Abstracts

New Mexico Geological Society spring meeting

The New Mexico Geological Society annual spring meeting was held on April 21, 2006, at New Mexico Institute of Mining and Technology, Socorro. Following are the abstracts from all sessions given at that meeting.

SESSION 1—BIG SCIENCE INITIATIVES

EARTHSCOPE AND USARRAY, *C. Pfeifer, M. Fort*, mdfort@passcal.nmt.edu, IRIS PASSCAL Instrument Center a7nd EarthScope USArray Array Operations Facility, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *R. Aster,* IRIS PASSCAL Instrument Center and EarthScope USArray Array Operations Facility and Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *B. Beaudoin,* IRIS PASSCAL Instrument Center and EarthScope USArray Array Operations Facility, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *J. Fowler, M. Alvarez,* and *R. Busby,* IRIS Consortium, Washington, DC 20005

EarthScope (www.earthscope.org) is a major NSF facility and science initiative to explore the geophysical and geological past and present of North America and general continental evolution. EarthScope includes the deployment of unprecedented numbers of high-quality seismic, geodetic, fault zone, magnetotelluric, and strain instruments, while supporting broad research in Earth science, including education and outreach initiatives. EarthScope's three principal facilities are: the Plate Boundary Observatory of permanent and campaign-style GPS stations and borehole strainmeters, the San Andreas Fault Observatory at Depth near Parkfield, California, and USArray, a continent-spanning seismograph and magnetotelluric array with both systematic (Transportable Array), and campaign-style (Flexable Array) components. Early results include new observations of geology and earthquake behavior on and around the San Andreas fault, coupled seismic/GPS observations of episodic tremor in the Cascadia subduction zone, and near-field observations of eruptions at Augustine Volcano, Alaska. The ongoing initial buildup of 400 Transportable Array sites (121 sites as of 1/29/06) will span the conterminous U.S. from the west coast to approximately 109° W by 2007 and will begin to rotate into New Mexico in 2008. USArray data gathering activities are expected to continue for approximately a decade, with the focus of associated tomography, earthquake, and other scientific study proceeding from the western to eastern U.S. and thence to Alaska. Key anticipated targets for EarthScope in New Mexico include high-resolution seismic studies of the Rio Grande rift and Socorro magma body, GPS studies of active deformation, and interdisciplinary studies of ground water and gas geochemistry from mantle sources.

OVERVIEW OF THE NSF MARGINS PROGRAM, RUPTURING CONTINENTAL LITHOSPHERE (RCL) INITIATIVE, AND RESULTS FROM A SEISMOLOGICAL AND GEOLOGICAL STUDY OF THE GULF OF CALIFORNIA FOCUS SITE, *G. J. Axen*, gaxen@ees.nmt.edu, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *D. Lizarralde,* Woods Hole Oceanographic Institute, Woods Hole, Massachusetts 02543; *S. Holbrook,* University of Wyoming, Laramie, Wyoming 82071; *A. Harding, G. Kent,* Scripps Oceanographic Institute, La Jolla, California 92037; *J. Fletcher,* CICESE, Ensenada, Baja California, MEXICO; *P. Umhoeffer,* Northern Arizona University, Flagstaff, Arizona 86011; and *A. Gonzalez-Fernandez,* CICESE, Ensenada, Baja California, MEXICO

The NSF MARGINS Program has four initiatives focused on continental margins: Source to Sink (sedimentary processes); SEIZE (subduction zone seismicity); SubFac (arc magmatism); and RCL (rifting). Each has two focus sites, in which various, complementary new data sets will synergistically advance the science. RCL targets the complete rifting process (initial extension to sea floor spreading), with focus sites in the Gulf of California and Red Sea (presently on hold). The MARGINS Program is in its seventh year of ten with a ten-year renewal anticipated.

The Gulf of California is a strongly oblique, active-margin rift, significantly different from typical mid-continent orthogonal rifts. Our study combines geology and marine seismology. Offshore-onshore wide-angle reflection transects used ocean-bottom seismometers approximately every 10 km and PASCAL RefTec seismometers similarly spaced onshore for ~ 100 km. Vertical-incidence reflection data were collected on transects and in transit between transects. We aimed to characterize the overall crustal rift architecture, offshore sedimentary sequences, and use onshore geology to constrain upper crustal strain, timing, and correlative sedimentary sequences. Three main transform-parallel transects connect originally conjugate margins. One composite transect crosses the peninsula, is offset approximately 300 km to the southeast, and continues onto mainland Mexico. Moho was well imaged to ~ 30 km inland of the coasts and locally has significant relief. Both wide-rift and narrow-rift styles occur in different spreading segments, but without a progressive north-to-south change. Preliminary total extension estimates (continental plus sea floor spreading) are ~ 450 km. Significant Moho topography exists in places, and continent-ocean transitions are abrupt.

LA RISTRA (COLORADO PLATEAU/RIO GRANDE RIFT SEISMIC TRANSECT EXPERIMENT): A GEOPHYSICAL SNAPSHOT OF ACCUMULATED COLLISIONAL PROCESSES ON THE CRATON MARGIN, *W. S. Baldridge*, sbaldridge@lanl.gov, Los Alamos National Laboratory, Los Alamos, New Mexico 87545*; R. Aster,* IRIS PASSCAL Instrument Center and EarthScope USArray Array Operations Facility and Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *W. Gao, S. P. Grand,* Department of Geological Sciences, University of Texas, Austin, Texas 78712*; J. Ni,* Department of Geological Sciences, New Mexico State University, MSC 3AB, Box 30001, Las Cruces, New Mexico 88003; *S. Semken,* Department of Geological Sciences, Arizona State University, Tempe, Arizona 85287; *M. West,* Department of Geological Sciences, New Mexico State University, MSC 3AB, Box 30001, Las Cruces, New Mexico 88003; and *D. Wilson,* Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

The LA RISTRA seismic experiment extends northwestward 1,400 km from west Texas, on the North American craton, across the Rio Grande rift and Colorado Plateau in New Mexico, Arizona, and Utah, to the Basin and Range province of western Utah. The experiment consists of two deployments (the second of which is still in progress) of IRIS PASSCAL broadband seismometers spaced at intervals of approximately 20 km. The line is parallel to the Laramide-age (70–40 Ma) subduction zone at the western North American plate margin, entirely crossing a region of postulated Laramide flat-slab subduction (Saleeby 2003, GSA Bull., 115, 655). Studies include shear-wave splitting, travel-time tomography, and analysis of surface-waves and receiver functions.

Although still in progress, preliminary conclusions arising from the full 1,400 km LA RISTRA include: (1) Crustal thickness is 45–50 km beneath the Colorado Plateau, 35 km beneath the Rio Grande rift, and 44 km beneath the Great Plains. Thus, the Rio Grande rift is coincident with upwarp of asthenosphere mantle. The broadly symmetric crustal thinning beneath the Rio Grande rift is indicative of a pure-shear mechanism of lithospheric thinning and suggests that extension may be gravity-driven. (2) Subcrustal lithospheric mantle beneath the Colorado Plateau is preserved to a depth of 125–150 km (i.e., was not removed by Laramide subduction). The presence of ancient lithospheric mantle is compatible with geochemical and isotopic attributes of Miocene to Quaternary magmatism in the region. (3) Northwest-dipping mantle discontinuities are imaged beneath the Colorado Plateau, and other subcrustal discontinuities beneath the Great Plains. These may represent preserved ancient structures, remaining from the original formation of Proterozoic lithosphere. Deeper (> 300 km) discontinuities may represent the foundering Farallon slab and part of an upper mantle convection cell. Finally, (4) flat discontinuities at depths of 410 and 600 km do not support a large-scale thermal anomaly beneath the Rio Grande rift region at these depths, precluding a deep-seated active rifting mechanism.

LA RISTRA is supported by the National Science Foundation and by the Los Alamos National Laboratory Institute of Geophysics and Planetary Physics.

THE CD-ROM EXPERIMENT: 4-D ANALYSIS OF THE STRUCTURE AND EVOLUTION OF LITHOSPHERE BENEATH THE ROCKY MOUNTAINS, *G. Randy Keller*, keller@ utep.edu, Department of Geological Sciences, University of Texas at El Paso, El Paso, Texas 79968; *Karl E. Karlstrom*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; and the CD-ROM working group

The goal of the Continental Dynamics of the Rocky Mountains Project (CD-ROM) experiment was to provide a new 4-D understanding of the structure and evolution of the lithosphere of the southern Rocky Mountain region. A wide variety of geological and geophysical data were collected and analyzed in an integrated fashion. In the mantle, the seismic data indicate the presence of relicts of several Proterozoic subduction zones. The northernmost one is associated with the Archean–Proterozoic boundary known as the Cheyenne belt. The present-day heterogeneous mantle structure, although strongly influenced by ancient compositional variations, has undergone different degrees of partial melting due to Cenozoic heating and/or hydration caused by transient plumes or asthenospheric convection within the wide western U.S. active plate margin. The crust in the southern Rocky Mountains is relatively thick compared to the global average for the continents. The mafic lower crust and Moho of the Proterozoic provinces of the southwestern U.S. likely formed, and reformed, in several stages. Initial formation of juvenile continental crust took place by development and assembly of magmatic arcs between 1.8 and 1.6 Ga. Volcanic and plutonic rocks of this age record whole-crust differentiation and probably resulted in a mafic lower crustal residue that was enhanced between 1.45 to 1.35 Ga as the crust underwent another period of differentiation leading to emplacement of A-type granites in the middle crust across southern Laurentia. This layer and ~ 10-km of Moho topography are interpreted to record progressive and ongoing differentiation of lithosphere, and a Moho that has changed position due to flux of basalt from the mantle to the crust. Epeirogenic uplift of the orogenic plateau in western North America, driven by mantle magmatism, continues to cause reactivation of the heterogeneous lithosphere in the Cenozoic, resulting in differential uplift of the Rocky Mountains.

THE TRAIL OF TIME—DEVELOPING EDUCATIONAL OUTREACH AT GRAND CANYON NATIONAL PARK, *L. Crossey*, lcrossey@ unm.edu, *K. E. Karlstrom*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; *S. Semken*, Department of Geological Sciences, Arizona State University, Tempe, Arizona 85287; and *M. Williams*, Department of Geosciences, University of Massachusetts, Amherst, Massachusetts 01003

The Grand Canyon, one of the world's premier geologic parks, offers an exceptional opportunity for public science education on themes of geology and geologic time. The University of New Mexico has a 5-year agreement with Grand Canyon National Park to design and implement a unique, world-class geoscience education exhibition, The Trail of Time. The project has had a lengthy gestation. It was written and presented to the Park in 1995, and subsequently funded by planning grants from the Geosciences and Informal Education programs at NSF. The project is designed to convey Grand Canyon research advances, and scientific methodology, to the park's 5 million annual visitors and to millions of web-based learners who also "visit" Grand Canyon. The exhibition is a 4.6-km-long trail at the south rim, scaled so that 1 m represents one million years of Earth history. The primary exhibit is the canyon itself. Visitors see the rocks and relationships that shape our current understanding of the canyon's history, beginning with the formation of the continent ~ 2 Ga and ending with canyon incision, paleoclimate, and neotectonics. The ultimate goal is for visitors to walk through the geology and geologic history of the canyon, and gain an understanding of how geologic time is related to the rock record, fundamentals of Earth processes, and the vitality of the scientific method. The Trail of Time is designed to reach all levels of visitors, from children to scientists. Project implementation continues to move forward and has benefited from both top-down and bottom-up support from individuals within Grand Canyon National Park. We see the need for a park geoscience advisory committee and a comprehensive geoscience interpretation program that incorporates new science advances, new concepts in geoscience education, and research on informal learning within the park. The Trail of Time, and the partnership between the geoscience research community and the NPS, can be an example of a whole new type of education and outreach collaboration between scientists and the world's public.

OVERVIEW OF THE NSF EARTHTIME PROJECT—NO DATES NO RATES, *M. T. Heizler*, matt@nmt.edu, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

There are many fundamental problems in the geosciences that we cannot adequately address without a highly resolved, calibrated time scale. Temporal relations are often keys to causality arguments in Earth history, and our understanding of these processes depends on precise knowledge of rates. Documenting these rates requires precise knowledge of geologic time. Thus, the NSF sponsored Earthtime initiative seeks to achieve a highly precise (ca. ± 0.1%) geologic timescale as a basis for reaching a heretofore-unavailable record of several geological and biological processes. The first Earthtime meeting was held October 2003 and brought together nearly 100 scientists of variable background and NSF administrators to assess the need for and plausibility to achieve a highly precise and accurate geological timescale within the next 15 yrs. An overwhelming cry for the need has brought on the beginnings of research and administration to make the initiative a reality. The geochronology community has identified three beginning agenda items that are required to move forward. Primarily, to achieve our goal a community effort has to be established that uses an unprecedented level of data sharing and cooperation. Secondly, a dramatic increase in personnel and equipment is necessary to satisfy the remarkable demand for high quality geochronology data. Lastly, collaborative projects that are supported by peer-review to address Earthtime objectives need to begin immediately.

The New Mexico Geochronology Research Laboratory is spearheading an international effort among fifteen $^{40}Ar/^{39}Ar$ geochronology laboratories to evaluate the present level of data reproducibility between labs. We recognize that it will be impossible to achieve a useful timescale if individual laboratories cannot reproduce each other's work. Thus far the data are overall encouraging but have identified analytical and procedural areas that will require improvement. Most encouraging is the level of cooperation that has come of the effort and the genuine lack of concern for potential embarrassment that could result by providing data well outside the mean. This effort is raising the quality of all participating facilities. In addition, a U-Pb geochronology group has begun a similar effort. Indeed, it's a positive change for all of us geochronologists.

THE CRONUS-EARTH PROJECT—HOW COSMIC RAYS IMPACT THE STUDY OF EARTH'S HISTORY, *F. Phillips*, phillips@ nmt.edu, *S. McGee*, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; and *B. Borchers*, Department of Mathematics, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

In the past 20 yrs the measurement of rare nuclides produced in minerals at the surface of the earth has evolved from being an analytical geochemistry innovation to the status of a routinely applied method in geochronology and geomorphology. Unfortunately, understanding of the foundational systematics of cosmogenic nuclide production rates and variations with location and time have lagged far behind the analytical advances. The CRONUS-Earth Project has been established to remedy this deficiency. The NSF-funded project is headquartered at New Mexico Tech. It is highly interdisciplinary, with geologists, cosmochemists, experimental physicists, cosmic-ray physicists, and applied mathematicians working together in a coordinated program to establish benchmark models for cosmogenic-nuclide production and to optimally parameterize those models. The outcome will be a high degree of geochronological accuracy and intercomparability for a wide variety of cosmogenic nuclides, applied anywhere on Earth.

BIG WATER SCIENCE IN THE RIO GRANDE—THE NSF SAHRA CENTER, *Enrique R. Vivoni*, vivoni@nmt.edu, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

In this talk, we will discuss the progress made in understanding and modeling the basin scale water balance in the upper Rio Grande through the NSF SAHRA Center by investigators from Arizona and New Mexico. A major goal of the SAHRA program is to better understand the factors leading to water sustainability in our region in the face of growing concerns about climate, population, and land-use change. Particular attention will be placed on recent investigations of the hydrologic characteristics of the Valles Caldera National Preserve in the Jemez Mountains.

SESSION 2—PALEONTOLOGY

PALEOECOLOGY OF THE AQUEOUS PALEOENVIRONMENTS OF THE LATE CRETACEOUS (EARLY CAMPANIAN) ALLISON MEMBER OF THE MENEFEE FORMATION IN NORTHWESTERN NEW MEXICO, *C. Lewis*, muaddib7@unm.edu, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104; *A. B. Heckert*, Department of Geology, ASU Box 32067, Appalachian State University, Boone, North Carolina 28608; and *M. Forys*, Department of Biology, 167 Castetter Hall, MSC03 2020, University of New Mexico, Albuquerque, New Mexico 87131

Last year, we discovered an extremely rich microvertebrate locality in the early Campanian Allison Member of the Menefee Formation in northwestern New Mexico. This site has yielded a highly diverse paleofauna, including fish (Lepisosteidae and Amiidae) teeth, sharks (*Lissodus*, *Cretodus*, *Carcharias*, *Cretolamna*, *Ischyrhiza*, *Onchosaurus*, *Squatina*, and *Squatirhina*), rays (*Ptychotrygon*, *Pseudohypolophus mcnultyi*, *Protoplatyrhina renae*, *Protoplatyrhina hopii*, *Dasyatis*, and *Myledaphus*), the earliest confirmed New Mexico mammals (*Paracimexomys* group of Eaton and Cifelli 2001), maniraptoran (*Richardoestesia isosceles*), and dromaeosaurid (*Saurornitholestes langtoni* and *S*. sp.) theropod dinosaur teeth, hadrosaurid dinosaur teeth, *Brachychampsa*-like crocodilian teeth, lissamphibian teeth and jaw fragments referable to the salamander *Albanerpeton*, and squamate lizard scales. The aqueous fauna is by far the most abundant and diverse assemblage in the unit and provides information on the aqueous paleoecology of the Menefee Formation. Taphonomic study of the site indicates little or no transport of the fossils, and therefore little or no information addition, and thus this site yields an accurate representation of the aqueous paleofauna of the Menefee. The taxa identified here are principally freshwater forms, and our analysis of the sedimentology of the source area confirms this. There is enough information here to reconstruct a basic food web of the freshwater vertebrate fauna of the Menefee. This is done largely on the basis of tooth morphology and comparison with extant forms, as well as the use of ecological principles. We propose that dominant aqueous taxa in the Menefee were the chondrichthyans *Pseudohypolophus*, *Ptychotrygon*, *Lissodus*, and *Onchosaurus*. The dominance of these forms indicates that an abundant invertebrate fauna of crustaceans and mollusks in the Menefee was not preserved.

PLEISTOCENE (RANCHOLABREAN) MAMMALS DERIVED FROM FISSURE DEPOSITS IN THE JURASSIC TODILTO FORMATION, SANDOVAL COUNTY, NORTH-CENTRAL NEW MEXICO, *G. S. Morgan*, gary.morgan1@state.nm.us, and *L. F. Rinehart*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104

A Pleistocene site containing skeletons of large mammals preserved in fissure-fill deposits was discovered in 2005 at the White Mesa mine near San Ysidro in Sandoval County, New Mexico. The fissures occur in gypsum of the Middle Jurassic Todilto Formation. Structural analysis suggests the fissures opened to the surface during the Pleistocene in response to extension associated with the Rio Grande rift. Bones were found 12 m below the land surface in four different fissures within a 30 m radius. The most fossiliferous fissure, containing skeletons of a bison and a camel, was 20 cm wide and contained bones over a length of about 3.5 m and a depth of about 30 cm. There are four species of large mammals in these fissure deposits, each known from at least one partial to nearly complete articulated skeleton: giant llama *Camelops hesternus*, extinct bison *Bison antiquus*, mule deer *Odocoileus hemionus*, and the rare stilt-legged horse *Equus francisci*. *Camelops* is represented by a very old individual with heavily worn teeth and evidence of osteoarthritis on the articular surfaces of several limb bones and toes. There are also nearly complete skeletons of a juvenile *B. antiquus* and a female *O. hemionus*, and a front limb of *E. francisci*. This site differs from most Pleistocene cave faunas in the predominance of articulated skeletons and the lack of small vertebrates. An accelerator mass spectrometer radiocarbon date on a *Camelops* bone is pending; however, the presence of *Bison antiquus* establishes a late Rancholabrean age (late Pleistocene, <100 ka).

THE FIRST RECORD OF THE GIANT CROCODYLIAN *DEINOSUCHUS* FROM THE UPPER CRETACEOUS OF THE SAN JUAN BASIN, NEW MEXICO, *J. A. Spielmann*, Justin.Spielmann1@state.nm.us, *S. G. Lucas*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104; and *R. M. Sullivan*, Section of Paleontology and Geology, The State Museum of Pennsylvania, Third and North Streets, Harrisburg, Pennsylvania 17108

An incomplete right mandible and two associated osteoderms from the Fossil Forest Member of the Fruitland Formation in the San Juan Basin, New Mexico, show characteristic features (very large size; large, raised, confluent mandibular alveoli 3–4; thick and inflated osteoderms with deep pits) that justify their assignment to the giant "terror crocodile" *Deinosuchus*. These associated elements are the first definitive record of *Deinosuchus* from New Mexico. Three large, procoelous caudal vertebrae from the same stratigraphic unit may also pertain to *Deinosuchus*, based on their overall large size and procoelous nature. We consider the genus monospecific, with *D. rugosus* = *D. riograndensis* and *D. hatcheri*. The New Mexican *D. rugosus* is about 80% the size of the largest reported *Deinosuchus* from Texas. Thus, based on various size estimates the length of the New Mexican specimen would be between 9 and 10 meters, making *Deinosuchus* the largest semiaquatic predator present in the Late Cretaceous of New Mexico. Using this length estimate and extrapolating from age/length studies based on other *Deinosuchus* specimens, the New Mexican *Deinosuchus* was at least 55 years old. *Deinosuchus* records from the United States extend from Montana to Texas to New Jersey and are all of Campanian (Judithian–Kirtlandian) age, ~ 73–80 Ma.

PALEOPATHOLOGY IN NEW MEXICAN TYRANNOSAURS FROM THE UPPER CAMPANIAN KIRTLAND FORMATION, *T. D. Carr*, Department of Biology, Division of Natural Sciences, Carthage College, 2001 Alford Park Drive, Kenosha, Wisconsin 53140; and *T. E. Williamson*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104

Two tyrannosaur specimens from the upper Campanian Kirtland Formation, San Juan Basin, New Mexico, give evidence of numerous injuries that were sustained during life.

NMMNH P-27469 represents an adult partial skeleton of a new genus and species of basal tyrannosauroid. (1) The left maxilla bears a lesion in the rostroventral corner of the antorbital fossa and on the caudolateral surface of the interfenestral strut; (2) the left ectopterygoid possesses a large cavity on the ventral surface at the distal end of the jugal process. (3) the left intercoronoid has a lesion that healed as a hemicircular perforation notches the ventral margin between the eleventh and twelfth alveoli; (4) the left prearticular and angular are coössified at the rostral extent of their contact along the ventral margin of the mandible; (5) the right dentary bears a large crater-like cavity in the lateral surface, below the eleventh and twelfth alveoli; and (6) a rib bears a large swelling that probably represents a healed fracture.

NMMNH P-25049 is a partial skeleton that represents a subadult of the same taxon represented by P-27469. A large lesion is present between the neck of the femur and the diaphysis.

The majority of the cranial lesions of P-27469 are associated with the oral cavity, pharynx, and the external margins of the mouth and may be related to prey capture and/or feeding. The femoral lesion of P-25049 is unique among tyrannosaurs, where healed fractures of the fibula are the most common injuries to the long bones of the hind limb.

SESSION 3—HYDROLOGY AND VALLE GRANDE

INVESTIGATING PALEOHYDROGRAPHY OF THE PASO DEL NORTE USING GIS AND REMOTE SENSING TECHNIQUES, *J. F. Kennedy*, jfk2004@comcast.net, Caelum-Unitec, P.O. Box 366, Bldg. 163, Room 102, White Sands Missile Range, New Mexico 88002; *J. W. Hawley*, Hawley Geomatters, P.O. Box 4370, Albuquerque, New Mexico 87196; *G. R. Keller* and *R. P. Langford*, Department of Geological Sciences, University of Texas, El Paso, Texas 79968

A geographic information system (GIS), in conjunction with remotely sensed imagery can be used to reconstruct late Quaternary and early Holocene paleohydrography. The relative ease and rapidity with which high-resolution, quantitative, and georeferenced data can be manipulated over a broad area makes the GIS method extremely useful. Our model uses three steps. First, drainage networks are interpolated from a digital elevation model (DEM), paleodrainage basins were interpolated from the modern elevations and inferred reconstructions of climate and dated Pleistocene–early Holocene lake elevations. Second, precipitation and temperature maps were generated from modern topography and climate data. Maps of ancient temperatures and precipitation were generated by extrapolating temperature and climate using an elevation/precipitation correlation and from previous paleoclimate studies. Third, the runoff is inferred using a precipitation/runoff model. For this example, we borrowed the concept of an elevation/precipitation correlation used in the Parameter-elevation Regressions on Independent Slopes Model (PRISM) of Daly et al. (1994). As an example, we created a paleohydrographic model of the latest Pleistocene–Holocene pluvial lakes of the southeastern Basin and Range province, in New Mexico, Texas, and Mexico. Paleohydrographic databases can be used for many purposes, including the generation of paleo-topographic base maps, the estimation of drainage areas and volumes of individual water bodies and landforms, and the approximation of paleo-shoreline positions. GIS-based estimates of the location of surface water features and the dimensions of water bodies and associated landforms can be used to help constrain hydrological and climatic models of the late Quaternary and early Holocene.

ANALYSES OF SEQUENTIAL AQUIFER TESTS FROM THE GUAJE WELL FIELD, *Stephen G. McLin*, sgm@lanl.gov, Water Quality and Hydrology Group, Los Alamos National Laboratory, Los Alamos, New Mexico 87545

Four sequential aquifer tests were conducted in four new replacement wells in the Guaje well field in 1998. One of these tests was repeated in 2005. Each test consisted of a pumping phase and a recovery phase that totaled about four days. These tests reveal horizontal propagation of drawdown in the regional aquifer for varying distances up to approximately 4,700 ft from each pumping well. Dynamic spinner logs reveal a complex, highly stratified aquifer that varies in effective thickness from approximately 435 ft in the east to approximately 325 ft in the west. In the east, most of the higher yielding zones are located above Miocene basalt flows that separate medium-grained fluvial deposits from lower yielding fine-grained sands and silts in the Tesuque Formation of the Santa Fe Group. In the west, these high-yielding units are interbedded with the basalts. The observed westward thinning of the regional aquifer reflects eastern and northern source areas for these piedmont-slope deposits. The transmissivity of the high-yielding zone varies from approximately 2,900 ft^2/day near well G-2a (east), to approximately 1,650 ft^2/day at well G-4a, and approximately 700 ft^2/day at well G-5a (west). The storage coefficient averages approximately 0.00097. Barrier boundary effects were also observed and represent a complex response to pumping from an aquifer that may be simultaneously offset by at least one normal fault below Guaje Canyon. This fault is located approximately 1,500 ft east of well G-2a. Surface expressions of faulting were previously mapped in the Puye quadrangle by Dethier (2003).

A MID-PLEISTOCENE GLACIAL-INTERGLACIAL CYCLE FROM THE VALLES CALDERA, NEW MEXICO, *P. J. Fawcett*, fawcett@unm.edu, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; *J. Heikoop*, Earth and Environmental Sciences Division, EES-6, Los Alamos National Laboratory, Los Alamos, New Mexico 87545; *F. Goff*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; *R. S. Anderson*, Center for Environmental Sciences and Education, Northern Arizona University, Flagstaff, Arizona 86011; *L. Donohoo-Hurley, J. W. Geissman*, *C. Johnson*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; *C. D. Allen*, U.S. Geological Survey Fort Collins Science Center, Jemez Mountains Field Station, Los Alamos, New Mexico 87545; *G. WoldeGabriel*, and *J. Fessenden-Rahn*, Earth and Environmental Sciences Division, EES-6, Los Alamos National Laboratory, Los Alamos, New Mexico 87545

A long-lived middle Pleistocene lake formed in the Valle Grande when a post-caldera eruption (South Mountain rhyolite) dammed the drainage from the Valle Grande to San Diego Canyon. The deposits of this ancient lake were cored in May 2004 (GLAD 5 drilling project) and a total depth of 81 m of lacustrine mud and silts and gravels was recovered. The middle Pleistocene age of the core is constrained by an Ar-Ar date of 552 ± 3 kyr from a tephra at 75.8 m depth and a possible paleomagnetic field event corresponding to the Calabrian Ridge 2 event (~ 515 ± 3 kyr) at 17.25 m depth.

Initial analyses show considerable down-core variability in a variety of core properties. A major facies change at 27 m depth associated with lake shallowing correlates with changes in magnetic susceptibility and sediment density as well as a sharp increase in organic carbon, and a positive shift in carbon isotopes. The pollen spectra from sediments above 27 m indicate thermal maximum-like conditions. An age model constructed for core VC-3 shows this dramatic warming occurred at ~ 522 kyr, consistent with several published dates for glacial termination VI (OIS 14 to OIS 13). Cool, glacial conditions in the lower section of the core are punctuated by a warming event from ~ 536 to 532 kyr (49 to 42 m depth) and are followed by a return to glacial conditions from ~ 532 to 522 kyr. This pattern is reminiscent of the deglacial pattern of warming in the late Pleistocene.

GEOCHEMICAL AND MINERALOGIC INDICATORS OF REDOX CONDITIONS OF A MID-PLEISTOCENE LAKE IN THE VALLES CALDERA, NEW MEXICO, *C. M. Johnson*, catj1952@unm.edu, *P. J. Fawcett*, and *A. S. Ali*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131

The objective of this project is the interpretation of geochemical and mineralogic indicators of climate change present in an 80-m core recovered from the Valle Grande located in the Valles caldera, New Mexico. The core being examined here represents a climate record for the mid-Pleistocene. Due to the limited source terrain of the basin, this sediment core becomes valuable as an indicator of regional changes in climatic variations. The results of this geochemical analysis will be correlated with sediment mineralogy, sedimentology, and an array of other data compiled by the research team. Ultimately, the results will be combined to generate a model of regional climate for the mid-Pleistocene over the time interval sampled by the core.

The study of redox processes in lakes reveals an interesting explanation of many, interdependent chemical reactions that occur at the lake bottom. Preliminary geochemical data from the Valle Grande sediment core has been collected and analyzed using ICP-OES. Data sampling is on the scale of every 20 cm. Eight major elements and 13 trace elements are being analyzed for further consideration. The presence of Fe and Mn oxides in the sediment core can be used as an indicator of oxygenation of anoxic bottom waters. Oxygenation of bottom waters can be related back to lake depth and stratification. Correlations between the relative concentration of Fe and Mn values collected implies that there were periods of oxygenated bottom waters followed by reducing conditions. Additionally, a rise in Fe/Mn may indicate the onset of reducing conditions.

SESSION 4—STRATIGRAPHY AND TECTONICS

THE CHUSKA ERG—PALEOGEOMORPHIC AND PALEOCLIMATIC IMPLICATIONS OF AN OLIGOCENE SAND SEA ON THE COLORADO PLATEAU, *S. M. Cather*, steve@gis.nmt.edu, *R. M. Chamberlin*, *S. D. Connell, W. C. McIntosh*, and *G. E. Jones,* New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Great thicknesses of eolian dune deposits of Oligocene age crop out in the Chuska Mountains (535 m thick) and in Mogollon–Datil volcanic field (200–300 m thick). $^{40}Ar/^{39}Ar$ ages indicate eolian deposition in these areas was approximately contemporaneous with major eolianite accumulation beginning at ~ 34 Ma and ending at ~ 27–26 Ma. Probable eolian deposits of Oligocene age ~ 483 m thick were also penetrated by the Tamara #1–Y well in the northwestern Albuquerque Basin. The beginning of eolian deposition on the Colorado Plateau occurred near the Eocene–Oligocene boundary and corresponds closely to the beginning of significant glaciation in Antarctica and a global decrease in $\delta^{18}O$ composition in benthic marine foraminifera.

Oligocene eolian dune deposits on the Colorado Plateau are thicker than all of the better-known upper Paleozoic–Mesozoic eolianites in the region, except the Jurassic Navajo Sandstone. We interpret that the widely separated Oligocene eolianites in the Colorado Plateau region were probably originally contiguous, and are but erosional remnants of an extensive (~ 140,000 km^2), regional sand-sea (the Chuska erg). This interpretation is based on: (1) regional thickness trends of older eolianites in the Colorado Plateau region; (2) low topographic gradients (< 1.3 m/km) on regional surfaces of major modern ergs; and (3) evidence for a 300–400 m thick zone of saturation that existed during, and shortly after, eolian deposition in the Chuska Mountains.

The Chuska erg represents the final episode of regional Paleogene aggradation on the Colorado Plateau. Our results indicate the reconstructed top of the Chuska erg would lie at a modern elevation of ~3,000 m or more. Regional erosion and incision began ~ 26–25 Ma, soon after Chuska deposition. Major erosion ($\geq$ 1,230 m incision) occurred during the late Oligocene and early Miocene, before the onset of Bidahochi Formation deposition at ~ 16 Ma on the south-central part of the plateau. The Bidahochi Formation aggraded ~ 250 m between ~ 16 and 6 Ma, followed by ~ 500 m of late Miocene and younger incision in the valley of the Little Colorado River. Post-Chuska, pre-Bidahochi (late Oligocene–early Miocene; ~ 26–16 Ma) erosional denudation of the central and southern Colorado Plateau thus far exceeded later, post-Bidahochi (late Miocene–Holocene; < 6 Ma) erosion in this region.

FACIES VARIATIONS AND FLUID RELEASE FEATURES IN THE JURASSIC TODILTO AND "BASAL SUMMERVILLE" FORMATIONS, SOUTHERN CHAMA BASIN, NEW MEXICO, *Shari A. Kelley*, sakelley@ix.netcom.com, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

The Jurassic Todilto Formation in northern New Mexico is typically composed of a basal limestone member (Luciano Mesa) and an overlying gypsum member (Tonque Arroyo); however, a 0.5–2.0-m thick limestone bed generally caps the gypsum member of the Todilto Formation in the southern Chama Basin. Furthermore, a pale green, moderately sorted, fine-grained sandstone with subangular to subround quartz grains is interbedded with the gypsum at two localities northwest of the village of Arroyo del Agua. The Todilto Formation is overlain by 8–12 m of white to light green and red, fine- to very fine-grained quartzose sandstone that has been assigned by previous workers to the basal part of the Jurassic Summerville Formation. This thin-bedded sandstone has ripple marks and gypsum blade casts. West of Ghost Ranch, thin limestone beds appear in the sandstone unit; the limestone beds become thicker and more numerous toward the west. The white sandstone unit is overlain by variegated maroon and pinkish-gray quartzose to subarkosic siltstone. The thin-bedded white sandstone unit is more like the underlying Todilto Formation than the overlying maroon siltstones, particularly near Arroyo del Agua.

The thin-bedded white sandstone beds above the gypsum member of the Todilto Formation contain two types of fluid release features. One set of features formed during the earliest phase of burial, before the sediments were lithified. A breccia composed of both 1–5 m long blocks of the gypsum-capping limestone and <1 m long blocks of the thin-bedded sandstone characterizes the second type of fluid release structure. The breccia, which obviously formed after lithification, may have developed when gypsum converted to anhydrite at temperatures of about 60°C. Simple 1-D thermal models suggest that these temperatures could have occurred at burial depths of 1.3–1.5 km during deposition of the Cretaceous Lewis Shale.

REVISED ABO–YESO (LOWER PERMIAN) STRATIGRAPHY IN CENTRAL NEW MEXICO, *S. G. Lucas*, spencer.lucas@state.nm.us, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104; *K. Krainer*, Institute of Geology and Paleontology, Innsbruck University, Innrain 52, Innsbruck, A-6020 AUSTRIA; and *R. M. Colpitts, Jr.*, Consulting Geologist, 4220 SCR 1290, Odessa, Texas 79765

Strata traditionally assigned to the Abo and Yeso Formations comprise most of the Lower Permian stratigraphic section in central New Mexico. In 2005 we revised Abo–Yeso lithostratigraphy (NMMNH Bulletin 31). The Abo Formation is now divided into two formal members, a lower Scholle Member and an upper Cañon de Espinoso Member. Thick mudstone slopes and trough-crossbedded, channelform sandstone bodies, conglomeratic sandstone, and conglomerate characterize the Scholle Member, whereas siltstone and thin sheets of fine-grained sandstone with ripple and climbing-ripple laminations characterize the Cañon de Espinoso Member. The Yeso Formation has been raised to group rank, and the term Meseta Blanca Member has been abandoned as an unnecessary synonym of the De Chelly Sandstone. Strata in south-central New Mexico equivalent to, but lithologically distinct from, the De Chelly Sandstone (and formerly termed Meseta Blanca Member) have been named the Arroyo de Alamillo Formation. In central New Mexico, the Yeso Group thus consists of the De Chelly and San Ysidro Formations (Jemez Mountains and northern Sandia Mountains, Sandoval County), the De Chelly and Los Vallos Formations (Lucero uplift, Valencia County), and the Arroyo de Alamillo and Los Vallos Formations (southern Manzano Mountains, Torrance County, and Joyita Hills–Cerros de Amado, Socorro County). In Socorro County, the Los Vallos Formation consists of three members (ascending), Torres, Cañas, and Joyita. The Torres and Cañas Members show a pattern of transgressive-regressive cycles in which carbonate horizons mark transgressive events. A revised Abo–Yeso lithostratigraphy better reflects current lithostratigraphic understanding of these units and provides a more precise framework for analysis of regional correlations, depositional systems, and paleogeography.

PALEOMAGNETIC DATA FROM THE PENNSYLVANIAN–PERMIAN HORQUILLA FORMATION AND PROBABLE CENOZOIC ROTATION OF THE BIG HATCHET MOUNTAINS, SOUTHWESTERN NEW MEXICO, *K. E. Zeigler*, bludragon@gmail.com, *J. W. Geissman*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; *S. G. Lucas*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104; and *R. Molina-Garza*, Centro de Geociencias, Campus Juriquilla UNAM, Carretera San Luis Potosí km 13, Queretaro, MEXICO 76230

The Big Hatchet Mountains in southwestern New Mexico contain excellent outcrop exposures of the Pennsylvanian–Permian (Morrowan to Wolfcampian) Horquilla Formation. At New Well Peak in the Big Hatchets, the Horquilla section is about 1 km thick and consists of interbedded limestones and marine shales, all of which generally dip ~ 25º to the southwest. This section is one of the few in the western U.S. where sedimentation was apparently continuous across the Pennsylvanian–Permian boundary. We sampled each limestone bed in the ~ 180-m-thick part of the Horquilla section that spans the Pennsylvanian–Permian boundary, resulting in 42 sites (4–6 samples/site). To date, half of the samples (approximately 100 specimens) show well-defined magnetizations in both progressive thermal and alternating field demagnetization. Some 90% of the NRM is unblocked by about 420ºC, and in AF demagnetization, median destructive fields are about 40–60 mT. A single, well-defined, linear magnetization vector is typically isolated in progressive demagnetization. The in situ grand mean direction of the magnetization vector, which is exclusively of normal polarity, is D = 008.7º, I = 45.7º, α_{95} = 2.2º and k = 73 (n = 60), and a corrected grand mean direction is D = 356.7º, I = 69.7º. Preliminary rock magnetism experiments indicate that the bulk of the magnetic remanence in these rocks is carried by fine-grained magnetite. These initial data indicate that these upper Paleozoic carbonate rocks have clearly been remagnetized (probably during the Cenozoic), probably before or during deformation.

STRATIGRAPHIC CHANGES ACROSS AN INTRABASINAL FAULT, KASHA-KATUWE TENT ROCKS NATIONAL MONUMENT, NEW MEXICO, *G. A. Smith*, gsmith@unm.edu, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131

Within extensional basins stratal thicknesses change across intrabasinal faults as well as at the basin margins. Superb outcrops at Kasha-Katuwe Tent Rocks National Monument, in the northern Santo Domingo Basin of the Rio Grande rift, provide an opportunity to examine the changing character of a stratigraphic section across an intrabasinal fault. Between the Camada and Pajarito faults a ~ 500-m thick section of west-tilted Miocene Peralta Tuff Member of the Bearhead Rhyolite and Cochiti Formation are truncated by an angular unconformity. Pliocene gravel of Lookout Park, generally less than 20 m thick, overlies the unconformity to form a high-level constructional surface. Lower Pleistocene Otowi Member of the Bandelier Tuff locally is present above soil developed in the gravel of Lookout Park and also fills valleys above gravel deposited in a channel incised below the gravel of Lookout Park. Basinward (east) of the Pajarito fault the Otowi Member is enclosed within Cochiti Formation with no evidence of the unconformities that are present at the base and top of the gravel of Lookout Park in the footwall of the fault. Greater subsidence permitted accumulation and preservation of an apparently continuous Miocene-to-Pleistocene section in the hangingwall of the Pajarito fault, whereas the equivalent section contains prominent lacuna marked by unconformities in the footwall. The footwall unconformities, therefore, do not have any regional significance with regard to episodes of deformation or incision history of the Rio Grande but simply reflect variations in accumulation and preservation across intrabasinal faults.

STRUCTURAL AND STRATIGRAPHIC OBSERVATIONS OF WAULSORTIAN MUD MOUNDS IN THE SACRAMENTO MOUNTAINS, SOUTH-CENTRAL NEW MEXICO, *J. G. Romero*, giovaro@nmsu.edu, and *A. K. Giles*, kgiles@nmsu.edu, Department of Geological Sciences, New Mexico State University, MSC 3AB, Box 30001, Las Cruces, New Mexico 88003

Structural and stratigraphic observations on the Waulsortian mud mounds in the Sacramento Mountains of south-central New Mexico, suggest syn-depositional deformation as an important factor in the mounds' enigmatic evolution. Two end-member evolutionary models have been proposed, referred to as biohermal and allochthonous models. Recent detailed mapping of the entire Mississippian has shown that syn-depositional deformation is restricted to mound systems, where it is pervasive. This relationship is inconsistent with both of the proposed models. The biohermal model generates relief by biotic buildup and does not account for the deformational features documented in and around mound systems. Although the allochthonous model implies deformation related to mass transport processes, the deformation should extend away from the mounded areas. However, such implied deformational patterns have not been found.

Waulsortian mounds have been described as containing a mudstone core facies surrounded by flank facies of crinoidal and bryozoan debris. Our detailed observations of mound facies in the Sacramento Mountains show mound cores as chaotic accumulations of mudstone to packstone beds, with the coarser facies being most abundant. Remnant bedding is observed throughout and is chaotically oriented. Mud-filled injection dikes cut across these core facies, which often show soft sediment deformation such as slump folds and scars. Stratal geometries of the flanks indicate syn-depositional structural growth. The flank facies display both thinning and onlapping of beds as they approach the mound core, as well as stratal truncation patterns. These observations suggest that the cores of mounds were moving upward as the flank facies were being accumulated.

SESSION 5— VOLCANOLOGY, TECTONICS, AND MORE!

LONG-RANGE TRANSPORT OF PARTICLES FROM REGIONAL DUST STORMS, ORIGINATING IN THE CHIHUAHUAN DESERT, *S. M. Canalda*, smcanalda@utep.edu, *T. E. Gill*, and *S. P. Emmert*, Department of Geological Sciences, University of Texas, El Paso, Texas 79968

There are dust storms that originate in the El Paso region almost every year. There is scientific evidence that soil particles from the region have been deposited in the southeastern part of Canada and vicinity. In about a day, particles from the region travel a long distance through the United States to reach the area of deposition.

By tracking down the path of these storms, we are able to see how dust particles from our region are deposited as far as thousands of kilometers away in Canada. By using several scientific techniques, I will be able to verify that the dust particles from the El Paso area did migrate to Canada through these intense dust storms. I performed ion chromatography on the samples for their ionic levels. The samples are also being analyzed with the inductively coupled plasma mass spectrometry (ICPMS) and the environmental scanning electron microscope (ESEM). The ICPMS gives the inorganic constituents, and ESEM lets you view the particles at a micron-size fraction. By using these scientific instruments, I can determine where the particles in the Canadian precipitation originated. I have been working with IMPROVE data, to determine changes that occur in atmospheric ionic levels as these storms make their way to their Canadian destination. IMPROVE is a data base that has measurements of particles in the atmosphere taken from its nationwide locations on three-day intervals. I used data from the states in the path of these dust storms. It is well known that long-range transport can deposit pollutants into the precipitation. The research I am conducting will help give a better understanding of long-range transport from the El Paso area, and how pollutants in one area of the country can descend in the precipitation far from where the aerosols came.

INVESTIGATION OF OBSIDIAN HYDRATION AND IMPLICATIONS FOR THE ^{40}AR/^{39}AR DATING METHOD, *Ariel K. Dickens*, ariel@nmt.edu, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *William C. McIntosh*, and *Nelia W. Dunbar*, Department of Earth and Environmental Science and New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Preliminary results from a systematic investigation of obsidian by electron microprobe and the Ar/Ar method show that hydration can adversely affect Ar/Ar ages, but this effect can be mitigated by specialized sample preparation. Volcanic glass can be a problematic material for Ar/Ar geochronological studies, in part due to hydration and the resultant mobility of Ar and other elements. The No Agua Peaks volcanic complex was chosen for this study because of multiple obsidian flows displaying varying degrees of hydration. The twofold purpose of this study is to understand the effects of hydration on Ar/Ar ages of glass as well as to determine which sample preparations yield the most accurate and precise age for obsidian.

Multiple sample preparation methods including five and twenty-four hour ultrasonic baths in distilled water, as well as air abrasion and five and twenty-four hour ultrasonic washes in hydrofluoric acid (HF) were performed on sample splits. Samples were characterized using an electron microprobe to assess hydration and chemistry. To determine the effects that the extraction method has on the apparent age of a sample, furnace and CO_2 laser incremental heating were performed on splits, as well as a two-step laser extraction and laser fusion.

Microprobe results show that the hydration process does not cause significant element mobility, and most water is concentrated within the hydration rinds. Results also indicate that preparation by air abrasion, any HF treatment or a 24-hour ultrasonic rinse in distilled water can remove hydration rinds from an obsidian core, thereby increasing the quality of the data. Different argon extraction methods yield the same age for different splits of the same sample within uncertainty. Two eruptive periods at 4.08 ± 0.07 Ma and 3.72 ± 0.11 Ma represent chemically different magmas, which are separated by a paleosol at the No Agua Peaks complex. Preparation methods that include HF decrease the yield of $^{40}Ar^*$, decreasing the accuracy and precision of the apparent age for a given sample. So far, furnace step-heating has produced encouraging results for displaying the effects for argon loss and the true eruption age. The preparation and extraction methods presented begin to permit the dating of young and poorly constrained volcanic events, which can be used to predict future volcanic hazards.

PETROGRAPHY AND GEOMETRY OF OLIGOCENE MAFIC DIKES NEAR RILEY, NEW MEXICO—INDICATIONS OF NORTHWARD DIKE PROPAGATION INTO THE SOUTHEASTERN MARGIN OF THE COLORADO PLATEAU, *Melissa I. Dimeo*, mdimeo@nmt.edu, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Mafic dikes are rarely recognized to radiate from calderas and central New Mexico provides an exceptional opportunity to study such dikes. Many North-northeast- and north-northwest-striking mafic dikes (~ 100) are exposed across an eight km-wide swath of gently southwest-dipping pre-Oligocene strata on the southeast Colorado Plateau north of the Socorro–Magdalena caldera cluster, near Riley. Basaltic dikes are dominant and typically contain sparse phenocrysts of augite and olivine in a groundmass of plagioclase microlites and intergranular pyroxene. Minette and nephelinite dikes are rare; the minettes contain 3–4 cm biotite clots and the nephelinite dikes contain phenocrysts of titanaugite and leucite trapezohedrons. Most of the dikes are highly altered; pyroxene is commonly replaced by carbonate and chalcedony and olivine is commonly replaced by serpentine.

The subparallel dikes commonly show en echelon steps and several dikes show zigzag or branching patterns, which imply that the north-northeast and north-northwest trends are penecontemporaneous. A few dikes have baked and reduced wallrock aureoles as much as 20 m wide indicating that they probably erupted and fed lava flows that were once laterally continuous with the Oligocene La Jara Peak Basaltic Andesite, which is preserved in the adjacent Bear Mountains. The width of one apparent feeder dike decreases north of the contact metamorphic zone and terminates within ~ 200 m. Dike terminations and dike branching indicates magmatic pressure drops to the north. Eocene sandstone beds are locally upturned or folded at dike step-overs, with the steepest beds dipping north. Near dike intersection points, younger dikes often abruptly change strike, which suggests that older dikes formed a stress guide during subsequent dike propagation. These observations support the hypothesis that the dikes propagated northward from the mafic roots of the Oligocene Socorro-Magdalena caldera cluster (24–32 Ma). Preliminary $^{40}Ar/^{39}Ar$ age determinations indicate the dikes are 26–30 million years old

MAGMATISM, METAMORPHISM, AND DEFORMATION OF PROTEROZOIC MAZATZAL PROVINCE CRUST: A COMPREHENSIVE CASE STUDY FROM THE BURRO MOUNTAINS, SOUTHWEST NEW MEXICO, *J. M. Amato*, amato@nmsu.edu, *A. O. Boullion*, *A. E. Sanders*, Department of Geological Sciences, New Mexico State University, Las Cruces, New Mexico 88003; *G. Gehrels*, Department of Geosciences, University of Arizona, Tucson, Arizona 85721; *C. L. Andronicos*, Department of Earth and Atmospheric Sciences, Cornell University, Ithaca, New York 14853; *M. T. Heizler*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico, 87801; and *G. L. Farmer*, Department of Geological Sciences, University of Colorado, Boulder, Colorado 80309

A diverse suite of Proterozoic rocks is present in the Burro Mountains. of southwest New Mexico. Rock types include deformed granitic orthogneisses, amphibolite, and metasedimentary rocks and undeformed gabbro, granodiorite and granite. U/Pb zircon geochronology was performed using multicollector LA-ICPMS. A granite orthogneiss yielded an age of 1,672 ± 17 Ma (2σ uncertainties) and a tonalite orthogneiss an age of 1,625 ± 50 Ma. The granite orthogneiss has ε_{Nd} of –1 and a model age of 2.1 Ga. The tonalite orthogneiss has ε_{Nd} of +2 and a model age of 1.8 Ga. Model ages older than intrusive ages suggest involvement of older continental crust during petrogenesis. Detrital zircons from a gt-bi schist have a main peak at 1,714 Ma, and the youngest grains yield a weighted mean age of 1,684 ± 12 Ma. Zircons from two quartz-mica schists yield youngest peaks at 1,649 ± 17 Ma and 1,645 ± 5 Ma, and main peaks at 1,753 Ma and 1,673 Ma. Deformed undated amphibolite has xenoliths of metasedimentary rocks. Undeformed 1,633 Ma gabbro (Ramo et al. 2003) cuts metasedimentary rocks, bracketing their deposition between 1,645 and 1,633 Ma. Undeformed granitic plutons have U/Pb zircon ages of 1,449 ± 12 Ma, 1,441 ± 41 Ma, 1,431 ± 24 Ma, 1,427 ± 23 Ma, and 1,416 ± 18 Ma. Several have magmatic foliations that parallel their margins, decrease in intensity away from their contacts, and have different attitudes than adjacent gneisses.

Metamorphism reached peak conditions of 0.5 GPa and 725°C based on P-T analysis of gt-bi schists. These conditions were attained after 1,645 Ma, the depositional age of the protoliths, but before 1,633 Ma because metasedimentary rocks adjacent to the 1,633 Ma gabbro have static low-pressure mineral growth overprinting the foliation. Metamorphic events at 1,465 ± 5 Ma, 1,420 ± 6 Ma, and ~ 1,250 Ma as recorded by U/Pb monazite and $^{40}Ar/^{39}Ar$ hornblende ages were static and coeval with magmatism. P-T conditions attained during the ~1.4 Ga event were 0.25 GPa and > 550°C. The main fabric-forming event occurred between 1,645 and 1,633 Ma and is probably related to the Mazatzal orogeny. The main magmatic event occurred between 1,460 and 1,420 Ma, occurred at high temperatures, and formed static textures in previously deformed metasedimentary rocks. Lack of pervasive ~ 1.4 Ga deformation indicates the rocks were located in the interior of a block that may have been deforming along shear zones at its margins.

A NEW AGE OF 1,600 MA FOR DEPOSITION OF THE UPPER MANZANO GROUP—EVIDENCE FOR A PROGRESSIVE (1.66–1.60 GA) MAZATZAL OROGENY, CENTRAL NEW MEXICO, *A. L. Luther*, aluther@unm.edu, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; *J. V. Jones, III*, Geology Division, University of Minnesota, Morris, Minnesota 56267; *L. L. Shastri,* Ballet Tennessee, Chattanooga, Tennessee 37415; *M. L. Williams*, *M. Jercinovic*, Department of Geosciences, University of Massachusetts, Amherst, Massachusetts 01003; and *K. E. Karlstrom*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131

New mapping and U-Pb geochronology revise two prior interpretations of the Proterozoic tectonic history of the Manzano–Los Pinos uplift of central New Mexico: (1) A new 1,601 +4/-3 Ma zircon age for the uppermost Blue Springs Rhyolite of the Manzano Group indicates deposition lasted from approximately 1,662–1,600 Ma. The maximum age of the metasedimentary sequence is constrained by the Sevilleta Metarhyolite (1,662 ± 1 Ma; Shastri 1992). (2) New facing information in quartzites indicates that these rocks are folded into a megascopic, northwest-trending syncline, rather than a homocline as had been previously suggested (Myers et al. 1981)

These data and observations suggest that the Mazatzal orogeny in New Mexico involved syntectonic deposition of sediments and bimodal volcanics, intrusions of plutons, northwest-shortening, and pluton-enhanced metamorphism. Field evidence indicates that Sevilleta Metarhyolite and interlayered basalts were deposited, subsequently deformed, and then intruded by syn-tectonic granitoids, such as the Los Pinos pluton. Arenite, quartzite, schist, and the Blue Springs Rhyolite were then deposited on top and deformed, suggesting temporal interplay between deposition and tectonism lasting until 1,600 Ma. Variably intense 1,350–1,430 Ma movements took place on S2 (the dominant regional fabric) and in the mylonitic Monte Largo shear zone based on new microprobe monazite ages. Deformation during this time reactivated and intensified existing fabrics as evidenced by truncation of S2 at the northern 1,427 Ma Priest pluton contact and by the presence of strong S2 in ~ 1,650 Ma suite of pluton aureoles and foliated xenoliths within these plutons.

DEVELOPMENT OF A KARST INFORMATION PORTAL (KIP) TO ADVANCE RESEARCH AND EDUCATION IN GLOBAL KARST SCIENCE, *D. E. Northup*, dnorthup@unm.edu, Department of Biology, University of New Mexico, Albuquerque, New Mexico 87131; *L. D. Hose*, National Cave and Karst Research Institute, 1400 Commerce Drive, Suite 102, Carlsbad, New Mexico 88220; *T. A. Chavez*, Library Administration, University of South Florida, 4202 E. Fowler Avenue, LIB122, Tampa, Florida 33620; and *R. Brinkmann*, Department of Geography, University of South Florida, 4202 E. Fowler Avenue, NES107, Tampa, Florida 33620

The University of New Mexico, the National Cave and Karst Research Institute, and the University of South Florida are developing the Karst Information Portal (KIP) to promote open access to karst, cave, and aquifer information and linkages among karst scientists. The resulting connectivity and collaboration will drive innovative solutions to the critical human and environmental challenges of karst. Our purpose is to advance karst knowledge by: (1) facilitating access to and preservation of karst information both published and unpublished, (2) developing linkages and communication within the karst community, (3) promoting knowledge-discovery to help develop solutions to problems in karst, (4) developing interactive databases of information of ongoing karst research in different disciplines, (5) enriching fundamental multidisciplinary and interdisciplinary science, and (6) facilitating collection of new data about karst. The KIP project is currently (1) transforming *A Guide to Speleological Literature of the English Language 1794–1996* into the portal's first searchable on-line product and (2) creating an institutional repository of scanning electron micrographs from research in caves that includes social software to promote linkages among karst scientists. In the future, thematic areas, such as cave sediments, conduit flow models, sinkholes, geo-engineering, and speleothem records of climate change, are among the many topics to be included in the portal. A key project focus is the gathering of lesser-known materials, such as masters' theses, technical reports, agency file reports, maps, images, and newsletters. Thus, this project responds to disciplinary needs by integrating individual scientists into a global network through the karst information portal.

POSTER SESSION 1—HYDROLOGY

ARSENIC AND SODIUM IN GROUND WATER OF THE SOUTHERN ESPAÑOLA BASIN, NEW MEXICO—INDICATORS OF DEEP SOURCES AND AQUIFER COMPARTMENTS, *P. S. Johnson*, peggy@gis.nmt.edu, *S. Timmons*, *D. Koning*, *J. Whiteis*, and *L. Gillard*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Chemistry and isotopic data from ground water in the southern Española Basin are used to refine a conceptual model of ground water flow and evaluate sources of water and aquifer compartmentalization. Data include ion and trace element chemistry, oxygen-18 and deuterium, temperature, and conductivity from streams, springs, and wells, including State Engineer multi-level piezometers. Calcium bicarbonate water dominates the basin, but calcium-depleted, sodium-rich water occurs in limited areas. In the Buckman well field, Las Dos and Jacona fault systems, and at depths greater than 1,000 ft in the Tesuque Formation, sodium-rich waters are associated with a Pleistocene (?) stable isotope signature. West of Santa Fe adjacent to the Cerros del Rio volcanic field and the synclinal axis of the basin, sodium-rich, high temperature waters coincide with an arsenic plume. Logs from the exploration hole Yates La Mesa #2 indicate the plume also overlies deeply buried volcanic flows possibly associated with a buried eruptive center. Three-dimensional imaging of the arsenic plume indicates that concentrations exceeding 10 µg/L are independent of well depth and range across the upper 1,700 ft of saturated aquifer. Other results indicate mountain-block aquifers are associated with chloride- and sulfate-rich waters, and relatively elevated total dissolved solids (TDS), calcium, and bromide, which decrease west from the mountain front. Ground water in the vicinity of the Santa Fe River and Arroyo Hondo, has the lowest concentrations of TDS and major ions. Elevated chloride and chloride:bromide ratios in shallow wells beneath urban Santa Fe suggest anthropogenic sources.

HYDROGEOLOGIC CHARACTERIZATION OF A RIFT-BASIN AQUIFER SYSTEM—COMPARISON OF METHODS, *Elizabeth H. Keating*, ekeating@lanl.gov, Los Alamos National Laboratory, P.O. Box 1663 MS-T003, Los Alamos, New Mexico 87545; *Stephen G. McLin*, sgm@lanl.gov, Los Alamos National Laboratory, P.O. Box 1663 MS-K497, Los Alamos, New Mexico 87545; and *David E. Broxton*, broxton@lanl.gov, Los Alamos National Laboratory, P.O. Box 1663 MS-T003, Los Alamos, New Mexico 87545

Two separate aquifer tests were performed using an extensive network of observation wells. Initially a 25-day aquifer test was conducted at well PM-2 at a constant discharge rate of 1,249 gpm, and supply wells PM-4 and PM-5 were used as observation wells. Then a 21-day aquifer test was conducted at well PM-4 at a constant discharge rate of 1,494 gpm, and supply wells PM-2 and PM-5 were used as observation wells. These data reveal horizontal propagation of drawdown in the regional aquifer beyond 8,700 ft from each production well, and a pronounced resistance to vertical drawdown propagation at shallower depths. Hydraulically, the regional aquifer seems to behave like a semiconfined aquifer with leaky units located above a highly conductive layer that averages approximately 850 ft thick. Whereas these analyses yield excellent type-curve matches, they fail to explain differences in measured vertical pressure responses from multi-screened observation wells. In addition, multi-dimensional numerical flow models mimic both horizontal and vertical hydraulic responses very well, and suggest that the aquifer is actually phreatic. These tests demonstrate that the regional aquifer below Los Alamos is strongly heterogeneous and exhibits pronounced horizontal and vertical anisotropy in hydraulic transmitting properties. These results also illustrate that model dimensionality can influence inferred aquifer behavior and reinforce theoretical predictions (Neuman 1975) that say unconfined aquifers may exhibit confined or leaky-aquifer behavior at early times. Finally, the transition from leaky-confined to phreatic conditions is estimated to occur after approximately 200 days of continuous pumping.

ESTIMATING A RUNOFF COEFFICIENT BASED ON ADJACENT WATERSHEDS, *J. F. Kennedy*, jfk2004@comcast.net, Caelum-Unitec, P.O. Box 366, Bldg. 163, Room 102, White Sands Missile Range, New Mexico 88002; *J. W. Hawley*, Hawley Geomatters, P.O. Box 4370, Albuquerque, New Mexico 87196; *G. R. Keller*, and *R. P. Langford*, Department of Geological Sciences, University of Texas, El Paso, Texas 79968

Lake Lucero, a playa lake system located in the lowest topographic depression of the Tularosa Basin, is one of the largest remnants of a pluvial lake system (Lake Otero) that existed in the basin during the late Quaternary. The presence of this pre-existing lake is evident in the abandoned shorelines located topographically above the present day Lake Lucero plain. The climatic influences responsible for the presence of a larger lake must be different than those present today (i.e., higher precipitation and lower evaporation). However, before an investigation of climate change is possible, a better understanding of the current hydrographic system is necessary through the construction of a water-balance equation for the Lake Lucero system. Geographic information system technology is used in conjunction with modern climatic data to estimate a water balance for Lake Lucero.

LATE QUATERNARY GYPSIC AND CLASTIC LANDFORMS AND FACIES OF THE NORTHERN TULAROSA BASIN, NEW MEXICO, RESPOND TO CLIMATE CHANGE, *D. W. Love*, dave@gis.nmt.edu, *B. D. Allen*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; and *R. G. Myers*, U.S. Army, IMSW-WSM-PW-E-ES, White Sands Missile Range, New Mexico 88002

Two hydrologic systems determine landforms and sedimentary facies preserved in the northern Tularosa Basin: (1) the surface water runoff and clastic sediment delivery system of Malpais drainage, Salt Creek, and Three Rivers and their tributaries; and (2) the sulfate-laden ground water system that dissolves Permian evaporites and reprecipitates evaporite minerals in extensive springs, marshes, and lakes. The relative dominance of Quaternary springs, wetland habitats, rivers, and lakes in the northern basin has undergone extensive spatial and temporal changes as indicated by both clastic and precipitated sedimentary deposits and landforms. Clastic landforms and deposits are alluvial aprons with two or more inset levels of channel, fan, and eolian sand-loess-sheet development. Alluvial channels continue southward to the lowest part of the Tularosa Basin, disrupted by eolian blowouts and dunes.

The present-day Mound Springs south of the Oscura Mountains are crater-topped conical hills of gypsum deposited by calcium-sulfate-dominated brackish springs. These cratered mounds reach as much as 5.5 m high and 50–250 m across. Dozens of extinct cratered mounds occupy the western flank of an earlier and much larger accumulation of discharge-related gypsum, covering an area of at least 16 km^2. Similar extensive fossil discharge deposits are present to the northeast and southwest of the Mound Springs area. These older deposits are pitted with aligned sinkholes more than 8 and perhaps as much as 13 m deep.

During a late-Pleistocene wet episode along Salt Creek farther south, a huge, gypsum-precipitating wetland area covered at least 50 km^2 and formed fossiliferous deposits as much as 3 m thick. The water table has dropped 10 m since then.

The last glacial maximum expansions of Lake Otero (to 1,207 m elevation) represent times when fluvial and lacustrine systems and wetland habitats in contributing watersheds to the north were integrated and produced an extensive siliciclastic fluvio-deltaic complex along the lake's northern margin.

NECESSARY VARIATIONS IN HYDROMETER TESTS, *T. Munson*, tmunson@nmt.edu, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *K. Donahue*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *L. Gutierrez*, *H. Shannon*, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; and *V. T. McLemore*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Hydrometer analyses are performed when it is necessary to know fine particle size distribution. A glass bulb is inserted into a solution of dispersing agent and soil sample, which measures the relative density of the fluid surrounding the tip of the bulb. In conducting hydrometer analyses on rock pile samples from Questa mine, it is noticed that samples can drastically vary in behavior due to physical and chemical properties. A possible problem that could arise is the need to change the amount of dispersing agent in order to keep particles from flocculating. Early tests indicate that certain samples need more than the usual amount of dispersing agent, but that too much in turn causes additional problems.

The hydrometer method is used on fine particles because it is much easier, faster, and as accurate when compared to dry sieving. Possible problems that exist are statistical variation (inherent in sample preparation/choice) and how to determine whether to use 50 or 100 grams of sample without actually performing a dry sieve analysis, thus negating the need for the hydrometer.

Chemical composition also causes variations in particle surface forces. A phenomenon known as flocculation (clumping) was observed during certain samples' tests, indicating the clay particles are attracted to each other. Intuitively the larger, clumped particle will now settle faster, negating Stoke's Law, and invalidating the hydrometer analysis. We endeavor to determine ideal calgon and sample concentrations to be used for each test based on properties of the sample and if statistical variation is significant.

POSTER SESSION 2— PALEONTOLOGY

PRELIMINARY AGE OF MAMMAL FOOTPRINTS IN PLEISTOCENE LAKE-MARGIN SEDIMENTS OF THE TULAROSA BASIN, SOUTH-CENTRAL NEW MEXICO, *B. D. Allen*, allenb@gis.nmt.edu, *D. W. Love*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; and *R. G. Myers*, U.S. Army, IMSW-WSM-PW-E-ES, White Sands Missile Range, New Mexico 88002

Fossil footprints, thought to represent underprints of Rancholabrean proboscideans and camelids, have previously been documented in Pleistocene lakebeds on the floor of the Tularosa Basin. Here we present preliminary results from radiocarbon chronology of associated deposits. The originally documented tracksite is located along the northwest side of the lake basin, approximately 20 km north of Lake Lucero on the west side of Alkali Flat. The footprints are weathering out of the lowermost exposures of lacustrine beds, and similar features can be found at the same general stratigraphic level over a distance of at least a few kilometers parallel to shore. Basal exposures of the lacustrine sequence along the northeast side of Alkali Flat have also been identified that are stratigraphically equivalent to the western-margin track-bearing beds. Lithofacies in the track-bearing deposits include beds of gypsiferous clay, laminated and massive gypsum, carbonate mud, and thin beds containing abundant fragments of aquatic macrophytes. Lithofacies, sedimentary structures, fossil algal mats, and the preservation of aquatic organisms in some beds are consistent with subaqueous deposition and periodic subaerial exposure along the margin of a shallow saline lake. Three samples of aquatic macrophyte fragments from the level of the tracks have yielded radiocarbon ages slightly greater than 31,000 ^{14}C yrs B.P. Accuracy of these ages is uncertain because contamination of samples of this antiquity with small amounts of modern carbon would cause the apparent ages to be significantly too young. The track beds are overlain unconformably by sediments containing a relative abundance of siliciclastics and diverse assemblages of ostracodes and other aquatic organisms, suggesting input of sediment-laden surface water and relative freshening of the lake. These overlying deposits have yielded four radiocarbon ages from ostracode valves, aquatic macrophytes, and charcoal ranging from 22,800 to 19,430 ^{14}C yrs B.P., comparable with independent chronologies for the onset of significantly wetter climatic conditions in the Southwest during the late Wisconsinan. The stratigraphic relations and radiocarbon dates suggest that the footprints and trackways on the floor of the Tularosa Basin were made before this major late Wisconsinan pluvial episode.

FIRST RECORD OF THE ARTHROPOD TRACE FOSSIL *CRUZIANA PROBLEMATICA* FROM THE LOWER PERMIAN ABO FORMATION, CERROS DE AMADO, SOCORRO COUNTY, NEW MEXICO, *A. J. Lerner*, hanallaine@aol.com, and *S. G. Lucas*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104

In recent years there has been considerable interest in the Early Permian tetrapod ichnofauna from the red beds of central New Mexico. However, very little is known of the invertebrate ichnofauna in this area. Here, we add to this meager record the first documentation of *Cruziana* in the Abo Formation. These ichnofossils are from New Mexico Museum of Natural History locality 6708, in the upper part of the Abo Formation in the Cerros de Amado of Socorro County. The traces are preserved in convex hyporelief on mud-draped surfaces of several small slabs of ripple-laminated sandstone. The slab surfaces show numerous bilobate trails that consist of paired ridges and a median furrow. The ridges are covered with thin, uneven, closely spaced transverse striations. All external trail widths are similar and typically approach 1 cm or less. The longest individual trail is 80 mm in length. Trail courses are straight to gently curved. Rheotaxic alignment of trails is seen. No associated or intergradational *Rusophycus* resting-type forms are present. These relatively small bilobate trails are assigned to *Cruziana problematica* (Schindewolf 1921) based on the thin, closely spaced transverse striations and the absence of markings external to the bilobate rows. *C. problematica* is ethologically considered a locomotion trace. Notostracan crustaceans are the probable producers of some *C. problematica* in North American Lower Permian nonmarine deposits. Further prospecting within the Cerros de Amado may prove valuable in increasing what is otherwise a poorly known record of Early Permian invertebrate ichnotaxa from central New Mexico.

THE FURCULA OF *COELOPHYSIS BAURI*, A LATE TRIASSIC (APACHEAN) DINOSAUR (THEROPODA:CERATOSAURIA) FROM NEW MEXICO, *L. F. Rinehart*, larry.rinehart@.state.nm.us, *S. G. Lucas*, and *A. P. Hunt*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104

Furculae were known only in birds throughout much of the history of biology and paleontology. However, furculae have now been identified in many dinosaurs and are considered to be synapomorphic in some groups (e.g., dromeosaurids). All coelophysid dinosaurs except *Coelophysis bauri* have previously been shown to possess furculae. To date, the oldest documented furculae have been those of the Early Jurassic coelophysids, *Coelophysis kayentakatae* (= *Syntarsus kayentakatae* = *Megapnosaurus kayentakatae*) and *Coelophysis rhodesiensis* (= *Syntarsus rhodensiensis* = *Megapnosaurus rhodesiensis*). Now, a total of five *C. bauri* furculae have been found in the New Mexico Museum of Natural History's (NMMNH) Ghost Ranch, New Mexico, Whitaker Quarry block C-8-82. Three of the furculae are articulated in juvenile skeletons; two of these are missing fragments but are nearly complete, and one is apparently complete. A small fragment of a furcula associated with an adult *C. bauri*, and one complete but isolated furcula, are also described. The furculae have epicledial facets for articulation to the acromion processes of the scapulae, and some show a ventromedian process (hypocleidium) that articulates to the (apparently cartilaginous) sternum. Using accurate measurements of the scapulocoracoid and furcula we reconstruct the complete shoulder girdle of *C. bauri* with proper spacing and angles between the elements for the first time. The discovery of furculae in Apacheanaged *C. bauri* pushes the first appearance of these elements back to the Late Triassic and shows that furculae are synapomorphic in the Coelophysidae. One implication of furculae in these basal theropods is that the presence of a furcula may be synapomorphic for the Dinosauria.

TURONIAN AMMONITES FROM THE TYPE AREA OF THE JUANA LOPEZ MEMBER OF THE MANCOS SHALE, SANTA FE COUNTY, NEW MEXICO, *P. L. Sealey*, ammonoidea@comcast.net, and *S. G. Lucas*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104

At the type section of the Juana Lopez Member of the Mancos Shale at Galisteo Dam in central New Mexico, the unit is approximately 33 m thick and consists of three lithostratigraphic intervals—lower calcarenites, a middle shale, and upper calcarenites. It is underlain by the Carlile Shale and overlain by the D-Cross Member of the Mancos Shale. The ammonite fauna includes *Scaphites whitfieldi* Cobban, *Prionocyclus novimexicanus* (Marcou), *Prionocyclus wyomingensis* Meek, *Prionocyclus macombi* Meek, *Scaphites warreni* Meek and Hayden, and *Coilopoceras colleti* Hyatt. Most of the ammonite diversity in the Juana Lopez Member at Galisteo Dam is in the upper calcarenite interval and is dominated by *P. novimexicanus*, *S. whitfieldi*, and *S. warreni* with an occasional *P. wyomingensis*. The middle shale interval has a low diversity ammonite assemblage dominated by *P. macombi* with an occasional *C. colleti*.

The Juana Lopez Member encompasses three widely recognized Turonian ammonite zones, the *P. macombi*, *P. wyomingensis*, and *P. novimexicanus* zones. The *P. macombi* zone also occurs in many other places in New Mexico, including the basal part of the Juana Lopez Member in Colfax County where the lectotype of *P. macombi* was collected. In New Mexico, the *P. wyomingensis* zone occurs in the Juana Lopez and D-Cross Members. The zone of *P. novimexicanus* also occurs in various New Mexico locations, especially in the D-Cross Member of the Mancos Shale. The *P. macombi* and *P. wyomingensis* zones are of late-middle Turonian age, whereas the *P. novimexicanus* zone is of late Turonian age.

MIDDLE TURONIAN SELACHIAN FAUNAS AND PALEOECOLOGY, CENTRAL NEW MEXICO, *Sally C. Williams*, stripepike@mac.com, and *Spencer G. Lucas*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104

Middle Turonian strata in central New Mexico cover a large range of depositional environments. The Atarque Sandstone Member of the Tres Hermanos Formation represents a shoreline deposit, that yields a diverse selachian fauna. Although Wolberg reported 22 species from the Atarque Sandstone, it only contains 11 of the species that he reported: *Scapanorhynchus raphidon*, *Squalicorax falcatus*, *Ptychodus whipplei*, *Ptychodus anonymus*, *Hybodus* sp., *Chiloscyllium greeni*, *Cretodus semiplicatus*, *Ptychotrygon triangularis*, *Ischyrhiza avonicola*, *Pseudohypolophus mcnultyi,* and *Rhinobatos* sp. This assemblage is dominated by the teeth of the pelagic sharks *Scapanorhynchus raphidon* and *Squalicorax falcatus*, and the benthic ray *Pseudohypolophus mcnultyi*. The Semilla Sandstone Member of the Carlile Shale is an offshore shoal. The species present are *Scapanorhynchus raphiodon*, *Squalicorax falcatus*, *Ptychodus whipplei, Ptychodus anonymus*, *Hybodus* sp., *Cretodus semiplicatus*, *Ptychotrygon triangularis*, *Ischyrhiza avonicola*, *Pseudohypolophus mcnultyi,* and *Rhinobatos* sp. The Juana Lopez Member of the Mancos Shale represents a deep water shoal. The species present are *Ptychodus whipplei*, *Ptychodus anonymus*, *Scapanorhynchus raphiodon*, *Cretoxyrhina mantelli*, *Cretolamna* sp., and *Squalicorax falcatus*. Whereas as many as six species may be present, the assemblage is nearly monospecific with *Ptychodus whipplei* being the dominant species. The abundance of *Ptychodus whipplei* in the deep water shoals of the Juana Lopez Member may indicate that *Ptychodus whipplei* was a deep water shark that fed at these shoals. All of the members of Rajaformes that are present in the Semilla Sandstone and the Atarque Sandstone are absent in the deeper water deposits of the Juana Lopez Member.

TRANSFER OF UALP SAN JUAN BASIN VERTEBRATE COLLECTION TO THE NMMNH, *T. E. Williamson*, thomas.williamson@state.nm.us, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104; *P. M. Hester*, U.S. Bureau of Land Management, 435 Montano NE, Albuquerque, New Mexico 87107; and *S. P. Bednarski*, New Mexico Museum of Natural History and Science, 1801 Mountain Road NW, Albuquerque, New Mexico 87104

The University of Arizona Laboratory of Paleontology (UALP) collected Late Cretaceous (Judithian and Lancian), early Paleocene (Puercan and Torrejonian), and early Eocene (Wasatchian) vertebrates from BLM lands of the San Juan Basin in the 1970s from over 400 localities. Most specimens are accompanied by precise locality information based on plots on USGS 7.5′ maps. These collections were used in many theses, dissertations, and scientific publications. However, for approximately the last decade, the University of Arizona had stored the collection off campus among various facilities, making it nearly inaccessible to researchers. Ultimately, the University of Arizona (UA) agreed to transfer this collection to the NMMNH.

In September 2005, a crew from the NMMNH traveled to Tucson to pack up and move this collection to Albuquerque. Specimens were stored offsite in two different storage areas; one a commercial storage facility and the other, the Duval Street garage building. A rented U-Haul truck was loaded with storage cabinets at the NMMNH and driven to Tucson. The packing and transfer of specimens were accomplished in just three days. The specimens have subsequently been cataloged into the NMMNH collection (a total of over 2,800 cataloged specimens). The locality database has also been incorporated into that of the NMMNH. In addition, the UTM coordinates have been estimated for all locality plots so that data can be easily shared between agencies and used for land-use decisions.

POSTER SESSION 3— STRATIGRAPHY, TECTONICS, AND VOLCANOLOGY

STRATIGRAPHY AND STRUCTURE OF THE SOUTHERN ESPAÑOLA BASIN, NEW MEXICO, *D. J. Koning*, dkoning@nmt.edu, *P. S. Johnson, A. S. Read*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *V. J. S. Grauch*, and *S. A. Minor*, U.S. Geological Survey, Box 25046, Federal Center, MS 964, Denver, Colorado 80225

On-going studies have refined our understanding of the stratigraphy and structure of the southern Española Basin south of Santa Fe. Here, four lithostratigraphic units of the Tesuque Formation (Oligocene–Miocene) laterally grade into one another. Lithosome S is mostly a pebbly sand deposited by an ancestral Santa Fe River sourced east of the Picuris–Pecos fault. To the south, lithosome S laterally grades into sand and silty sand of lithosome A derived from the southern Sangre de Cristo Mountains. Lithosome E generally consists of muddy sand derived from erosion of Cieneguilla Basalt and Espinaso Formation on the eastern flank of a paleotopographic high between the Santa Fe embayment and Santo Domingo Basin. A fourth lithosome within lithosome S consists of clay and sandy clay, possibly as thick as 150 m, that is penetrated by drill holes north of Arroyo Hondo near the Santa Fe Airport. We interpret that these clayey sediments were deposited in a lake or playa in a closed basin, possibly during rapid tectonic subsidence during the middle(?) Miocene.

Miocene-age tectonic activity also formed a broad, north-plunging, synclinal trough in strata beneath relatively undeformed Ancha Formation (Pliocene–Pleistocene), based on well cuttings that compliment aeromagnetic, gravity, and seismic data. Both aeromagnetic data and subsurface stratigraphic correlations indicate an approximate east-northeast trending hinge line near Bonanza Creek. Near the State Penitentiary, strata steepen northward across this hinge line. To the east, the southern boundary of lithosome S approximately corresponds with the hinge line location, suggesting possible structural control on its deposition.

U-PB SHRIMP DATING TO DETERMINE THE AGE OF ZIRCONS FROM CRUSTAL XENOLITHS OF THE ELEPHANT BUTTE VOLCANIC FIELD—IMPLICATIONS FOR THE TIMING OF RIFTING IN SOUTHERN NEW MEXICO, *C. C. Athens*, cathens@nmsu.edu, and *J. M. Amato*, Department of Geological Sciences, New Mexico State University, Las Cruces, New Mexico 88003

Three large xenolith samples were collected from the Elephant Butte volcanic field in the spring of 2005. Samples were chosen for U-Pb SHRIMP dating at Stanford University. The xenoliths consist of quartz, plagioclase, and K-feldspar with minor clinopyroxene, magnetite, and zircon. This mineral assemblage suggests the protoliths were granitic rocks. No hydrous minerals were observed, suggesting that these rocks reached granulite facies.

The zircons from the samples were subhedral to rounded indicating recrystallization has likely occurred. Some of the grains that were dated have normal zonation, whereas others have a spirally pattern of zonation also indicating recrystallization. Thirty-four dates were obtained from sample 05-AR-01. Core analyses had an average age of 1,465 ± 36 Ma. The weighted average of seven rim ages is 9.1 ± 1.5 Ma. Twenty-two dates were obtained from sample 05-AR-02. The cores had an average age of 1,445 ± 40 Ma. This sample also had rim ages of 21 Ma, 27 Ma, 9 Ma, and 6 Ma. This means that the rocks are originally Proterozoic in age but that they were recrystallized in the Tertiary. The core ages are similar to the age of the Proterozoic granites throughout New Mexico. The rims reflect Tertiary heating possibly related to Rio Grande rifting between 27–6 Ma.

CONSTRAINTS ON LARAMIDE SHORTENING AND RIO GRANDE RIFT EXTENSION IN THE FRANKLIN MOUNTAINS, WEST TEXAS AND SOUTHERN NEW MEXICO, *M. R. Scharman*, mrscharman@utep.edu, Department of Geological Sciences, University of Texas, 500 W. University Avenue, El Paso, Texas 79968; *C. L. Andronicos*, Department of Earth and Atmospheric Sciences, Snee Hall, Cornell University, Ithaca, New York 14853; *G. R. Keller, J. M. Hurtado, Jr.*, and *A. A. Velasco*, Department of Geological Sciences, University of Texas, 500 W. University Avenue, El Paso, Texas 79968

The Franklin Mountains in west Texas and southern New Mexico contain geologic structures associated with Laramide shortening and Rio Grande rift extension. Laramide shortening affected west Texas and southern New Mexico from Late Cretaceous to early Tertiary time, whereas Rio Grande rift extension began in mid-Tertiary time. Thin-skinned, basement-cored folding, and transpressional tectonic models have been suggested for Laramide deformation, among others. However, a general agreement has not been reached on a single tectonic model. Micro- and macro-structural observations of fault system geometries, kinematics, and dynamics must be completed to provide constraints on tectonic and geologic models for Laramide shortening and Rio Grande rift extension in west Texas and southern New Mexico. Detailed geologic mapping has been completed in the area of Tom Mays Park, Texas, in order to refine the geologic structures and construct better cross sections in the central Franklin Mountains. Measurements of fault orientations and associated lineations were also collected, which will be used for fault slip analysis of the faults in order to determine principal stress orientations for different periods of deformation present in the region.

PROTEROZOIC DEFORMATION OF THE SAN ANDRES MOUNTAINS, SOUTH-CENTRAL NEW MEXICO, *A. Serna*, antserna@nmsu.edu, *J. M. Amato*, Department of Geological Sciences, New Mexico State University, Las Cruces, New Mexico 88003; and *G. Gehrels*, Department of Geosciences, University of Arizona, Tucson, Arizona 85721

The Proterozoic history of the San Andres Mountains has been investigated through detailed field mapping, geochronology, and geochemistry. SHRIMP U-Pb zircon geochronology was performed on a quartzite and several granitic plutons. The quartzite was collected from below the Bliss unconformity. Zircons ($n = 98$, 2σ) from the quartzite yield a large population at 1,668 ± 7 Ma and two smaller populations at 1,729 ± 8 Ma and 1,793 ± 15 Ma. The ~ 1.67 Ga zircons probably were locally derived from basement rocks as rocks of this age have been dated in other Mazatzal province crust in southern New Mexico. The older populations were derived from Yavapai province rocks from the north. In the southern part of the range, Proterozoic crystalline rocks include a deformed granitic orthogneiss that experienced east-west shortening. Zircons from this unit were dated at 1,649 ± 9 Ma ($n = 8$, 2σ). An unfoliated granitic pluton that cuts the orthogneiss has yielded ages of 1,632 ± 17 Ma ($n = 5$, 2σ) and 1,626 ± 14 Ma ($n = 10$, 2σ). These plutons were intruded by a series of amphibolite dikes at ~ 1,600 Ma ($n = 8$). Boudinage of these dikes in the southern part of the range suggests subsequent east-west extension. Though abundant in the southwestern U.S., ~ 1.4 Ga plutons have not been dated in this study. However, zircons from the overlying Cambrian Bliss sandstone yielded dates of 1,455 Ma ($n = 87$), suggesting these rocks may have once been locally present.

ROCK WATCHING ALONG THE CANYON TRAIL, BOSQUE DEL APACHE NATIONAL WILDLIFE REFUGE—A PICTORIAL GUIDE TO NEOGENE LANDSCAPE EVOLUTION IN CENTRAL NEW MEXICO, *R. M. Chamberlin*, richard@gis.nmt.edu, *D. W. Love*, and *L. Peters*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Recent geologic mapping and paleocurrent observations indicate that interbedded volcanic-rich conglomerates and crossbedded eolian sandstones exposed along the Canyon Trail predate the Rio Grande and mark the time "before a river ran through it." Equivalent volcanic-rich conglomerates northwest of the Bosque Visitor Center are overlain by a basaltic lava flow that yields a $^{40}Ar/^{39}Ar$ age of 8.57 ± 0.26 Ma; they are therefore assigned to the Miocene Popotosa Formation of the lower Santa Fe Group.

Pebble imbrications and clast compositions in the cobbly conglomerates indicate paleocurrents to the west-southwest (250 ± 45°, n = 15); whereas maximum dip directions (> 25–35°) in the coeval eolian sandstones show prevailing wind directions toward the east-northeast (080 ± 30°, n = 23). In late Miocene time, about 9–10 Ma, the Little San Pascual Mountains (east of the Canyon Trail) must have been a prominent fault block range capped by a thick volcanic pile overlying the Permian Abo Formation. Mountain streams carried the volcanic-rich gravels and rare Abo siltstone clasts westward toward a basin floor. At the same time strong westerly winds carried fine sand eastward across the toes of the alluvial fans. Minor mudstone drapes found where conglomerate beds overlie eolian sandstones probably mark small marshlands formed at the toe of alluvial fans, on the lee (mountainward) sides of the dunes. The Ibex Dunes, in the Death Valley region of southern California, are considered to be a modern analog for the Canyon Trail area in late Miocene time. Remnants of east-transported piedmont-slope gravels (early? Pleistocene) disconformably overlie the Popotosa conglomerates where they are locally preserved on the downthrown side of the north-northwest-striking Solitude fault, which transects the Canyon Trail.

DISTRIBUTION OF INTERMEDIATE VOLCANIC ROCKS ON THE PAJARITO PLATEAU, JEMEZ MOUNTAINS, NEW MEXICO, *K. E. Samuels*, ksamuels@lanl.gov, *D. E. Broxton, D. T. Vaniman, G. WoldeGabriel*, EES-6, Hydrology, Geochemistry, and Geology, Los Alamos National Laboratory, MS T003, P.O. Box 1663, Los Alamos, New Mexico 87545; *J. A. Wolff*, Department of Geology, Washington State University, P.O. Box 642812, Pullman, Washington 99164; *D. D. Hickmott, E. C. Kluk*, and *M. M. Fittipaldo*, EES-6, Hydrology, Geochemistry, and Geology, Los Alamos National Laboratory, MS T003, P.O. Box 1663, Los Alamos, New Mexico 87545

Boreholes drilled for ground water characterization at Los Alamos National Laboratory encountered at least three petrographically and chemically distinct intermediate lavas in the west-central Pajarito Plateau. These lavas represent a narrow time interval (2.3–3.6 Ma) during which both the Jemez Mountains volcanic field and Cerros del Rio volcanic field were active.

Boreholes in the northern part of the laboratory encountered fine-grained dacitic lava with 2–5% phenocrysts (5–35% plagioclase, 61–86% pyroxene, absent or minor amphibole) and relatively low SiO_2 (~ 63.5%). Boreholes in the southwest part of the laboratory encountered coarsely porphyritic lavas with 22% phenocrysts (59% plagioclase, 13% pyroxene, 25% amphibole) and 64.9–66.3% SiO_2. Glomerophyric, sieved plagioclase grains are abundant in these samples. Boreholes in the central part of the laboratory encountered fine-grained lavas with 22% phenocryst abundance (59% plagioclase, 13% pyroxene, and 1% relict amphibole) and relatively high SiO_2 (67.4%).

Although the relationship between the northern intermediate lavas and the adjacent volcanic fields is unclear, dacites in the central part of the laboratory overlie late Pliocene basalts that thin to the west, suggesting a link with the Cerros del Rio volcanic field. The southwestern lavas resemble adjacent Sierra de los Valles Tschicoma Formation lavas, particularly Pajarito Mountain and Cerro Grande, which have an average of 23% phenocryst content (70% plagioclase, 10% pyroxene, and 17% amphibole), and range in SiO_2 composition from 63.77–68.9%. Pajarito Plateau intermediate lavas, erupted near the active western margin of the Española Basin, represent an important link between coeval volcanism in the Cerros del Rio and Jemez volcanic fields.

POSTER SESSION 4— LAKES, MAGMAS, AND LANDFORMS

LACUSTRINE DEPOSITIONAL ENVIRONMENTS OF THE PLIOCENE-PLEISTOCENE MANGAS BASIN, SOUTHWESTERN NEW MEXICO, *D. M. Stout*, dsfunk @yahoo.com, Department of Geological Sciences, New Mexico State University, Las Cruces, New Mexico 88003

The Mangas Basin in southwest New Mexico, USA, is a Pliocene–early Pleistocene extensional basin. During this time an axial fluvial system flowed southeast through the basin and into a closed lake (Lake Buckhorn) near the present towns of Buckhorn and Cliff, New Mexico. The sediments deposited in the paleolake are part of the Gila Formation, also known as the Gila Conglomerate. The Gila Formation is basin-fill sediment deposited in the drainages of the Gila and Mimbres Rivers, overlying Cenozoic volcanic rocks. The Gila River and its tributaries have exposed all or part of the Gila Formation in the Mangas Basin. It is approximately 200 m thick and is no older than late Miocene. Most of the sediment is Pliocene age based on vertebrate fauna and zircon-fission-track dates of vitric tuffs. The younger age is poorly constrained at early Pleistocene due to the presence of Pleistocene fauna. The focus of this research is on the lacustrine sediments and using their sedimentology to determine the size, chemistry, depth, and the scale of the shrinking and expanding of the lake.

The lake was approximately 250 km^2, extending from Cliff to north of Buckhorn, New Mexico. The lacustrine facies are green mudstones, siltstones, sandstones, limestones, diatomites, and Magadi-type cherts. These are rooted and bioturbated indicating a shallow depositional environment. The lacustrine facies are interbedded with alluvial-fan facies, mainly conglomerates on sandstones of distal to proximal fan environments. Periodically the lake was concentrated in silica and sodium and often alkaline. The lake might have had two scales of shrinking and expanding cycles. The small-scale cycles possibly represent a time period of thousands of years and the large scale millions of years.

AN ENVIRONMENTAL MAGNETISM INVESTIGATION OF THE PLEISTOCENE LACUSTRINE SEDIMENTS FROM THE VALLE GRANDE, NEW MEXICO, *L. L. Donohoo-Hurley*, ldonohoo@unm.edu, *J. W. Geissman, P. J. Fawcett, T. F. Wawrzyniec*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; and *F. Goff*, Los Alamos National Laboratory, Los Alamos, New Mexico 87545

Environmental magnetic data are being obtained from over 80 m of Pleistocene age lacustrine sediments (core GLAD-VC3-04) retrieved in 2004 from the Valles caldera, New Mexico. The purpose of this study is to assess past climate variation within the Valles caldera over the time period of sedimentation by quantifying variations in magnetic mineralogy as a proxy for changes in sediment influx resulting from climatically driven surficial processes. Typical intensities of natural remanent magnetization (NRM) of VC3-04 range from 3 to 6 mA/m. Intensities of anhysteretic remanent magnetization (ARM) that reflect total magnetite population, range from 15 to 30 mA/m. Results of alternating field demagnetization and other rock magnetic tests indicate that fine-grained magnetite (single-domain and pseudo-single domain magnetite) carries the principal magnetization signal in much of the section. The VC3-04 core is not oriented and thus paleomagnetic evaluation of the NRM is limited to inclination values. The oldest part of the VC3-04 core is about 552 ± 3 ka, based on $^{40}Ar/^{39}Ar$ isotopic age determination on sanidine in a tephra layer at 76.4 m depth, and thus the entire core is within the current Brunhes chron. Although this chron is exclusively of normal polarity, several geomagnetic “events” reflecting short-lived high-amplitude directional deviations in the geomagnetic field (e.g., the Calabrian Ridge II at 515 ± 3 ka) have been documented for the Brunhes chron. Samples obtained from the depth interval 17.22–17.30 m yield moderate negative inclinations, which we interpret represent the Calabrian Ridge II event.

INTERDISCIPLINARY DETERMINATION OF ACTIVE MAGMATIC PROCESSES OF THE SOCORRO MAGMA BODY, CENTRAL NEW MEXICO, *J. J. Morton*, jmorton@nmt.edu, *S. L. Bilek, R. Aster*, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801; *C. A. Rowe*, Los Alamos National Laboratory, Los Alamos, New Mexico 87545; and *A. V. Newman*, School of Earth and Atmospheric Sciences, The Georgia Institute of Technology, Atlanta, Georgia 30332

In this project we integrate complementary analyses of GPS and passive seismic data to explore the mechanisms of magma inflation and crustal deformation caused by the Socorro Magma Body (SMB), a mid-crustal magma body residing at 19 km depth, which is responsible for as much as 45% of earthquakes above magnitude 2.5 in New Mexico. Previous studies involving active-source seismic refraction have contributed to determining the geometry of the SMB. New work using campaign geodetic measurements and InSAR interferometry during 1992–1999 has suggested that average uplift is occurring at 2–3 mm/year. Two new continuously telemetered GPS stations have been installed near two seismic stations in the Sevilleta National Wildlife Refuge located at 34°12'N 106°45'W and 34°15'N 106°58'W. Co-location of these stations will help illuminate the temporal relationship between deformation and seismicity associated with the SMB at time scale that have not previously been examined. We are developing a new catalog of seismicity occurring between 33°30'N and 35°N and 106°15'W to 107°30'W. It is a combination of arrival time data from larger events from the years 1996–2004 and waveform data for all locatable events, with preliminary data quality thresholds requiring a minimum of four recognizable arrivals recorded between September 2004 and the present. This combined catalog of at least 500 events will be relocated using waveform cross-correlation and travel-time differential methods to sharpen our image of the seismogenic sources associated with inflation-induced seismicity.

CHARACTERIZATION OF THE OCTOBER 2005 MICROEARTHQUAKE SWARM IN THE SOCORRO REGION, *J. Stankova*, janas @nmt.edu, and *S. Bilek*, Department of Earth and Environmental Science, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

Socorro, New Mexico, lies in a region of increased seismicity caused by a mid-crustal magma body. The magma body is at approximately 19 km depth beneath central New Mexico and has an area of approximately 3,000 km^2. On October 30, 2005, at 02:57:35 (UTC), many residents of the city of Socorro felt an earthquake of magnitude 2.4. Although events of such magnitude are rarely felt, this earthquake was very close to the city's population center. The earthquake's epicenter was located at 34.06N and 106.96W, or approximately 5.4 km west of the city. The depth to the hypocenter was approximately 7 km. Subsequently, seismic activity increased in the region of the main shock. On the day of the main event, over 200 microearthquakes occurred. In the period between October 30 and November 17, 2005, many microearthquakes occurred with numbers decreasing exponentially in time. Here we describe the location of these events, present analyses of their waveform similarity, and compare with previous microearthquake swarms in this area. These microearthquakes seem to have very similar waveforms to the main event, which suggests that they occurred in proximity to the main event. This earthquake swarm appears to be similar to the previous swarms in May and July 1983, with earthquakes occurring in approximately the same location.

LOCALIZED LITHOLOGIC CONTROLS ON SLOPE FORMING PROCESSES ALONG THE SANDIA MOUNTAIN FRONT, *J. D. Frechette*, jdfrech@unm.edu, *J. New*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131; *L. Burnette*, Los Alamos National Laboratory, Los Alamos, New Mexico 87545; *L. Persico*, *C. Domrose*, and *L. D. McFadden*, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131

The western slope of the Sandia Mountains is dominated by corestone topography with weak soils forming between large granite boulders. Rarely slopes are mantled by thick, well-developed soils. In multiple locations these stable slopes are observed to be capped by rock types that are more resistant to weathering than the surrounding granite but are of limited spatial extent. We propose that these volumetrically minor cap rocks have a significant impact on slope form through a variety of processes that decrease retreat rates.

We tested this hypothesis by comparing slopes that are underlain entirely by coarse-grained granite to slopes that are underlain by granite and capped by more resistant rock types. Given enough time, the thick, clay-rich soils observed on slopes that are capped by resistant rock types could form by weathering of the local bedrock. However, a more likely explanation is that the soils formed through weathering of fine-grained material, probably dust, from an external source. In either case, a significant period of slope stability was required for the observed soils to develop.

Preliminary data suggest that the spatially restricted cap rocks are responsible for increased slope stability by converting weathering-limited to transport-limited slopes. In contrast to the grus found on slopes underlain entirely by granite, weathering of the resistant rock types produces large clasts. These clasts are less mobile than grus and appear to play an important role in decreasing sediment transport rates on slopes while possibly increasing the dust-trapping efficiency of the surface.

POSTER SESSION 5—MAPS

COLOR, AERIAL-PHOTOGRAPHIC SECTION OF A LAVA DELTA, CARRIZOZO LAVA FLOW, LINCOLN COUNTY, NEW MEXICO, *Robert G. Myers*, robert.g.myers @us.army.mil, U.S. Army, IMSW-WSM-PW-E-ES, White Sands Missile Range, New Mexico 88002

Color aerial photographs were obtained by White Sands Missile Range of the San Andres National Wildlife Refuge, White Sands National Monument, the northwestern section of the Jornada del Muerto, and White Sands Missile Range in 2003. The aerial photographs were compiled as a digital, orthophotographic map of the area. The map includes aerial photography of the textural features of a distal portion and a lower, middle portion of the Carrizozo lava flow on White Sands Missile Range. The aerial photography can be viewed at any user-defined scale from a maximum scale of 1:908.5. The topography and flow features of the Carrizozo lava flow have been the focus of studies by J. R. Zimbelman and A. K. Johnston from the Center of Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, funded by the Planetary Geology and Geophysics Program of the National Aeronautics and Space Administration.

This poster compares the previously available aerial-photographic coverage at a scale of 1:24,000 of a photographic section of a lava delta in the distal portion of the Carrizozo lava flow to 2003 aerial-photographic sections at scales of 1:12,000, 1:6,000, and 1:908.5.

This poster has been approved for public release by White Sands Missile Range for unlimited distribution. The White Sands Missile Range Operational Security review was completed on 31 January 2006.

GEOLOGIC MAP OF THE LUNA 7.5 MINUTE QUADRANGLE, WEST-CENTRAL NEW MEXICO, *T. L. Finnell* (deceased) and *J. C. Ratté*, jratte@juno.com, U.S. Geological Survey, P.O. Box 25046, Federal Center, MS-973, Denver, Colorado 80225

The northeast trending Luna graben cuts diagonally across the center of the Luna quadrangle, is 3–5 mi wide, and is filled with volcaniclastic rocks of the Gila Group (aka Gila conglomerate) ~ 600 ft thick. The Luna graben separates Datil Group volcanic rocks and Spears Group volcaniclastic sediments of Eocene age, approximately 1,000 ft thick, in the northwestern third of the quadrangle, from Mogollon Group volcanic rocks of Oligocene and Miocene age, 1,000–1,500 ft thick, in the San Francisco Mountains in the southeast third. Datil Group rocks include thin (0–15 ft thick), discontinuous ignimbrites that represent distal outflow from Eocene calderas in the Socorro–Magdalena area. Mogollon Group rocks in the San Francisco Mountains block are mainly outflow ignimbrites (Bloodgood Canyon, Shelley Peak, and Davis Canyon Tuffs) and lava flows (Bearwallow Mountain Andesite) from the Mogollon Mountains caldera complex, 40–50 mi southeast of Luna. Pliocene olivine basalt flow(s) of Trout Creek cut diagonally northwest-southeast across the Luna graben, and Luna Valley of the San Francisco River, and probably dammed an ancestral San Francisco River, forcing the river to the south side of the graben, where it carved a steep-walled canyon that continues into the Dillon Mountain quadrangle to the east.

Narrow, east-west-trending horsts and grabens in the San Francisco Mountains block appear to be bounded by tension fractures between the Spur Lake–Luna fault system and the San Francisco Mountains fault zone east of the San Francisco Mountains, and are interpreted to be formed by transtension related to a simple shear couple, resulting in an unknown amount of dextral strike slip on the bounding faults.

PRELIMINARY GEOLOGIC MAP OF THE HOLT MOUNTAIN 7.5 MINUTE QUADRANGLE, MOGOLLON–DATIL VOLCANIC FIELD, CATRON COUNTY, NEW MEXICO, *J. C. Ratté*, jratte@juno.com, U.S. Geological Survey, Federal Center, P.O. Box 25046 MS-973, Denver, Colorado 80225; *S. D. Lynch* and *W. C. McIntosh*, New Mexico Bureau of Geology and Mineral Resources, New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801

The Holt Mountain 7.5-min quadrangle is located east of Glenwood, New Mexico, in the southwestern part of the mid-Tertiary Mogollon–Datil volcanic field, and at the west end of the Mogollon Mountains. The quadrangle includes the western and southern margins of the huge, 40 km (25 mi) diameter, Oligocene (28 Ma) Bursum caldera, as well as evidence indicating a pre-existing Mogollon caldera of Eocene (~ 34 Ma) age, within which the Bursum caldera is nested. Other evidence for the Mogollon caldera seems to have been largely destroyed during the development of the younger caldera cluster, including the Bursum caldera in the Mogollon Mountains region.

The Holt Mountain quadrangle also is noteworthy for its base and precious metals mineral resource potential, including molybdenum, copper, lead, zinc, gold, and silver, as well as past fluorite mining. The area's mineral resource potential is enhanced by its location immediately south of the Mogollon mining district, but exploration is somewhat impeded by the location of most of the mineralized rocks within the boundaries of the Gila Wilderness.

The Holt Mountain quadrangle includes the trailhead and large stretches of the Catwalk National Recreation Trail in Whitewater Canyon, a major western gateway to the Gila Wilderness and a popular tourist attraction in the Glenwood area. The Catwalk Trail is a beautiful hike for people of all ages and interests, and it traverses some of the rock exposures that are most critical to the interpretation of the geology in the Holt Mountain quadrangle and the Mogollon Range.

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NMGS spring meeting
Student winners for best presentation

Each year a panel of judges evaluates student oral and poster presentations. Scores are tallied from judging forms. This year the award of $100.00 for best student talk was given to Kate Zeigler for her presentation "Paleomagnetic data from the Pennsylvanian–Permian Horquilla Formation and probable Cenozoic rotation of the Big Hatchet Mountains, southwestern New Mexico." Kim Samuels' poster presentation "Distribution of intermediate volcanic rocks on the Pajarito Plateau, Jemez Mountains, New Mexico," won the $100 award.

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