capitol Reef), Utah: Richard Waitt (ed.), Thure Cerling, Dave Marchetti, Lee Kreutzer, Adrienne Anderson
45	2001	Oct. 12–14	Plio-Pleistocene stratigraphy and geomorphology of the central part of the Albuquerque Basin: Sean Connell, David Love, John Sorrell, Bruce Harrison
46	2002	Oct. 11–13	Quaternary stratigraphy and tectonics, and Late Prehistoric agriculture of the Safford Basin (Gila and San Simon River valleys), Graham County, Arizona: Brenda Houser, Philip Pearthree, Jeffry Homburg, Lawrence Thrasher
47	2003	Sept. 5–7	Fan-tastic, flaming, firn-filled fluvial FOP [central Idaho]: Jennifer Pierce (ed.), Grant Meyer, Charlie Luce, Tom Black, Glenn Thackray, Spencer Wood
---	2004		No trip conducted
---	2005	July 29–31 (canceled)	Glacial stratigraphy, erosion, and paleoenvironments of the southern Wind River Range, Sinks Canyon, Lander, Wyoming: Dennis Dahms
---	2006		No trip conducted
48	2007	Sept. 7–9	Quaternary geology of the San Luis basin, southern Colorado and northern New Mexico: Michael Machette, Cal Ruleman, Ralph Shroba, David Marchetti, Ren Thompson, Andrew Valdez, Steve Forman, and others