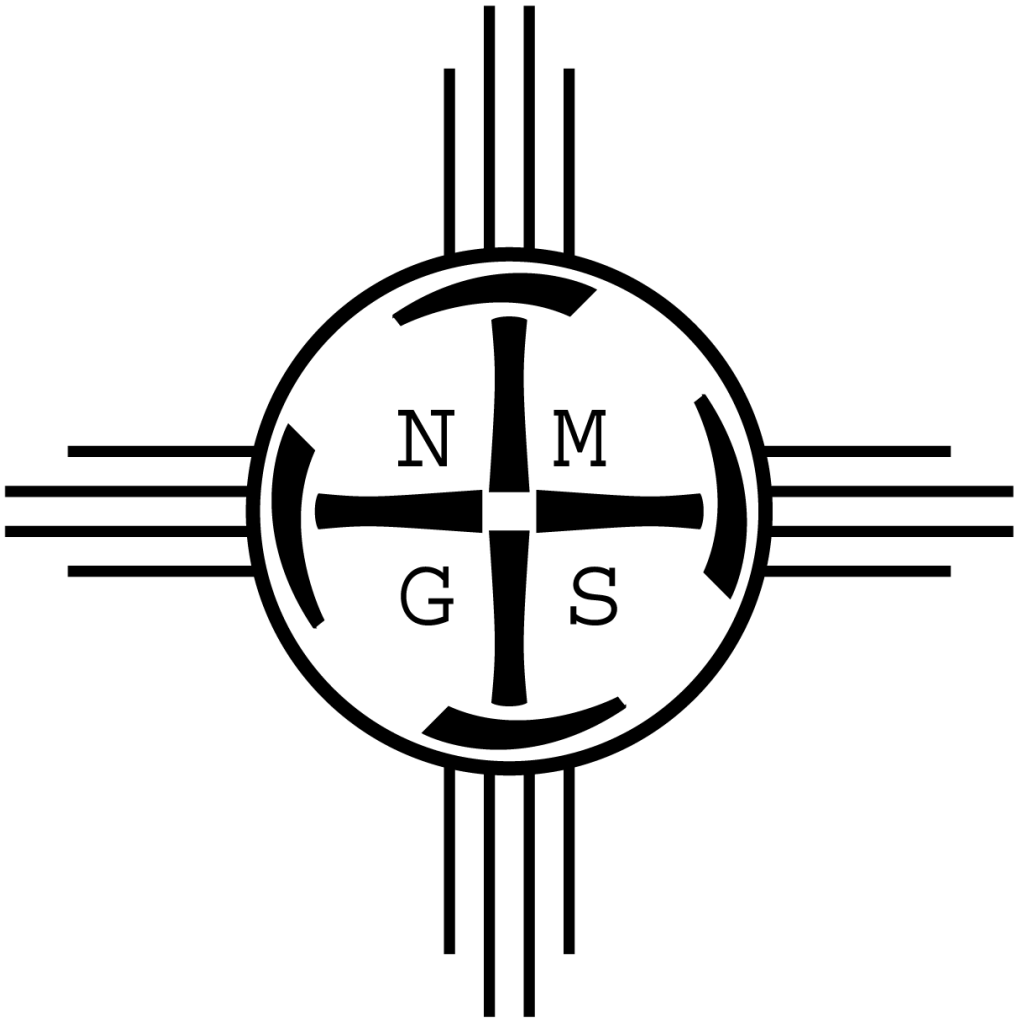
New Mexico Geological Society



Proceedings Volume

Lessons Learned from New Mexico's Landscapes

2026 Annual Spring Meeting

Macey Center

New Mexico Tech

Socorro, NM

Friday April 17, 2026

NEW MEXICO GEOLOGICAL SOCIETY
2026 SPRING MEETING
Friday, April 17, 2026
Macey Center
New Mexico Tech Campus
Socorro, New Mexico 87801

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New Mexico Geological Society Members and Colleagues,

As we embark on the annual Spring meeting, the NMGS Foundation Board is pleased to announce that last year, twenty-five donors contributed a record $87,500 to the Foundation. Thank you to all those that have contributed! This total includes three endowment payments including the newly created Frank Ramos Student Fall Field Conference scholarship. These scholarships replace or enhance current NMGS expenditures. 2025 also saw an increase in Donor Advised Fund checks and Qualified Charitable Distributions. We also accepted a gift of stock as a contribution again. These approaches are simple and tax efficient ways to contribute. Please contact James Cearley to discuss these options.

We also say farewell to Foundation President Frank Ramos whose effective guidance and focus on strict financial budgeting have led to significant growth in the financial assets of NMGS Foundation. The NMGS's financial position is much stronger now than it was when he joined in 2012.

Our goal for 2026 again is to raise $30,000 in gifts to continue this support. To ensure the success of this campaign, NMGS Foundation Board members have committed to match the first $15,000 of funding, dollar for dollar. By increasing the endowment's principal, we can enlarge its annual distributions and multiply the fund's impact on student success in geosciences in New Mexico.

NMGS Foundation revenues from investments of charitable contributions as well as revenue from NMGS events annually provide up to $70,000 in support of student activities including: Grants-in-Aid to students undertaking geological research in New Mexico, scholarships to students attending New Mexico's 4-year colleges and research universities, and student participation in the annual NMGS Fall Field Conference and Spring Meeting. This student support will positively impact student and faculty contributions to our science as well as the NMGS. Please join us in expanding the resources available to geoscience students in New Mexico. You can go to https://nmgs.nmt.edu/donations to make your gift.

If you are interested in establishing a lasting legacy by creating your own scholarship or endowment, you can contact James Cearley, Outreach Officer to discuss these options at jbcearley@gmail.com, or by calling 832-623-1437.

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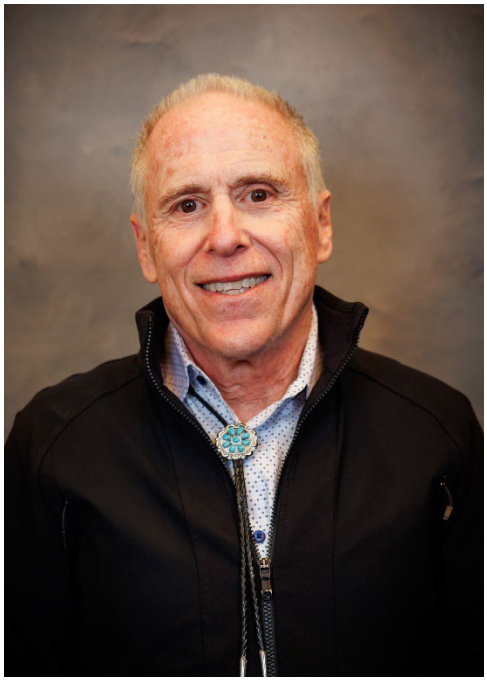
KEYNOTE SPEAKER

Post-Fire Hydrologic Impacts and Lessons Learned from the Hermit's Peak/Calf Canyon Fire, San Miguel, Mora and Taos Counties, New Mexico



Jay Lazarus, VP and Principal at Glorieta Geoscience (GGI), a Division of GZA, Inc. has been practicing geology and hydrology since 1976 and started GGI in 1979. Mr. Lazarus' experience includes managing and completing over 1000 hydrogeologic and water rights investigations in multiple states for municipalities, state and federal governments, agricultural and industrial interests, tribal entities, ski areas, mines, irrigation districts, insurance companies, and individuals.

Friday, April 17, 2026

Breakfast (burritos, muffins, fruit, coffee, tea, lemonade)
Macey Upstairs Lobby: *7:30 AM - 8:15 AM*

Welcome and Opening Remarks
Auditorium: *8:15 AM - 8:20 AM*

Theme Session- Lessons Learned from New Mexico's Landscapes:

Auditorium: *8:20 AM - 10:00 AM*
Chair: Steve Wells

A Seismic-Hydraulic Approach to Monitoring Bedload Flux

— Daniel Cadol, Loc Luong, John Mitchell McLaughlin, and Susan Bilek
8:30 AM - 8:45 AM

Predicting Remotely Sensed Burn Severity using Bayesian Statistical Methods for Pre-fire Hazard Assessment

— Abelino Fernandez Leger, Dan Cadol, and Enrico Zorzetto
8:45 AM - 9:00 AM

Geomorphic Implications of Late Pleistocene Pediment-Terrace Deposits on the Eastern Chuska Mountain Front in the Chaco River Watershed, Navajo Nation and McKinley County, New Mexico

— Kevin M. Hobbs
9:00 AM - 9:15 AM

Lessons Learned from the Desert Soil-Geomorphology Project, Southern New Mexico

— Curtis Monger and John W. Hawley
9:15 AM - 9:30 AM

Reconciling Faulting, Stratigraphy, and Paleoclimate in Low-Slip-Rate Basins: Climatic Modulation of Fault-Controlled Hanging-Wall Wedges in the Northwestern Albuquerque Basin, New Mexico

— Sean D. Connell, Daniel J. Koning, and Andrew P. Jochems
9:30 AM - 9:45 AM

Towards a Return to Stewardship: Lessons Learned from Watersheds and Communities Under Stress in the Eastern Navajo Nation

— Lani Tsinnajinnie
9:45 AM - 10:00 AM

Economic and Environmental Geology:

Galena Room: *8:30 AM - 10:00 AM*
Chair: Nels Iverson

HYDROTHERMAL CALCITE-FLUID REE PARTITIONING EXPERIMENTS AT 200 °C AND SATURATED WATER VAPOR PRESSURE

— Willa Obringer and Alexander Gysi
8:30 AM - 8:45 AM

GEOLOGICAL EVOLUTION AND MINERAL DEPOSITS OF THE EUREKA AND SYLVANITE DISTRICTS IN THE LITTLE HATCHET MOUNTAINS

— Sarah Ann Moses, Virginia McLemore, Nels Iverson, and Nicole Hurtig
8:45 AM - 9:00 AM

URANIUM IN-SITU RECOVERY (ISR) IN NEW MEXICO

— Benjamin Russ
9:00 AM - 9:15 AM

GEOCHEMICAL ASSESSMENT OF CRITICAL MINERALS IN MINE WASTES IN CENTRAL AND SOUTHERN NEW MEXICO

— Sebastian Nipah, Virginia McLemore, and Richard Kelley
9:15 AM - 9:30 AM

GEOCHEMICAL CHARACTERIZATION OF CRITICAL MINERALS IN MINE WASTE IN THE CARLSBAD POTASH DISTRICT, AND AT THE QUESTA MINE, NEW MEXICO

— Lawrence Sarpong, Virginia T. McLemore, and Richard Kelley
9:30 AM - 9:45 AM

WILDFIRES & MINING LEGACY: INTERFACIAL REACTIONS AFFECTING METAL MOBILITY

— Eresay Alcantar-Velasquez, Lawrence Rael, Kahleya Chapmen, Katelin Fisher, Sakshi Patil, Eliane El Hayek, Angelica Benavidez, Abdul-Mehd Ali, Michael N. Spilde, Angélica Sáenz-Trevizo, Adrian Brearley, José M. Cerrato, and Johanna M. Blake
9:45 AM - 10:00 AM

Morning break featuring drinks, snacks, and conversation

Macey Upstairs Lobby: *10:00 AM - 10:30 AM*

Keynote Address:

Auditorium: *10:30 AM - 11:15 AM*
Chair: Steve Wells

KEYNOTE ADDRESS: POST-FIRE HYDROLOGIC IMPACTS AND LESSONS LEARNED FROM THE HERMIT'S PEAK/CALF CANYON FIRE, SAN MIGUEL, MORA AND TAOS COUNTIES, NEW MEXICO

— Jay Lazarus, Jim Riesterer, Paul Drakos, and Dane Goble
10:30 AM - 11:15 AM

NMGS Business Meeting and Awards Ceremony
Auditorium: *11:15 AM - 11:45 AM*

Presentation of NMBGMR Earth Science Achievement Award to Dave Love
Auditorium: *11:45 AM - 12:00 PM*

Student-Professional Mixer Luncheon (ticket required)
Deju House: *12:00 PM - 1:30 PM*

Lunch Break
Socorro restaurants or New Mexico Tech cafeteria: *12:00 PM - 1:30 PM*

Hydrogeology:

Auditorium: *1:30 PM - 3:15 PM*
Chair: Rachel Coyte

WATERSHED ASPECT AS THE DOMINANT CONTROL ON WATER BUDGETS: RESULTS FROM AN ELEVEN-YEAR PAIRED BASIN STUDY
— Amy C. Lewis and Dan C. Cadol
1:30 PM - 1:45 PM

THREE YEARS OF WATER QUALITY DATA AFTER THE 2022 HERMITS PEAK/CALF CANYON FIRE; AMOUNTS, TRENDS, AND IMPACTS
— Jennifer Lindline, Kiara Takacs, Daniel Chadborn, and Marine Foucher
1:45 PM - 2:00 PM

WATER SALINITY AND TRACE ELEMENT COMPOSITION IN THE BOSQUE DEL APACHE
— Antonio Chavez and Rachel Coyte
2:00 PM - 2:15 PM

QUANTIFYING SURFACE AND GROUNDWATER INTERACTIONS IN THE SAN ACACIA REACH, NEW MEXICO
— Racha Berjaoui and Rachel M. Coyte
2:15 PM - 2:30 PM

HYDROGEOLOGICAL CONTROLS ON REDOX PARAMETERS IN ARID SHALLOW ALLUVIAL SYSTEMS
— Alexander Nelson Forsyth and Rachel Coyte
2:30 PM - 2:45 PM

RESISTIVITY-TO-LITHOLOGY RELATIONSHIPS DERIVED FROM AIRBORNE ELECTROMAGNETIC SURVEYS AND WELL LOGS IN NEW MEXICO
— Amy Jordan, Sean D. Connell, Seogi Kang, Noah Dewar, Stacy Timmons, and Laila Sturgis
2:45 PM - 3:00 PM

HYDROGEOPHYSICAL IMAGING OF AQUIFERS: BUILDING A STATEWIDE HYDROGEOLOGIC FRAMEWORK FOR NEW MEXICO
— Sean D. Connell, Amy Jordan, Peter Guerra, Ahsan Jamil, Seogi Kang, Noah Dewar, Stacy Timmons, and Laila Sturgis
3:00 PM - 3:15 PM

Tectonics, Stratigraphy, and Paleontology:

Galena Room: *1:30 PM - 2:45 PM*
Chair: Shari Kelley

HE:N_2 RATIOS OF GASES AND WHAT THEY CAN TELL US ABOUT BASEMENT GENERATING CAPACITY OF HELIUM: CLUES FROM NEW MEXICO

— Ronald F. Broadhead
1:30 PM - 1:45 PM

THE LATE PALEOZOIC PEÑASCO UPLIFT, NORTHERN NEW MEXICO

— Spencer G. Lucas and Karl Krainer
1:45 PM - 2:00 PM

ICHNOFOSSIL ASSEMBLAGE OF THE CAMBRO-ORDOVICIAN BLISS FORMATION, CABALLO MOUNTAINS, SOUTHERN NEW MEXICO: GREATER ICHNOIVERSITY THAN PREVIOUSLY RECOGNIZED

— Paul T. May, Spencer G. Lucas, and Anton Becker-Stumpf
2:00 PM - 2:15 PM

THE UTILITY OF TRACK WIDTH IN DINOSAUR TRACKWAY STUDIES

— John B. Rogers and Spencer G. Lucas
2:15 PM - 2:30 PM

RIO GRANDE TERRACE STRATIGRAPHY AND AGES NEAR TRUTH OR CONSEQUENCES, NEW MEXICO

— Daniel J. Koning, Brad D. Sion, Richard P. Lozinsky, Kathleen Rodriguez, Andrew P. Jochems, and Nelia Dunbar
2:30 PM - 2:45 PM

Posters, afternoon snacks, cash bar with one free drink ticket
Macey Upstairs Lobby: *3:15 PM - 5:00 PM*

Poster Session:

Macey Upstairs Lobby: *3:15 PM - 5:00 PM*
Chair: Nelia Dunbar

QUANTIFYING ARROYO-DERIVED SEDIMENT INPUTS TO THE MIDDLE RIO GRANDE

— Isabella Oviedo and Marisa Repasch
Booth: *1*

USING DETAILED FLASH-FLOOD SEDIMENT TRANSPORT DATA TO VALIDATE HYDRAULIC MODELS

— Tiffany Spence and Daniel Cadol
Booth: *2*

HOW BEAVER OCCUPATION INFLUENCED BURN SEVERITY, HABITAT RESILIENCE, AND LANDSCAPE RECOVERY FROM THE HERMITS PEAK CALF CANYON FIRE

— Colman Lee, Jennifer Lindline, and Marine Foucher
Booth: *3*

IMPROVED BEDROCK MAPPING AND ANALYSIS OF FAULT GEOMETRY IN THE SAN YSIDRO QUADRANGLE, NM

— Eli Roy Froning, Cameron Chavez Reed, Marisa Repasch, and Karl Karlstrom
Booth: *4*

ORIGIN AND CLIMATE IMPLICATIONS OF SEDIMENTARY CHERT IN WESTERN PANGEA: MIDDLE PENNSYLVANIAN GRAY MESA FORMATION, PLACITAS, NEW MEXICO

— Blaine Cecil, Spencer G. Lucas, Jeffrey M. Rahl, James E. Barrick, and William A. DiMichele
Booth: *5*

INVESTIGATION OF THE POSSIBLE CRETACEOUS STRATA EXPOSED ALONG THE WESTERN BOUNDARY FAULT ZONE, FRANKLIN MOUNTAINS, EL PASO, TX

— Yazmin Acuna, Daniela Jimenez, Victoria Olvera, Jay Chapman, Lily Jackson, and Richard Langford
Booth: *6*

SYNTECTONIC DEPOSITION, PROVENANCE, AND GEOCHRONOLOGY OF THE AMERICAN FLAG FORMATION, ORACLE, ARIZONA: CONSTRAINTS ON LATE CRETACEOUS–PALEOGENE DEFORMATION

— Alejandra Flores Aguilera, James B. Chapman, Lily J. Jackson, and Paulina Alverado
Booth: *7*

NEW PETROLOGIC DATA ON THE TOOTH OF TIME LANDARK, CIMARRON RANGE, NEW MEXICO; INSIGHTS INTO ITS ORIGIN AND EMPLACEMENT

— Isaiah Archuleta, Jennifer Lindline, Marine Foucher, and Thomas Albers
Booth: *8*

THE PEMADA CANYON DIKE, AN EXTENSION OF PREVIOUSLY IDENTIFIED VOLCANIC FIELDS WITHIN THE COLORADO PLATEAU OR A UNIQUE, STANDALONE MAGMATIC EVENT?

— Matthew Avery Ponce, Kevin M. Hobbs, Laura Waters, and Julia Ricci
Booth: *9*

NEW PROBE, WHO DIS?

— Nels Iverson
Booth: *10*

CRITICAL MINERALS POTENTIAL OF LEACHING MINE WASTES IN EUREKA, HILLSBORO, MCGHEE PEAK AND STEEPLE ROCK DISTRICTS IN NEW MEXICO, USA

— Rebecca A. Boakye, Virginia T. McLemore, Nicole Hurtig, and Bonnie Frey
Booth: *11*

MINERAL CHEMISTRY, ARCHITECTURE, AND FLUID EVOLUTION OF THE VICTORIO W–MO–BE–F MAGMATIC–HYDROTHERMAL SYSTEM

— Jakob Newcomer and William Chavez
Booth: *12*

GEOLOGIC EVOLUTION AND MINERALIZATION OF DISTAL MINERAL DEPOSITS: A COMPARATIVE STUDY OF LUNA AND SIERRA COUNTY, SOUTHWESTERN NEW MEXICO

— Samantha Beauchaine, Nels Iverson, Nicole Hurtig, and Virginia McLemore
Booth: *13*

MICROBIAL COMMUNITIES IN LEGACY MINE WASTE IN NEW MEXICO

— Melina C. Karavousanos, Mackenzie B. Best, Daniel S. Jones, and Virginia T. McLemore
Booth: *14*

IS NEW MEXICAN GYPSUM AN ANALOG FOR MARTIAN SULFATES? INSIGHTS FROM GEOCHEMICAL, MINERALOGICAL, AND DEPOSITIONAL SIGNATURES

— Luc E. Carbonneau and Daniel S. Jones

Booth: *15*

A PLAY FAIRWAY TECHNO-ECONOMIC ANALYSIS OF ENHANCED GEOTHERMAL SYSTEMS (EGS) RESOURCES POTENTIAL IN THE SOUTHERN ALBUQUERQUE BASIN UNDER PRIVATE SURFACE AND MINERALS OWNERSHIP STATUS

— James C. Witcher

Booth: *16*

GROUNDWATER DISCHARGE BEHAVIOR AT GOVERNMENT SPRING, CENTRAL NEW MEXICO

— Matthew Kaspar, Benjamin Tobin, and Margaret Furtner

Booth: *17*

MICROPLASTICS OCCURRENCE AND DISTRIBUTION IN FRESHWATER SYSTEMS OF AN ARID REGION: A CASE STUDY FROM THE FORT STANTON CAVE AREA, NEW MEXICO

— Angela Bosco Mensah and Ranalda Tsosie

Booth: *18*

LOOKING TO THE PAST TO PREPARE FOR THE FUTURE: A SPATIOTEMPORAL LAND USE ANALYSIS OF THE IRRIGABLE ACREAGE OF LA ACEQUIA DEL FINADO FRANCISCO MARTINEZ DEL LLANO QUEMADO IN TAOS COUNTY, NEW MEXICO

— Kamren S. Moore, Jennifer Lindline, Marine Foucher, and Michael Petronis

Booth: *19*

PRELIMINARY DATA ON FLOW AND SEEPAGE FOR ASSESSING SURFACE WATER–GROUNDWATER EXCHANGE IN THE LOW FLOW CONVEYANCE CHANNEL, MIDDLE RIO GRANDE

— Tin Trung Nguyen and Dan Cadol

Booth: *20*

HYPER-RESOLUTION HYDROLOGIC MODELING OF MOUNTAIN TERRAIN IN NEW MEXICO USING HYDROBLOCKS-NOAH-MP

— Bernard Nkrumah Attobrah and Enrico Zorzetto

Booth: *21*

UPPER CRETACEOUS SELACHIANS AND TELEOST FROM THE SEMILLA SANDSTONE MEMBER OF THE CARLILE SHALE, SOUTHEASTERN SAN JUAN BASIN, NEW MEXICO

— Randy J. Pence, Luke Toll, and Spencer G. Lucas

Booth: *22*

LATE CRETACEOUS (CENOMANIAN-CAMPANIAN) AMMONITES AND INOCERAMIDS FROM THE HAGAN BASIN, SANDOVAL COUNTY, NEW MEXICO

— Paul L. Sealey and Spencer G. Lucas

Booth: *23*

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Abstracts

INVESTIGATION OF THE POSSIBLE CRETACEOUS STRATA EXPOSED ALONG THE WESTERN BOUNDARY FAULT ZONE, FRANKLIN MOUNTAINS, EL PASO, TX

Yazmin Acuna[1], Daniela Jimenez[1], Victoria Olvera[1], Jay Chapman[1], Lily Jackson[1] and Richard Langford[1]

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https://doi.org/10.56577/SM-2026.3158 *(pending)*

The Western Boundary Fault Zone (WBFZ) is a complex structure that bounds the west side of the Franklin Mountains in El Paso, Texas. The nature and type of faults in the WFBZ are unresolved. Some researchers have suggested the fault zone contains both normal and reverse faults related to Rio Grande rifting and the Laramide orogeny. Part of the difficulty in resolving the type of faulting present is the uncertainty surrounding the age of rocks on the western side of the fault zone. Proterozoic to early Paleozoic rocks are exposed in the Franklin Mountains on the eastern side of the WBFZ; however, rocks on the western side are only locally exposed in a series of small, disconnected outcrops. In this study, we collected samples from these small outcrops and used field observations, fossil assemblages, sandstone petrography, and detrital zircon U-Pb geochronology to determine the age and formation name of the units. Geologic mapping and field observations suggest that the WBFZ consists mainly of small normal faults, and diagnostic fossils suggest the outcrops on the western side of the fault zone may be Cretaceous in age. Some lithologies observed in the WBFZ include the Anapra sandstone, yellow micritic limestone, and dark shale. However, our focus was on collecting the Anapra sandstone for U-Pb geochronologic dating. Ongoing work focuses on comparing sandstone units in the WBFZ to similar sandstone units in the Cristo Rey area, including the mid-Cretaceous Anapra Formation. We are testing whether the composition of sandstones and the spectra of zircon ages between the two exposures are comparable. The results of this study will help resolve the geology of the WBFZ and provide tectonic insights into how the region was affected by contractional and extensional deformation.

Keywords:

Laramide orogeny, detrital zircon geochronology, tectonic deformation

WILDFIRES & MINING LEGACY: INTERFACIAL REACTIONS AFFECTING METAL MOBILITY

Eresay Alcantar-Velasquez[1], Lawrence Rael, Kahleya Chapman, Katelin Fisher[4], Sakshi Patil[5], Eliane El Hayek, Angelica Benavidez[7], Abdul-Mehd Ali, Michael N. Spilde, Angélica Sáenz-Trevizo, Adrian Brearley, José M. Cerrato[12] and Johanna M. Blake

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[4]Center for Water and the Environment, Gerald May Department of Civil, Construction, and Environmental Engineering, University of New Mexico, Albuquerque, New Mexico, USA,
[5]Department of Pharmaceutical Sciences, University of New Mexico, Albuquerque, New Mexico, USA
[7]Center for Micro Engineering Materials, University of New Mexico, Albuquerque, New Mexico, USA
[12]Gerald May Department of Civil, Construction, and Environmental Engineering, University of New Mexico, Albuquerque, New Mexico, USA
https://doi.org/10.56577/SM-2026.3159 *(pending)*

We identified water-labile interfacial reactions between laboratory-burned pinewood ash and mine waste solids that influence metal mobilization. The Upper Gallinas Creek Watershed in New Mexico is affected by wildfires and mining legacy. Pinewood and mine waste sediments were sampled from the area, and the pinewood was burned at 350°C to simulate medium burn intensity ignition. The desorption and dissolution of Fe, Mn, Li, Pb, and Cu was detected by ICP-MS as pH decreased over time. After reacting 18 MΩ ultra-pure water with a mixture of pinewood ash and mine waste sediments,Fe (143%) and Mn (89.2%) concentrations increased over time. Spectroscopy revealed the presence of iron oxyhydroxides in the mine waste sediment and carbonates in the ash, which influence metal mobility in ash-sediment interactions. These findings provide relevant insights about metal release from areas affected by wildfires and mining to inform watershed management.

Keywords:

wildfire, mining, metal mobility, iron, manganese

NEW PETROLOGIC DATA ON THE TOOTH OF TIME LANDMARK, CIMARRON RANGE, NEW MEXICO; INSIGHTS INTO ITS ORIGIN AND EMPLACEMENT

Isaiah Archuleta[1], Jennifer Lindline[1], Marine Foucher[1] and Thomas Albers[2]

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[2]Chemistry Department, New Mexico Highlands University, P.O. Box 9000, Las Vegas, NM, 87701
https://doi.org/10.56577/SM-2026.3171 *(pending)*

The Tooth of Time is a notable geological feature in the Cimmaron Range, a subrange of the Sangre de Cristo Mountains of New Mexico. It is a prominent topographic landmark of the Santa Fe Trail and an iconic attribute of the Philmont Scout Ranch. The Tooth of Time is a trachydacitic sill that is part of a series of stacked laccolithic bodies that constitute the Paleogene Cimmaron pluton (numerical age unknown). We conducted petrographic, single crystal x-ray diffractometry, and rock magnetic analyses to gain insight into the Tooth of Time's origin and emplacement. Petrographic analysis shows major (30%) plagioclase and quartz (7%) phenocrysts (1.5-3.0 mm diameter) and hornblende (4%) and biotite (4%) subphenocyrsts (0.5-1.5 mm diameter) in a quartz-rich aphanitic groundmass. Minor minerals include 0.10 mm-diameter equant Fe-Ti oxides disseminated throughout the samples, along with accessory euhedral titanite crystals. Plagioclase and quartz occur as single phenocrysts or glomerocrysts, suggesting fractionation of and accumulation within the parent magma. Quartz phenocrysts range from subhedral polygonal-shaped crystals indicative of formation in the presence of melt to round, scalloped, and highly embayed forms indicative of late-stage magmatic absorption. Alteration is absent in the upper sheet but incipient to pervasive in the lower sheet characterized by sericitized plagioclase and recrystallized hornblende and biotite defined hematite and chlorite overprinting at crystal edges and in cleavage planes. Single crystal x-ray diffractometry analyses of 8 feldspar crystal separates from the lower (4) and upper (4) portions of the Tooth of Time sheet confirm plagioclase of the oligoclase variety (30% Ca-composition). The modeled crystal structure shows a high degree of uniformity among the samples and a high degree of disorder within the samples consistent with rapid cooling and shallow emplacement. Thermomagnetic experiments show that ferromagnetic minerals dominate the inner sheet samples, mostly magnetite with a minor contribution of a Fe-Ti mineral with a Curie temperature around 257 °C, most likely a titanomaghemite. The magnetic hysteresis curves and First-Order-Reversal-Curve (FORC) measurements indicate the presence of coarse-grained multidomain magnetite and a minor amount of smaller-grained minerals. The rock magnetic results from the outer sheet samples are dominated by paramagnetic minerals with a very small amount of fine-grained, high coercivity minerals such as hematite. Rock magnetic results indicate that alteration in the outer sheet significantly affected the magnetic mineralogy, which supports the incipient alteration observed in its thin section. 40Ar/39Ar age dating, in collaboration with the New Mexico Bureau of Geology and Mineral Resources, is pending. We submit, based on rock composition and igneous structure, that the Tooth of Time sheet and its parent Cimmaron Pluton were emplaced during compression related to the waning stages of the Laramide orogeny prior to Rio Grande rift extension and mafic volcanism that dominate the eastern Great Plains.

HYPER-RESOLUTION HYDROLOGIC MODELING OF MOUNTAIN TERRAIN IN NEW MEXICO USING HYDROBLOCKS-NOAH-MP

Bernard Nkrumah Attobrah[1] and Enrico Zorzetto[1]

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Mountainous regions in New Mexico and southern Colorado are vital sources of water for communities, agriculture, and ecosystems throughout the Southwestern United States. In these regions, high-elevation snowpack provides the majority of annual streamflow and groundwater recharge. However, existing land surface and hydrological models used in large-scale analysis often use grid cells that are too coarse (1-10 km) to capture the land heterogeneity over mountainous terrain, which controls snowmelt, soil moisture, and runoff. Accurately predicting water availability in these regions requires a physically realistic representation of the surface energy balance because radiation (shortwave and longwave) govern snow accumulation, melt timing, soil-moisture dynamics, and evapotranspiration. However, most land-surface and hydrologic models still rely on plane-parallel (1-D) radiation schemes that assume flat, uniformly illuminated terrain. These assumptions break down in complex mountain environments, where slope, aspect, terrain shading, sky-view factors, and terrain reflections strongly modify surface energy inputs. This study aims to improve how these mountain processes are represented in hydrologic models by integrating a land surface model (Noah-MP) with a spatial clustering algorithm (Hydroblocks) to study the land water and energy budget over mountainous terrain at a fine detail (< 100m, "hyper-resolution"), showing how terrain slope, aspect, and elevation affect water storage and flow. The project applies the HydroBlocks-Noah-MP model to mountain watersheds across northern New Mexico and the upper Rio Grande headwaters in southern Colorado for the period 2014-2024. The land domain in each model grid cell will be grouped into clusters, or "hydrologic response units" that share similar terrain, soil, and vegetation properties, capturing the spatial distribution of temperature and solar radiation over complex terrain. To better represent how sunlight and shading influence snowpack and soil temperature over mountainous watersheds, the study incorporates a recently developed scheme describing radiation over mountainous terrain. Model results will be compared with satellite observations from NASA's Soil Moisture Active Passive satellite (SMAP) mission and Moderate Resolution Imaging Spectroradiometer (MODIS) snow cover to assess model accuracy and performance in representing snow and soil moisture. The expected products of this research include high-resolution maps of soil moisture and snowpack, as well as analyses showing how terrain features control water availability across the region.

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GEOLOGIC EVOLUTION AND MINERALIZATION OF DISTAL MINERAL DEPOSITS: A COMPARATIVE STUDY OF LUNA AND SIERRA COUNTY, SOUTHWESTERN NEW MEXICO

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Southwestern New Mexico lies within a complex metallogenic province that records multiple episodes of magmatism and mineralization related to both Laramide age Cu-porphyry systems and younger Paleogene Mo-W deposits. This project examines the geologic evolution and mineralization of mineral deposits in the Cookes Peak, Old Hadley, and Macho districts of Luna and Sierra counties to determine whether their carbonate-replacement and volcanic-epithermal systems formed during a single magmatic-hydrothermal event or reflect multiple and or different mineralizing episodes. These districts are particularly important because they host Pb-Zn-Ag replacement bodies and epithermal veins that may represent the distal expressions of porphyry-related magmatism of the Cookes Peak pluton. In addition to Pb, Zn, and Ag, these mining districts are potential sources of critical minerals including Mo, W, REE, Te, and V.

The study focuses on the Eocene to Miocene magmatism at ca. 40–20 Ma which marks inceptions of extension and formation of additional smaller porphyry and epithermal systems. Existing mapping and limited geochronology suggest a possible relationship among the Cookes Peak, Old Hadley, and Macho districts, but the timing and genetic links among these systems remain poorly constrained. The Cookes Peak granodiorite has a reported K-Ar biotite age of 38.8 ± 1.4 Ma (Loring & Loring, 1980) and the Fluorite Ridge granodiorite has a reported 40Ar/ 9Ar hornblende date of 38.82 ± 0.57 Ma (McLemore, 2001). However, the Old Hadley and many other intrusive units lack direct and modern geochronologic data. Mineralization at Macho has been attributed to middle-Cenozoic magmatism based on field relations rather than radiometric constraints. To address this uncertainty, this study integrates field observations, petrography, mineralogical and geochemical characterization, and 40Ar/39Ar geochronology to better constrain the timing and relationships of magmatism and mineralization.

New emplacement ages of the Cookes Peak granodiorite are similar to previous dating attempts. A biotite sample from the summit granodiorite block produced an age of 40.1 ± 0.1 Ma, and a hornblende age from below the summit produced an age of 38.66 ± 0.21 Ma. A biotite age for the extrusive Rubio Peak Formation from the Northern part of the Cooke's peak districts shows an age of 38.95 ± 0.07 Ma.

Age dating and whole rock geochemistry from the Cookes Peak, Old Hadley, and Macho districts will be used to unravel mineralizing episodes and tectonomagmatic evolution of these magmatic-hydrothermal systems. By comparing intrusion ages, hydrothermal alteration, and mineral formation across the three districts, this research will clarify the role of post-Laramide magmatism in concentrating critical minerals and improve genetic models for carbonate-replacement and epithermal deposits in this underexplored region of southwestern New Mexico.

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Keywords:

Copper, porphyry, carbonate-replacement deposits, Southwestern New Mexico, epithermal-volcanic, Luna County, Sierra County, geochemistry, geochronology

QUANTIFYING SURFACE AND GROUNDWATER INTERACTIONS IN THE SAN ACACIA REACH, NEW MEXICO

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Effective water management in the Middle Rio Grande Basin requires a clear understanding of surface-groundwater interactions. These processes remain poorly defined in the San Acacia Reach, where water losses affect the state's ability to meet Rio Grande Compact deliveries to Elephant Butte Reservoir. Within this reach, the Low Flow Conveyance Channel (LFCC), an engineered drain built to support compact compliance, strongly influences surface and groundwater exchanges. Because it lies below the riverbed, it acts as a sink, and captures water from shallow alluvium, deep basin groundwater, and Rio Grande/irrigation return flow. However, their relative contributions are unresolved. This study quantifies surface-water and groundwater inputs to the LFCC across contrasting seasonal hydrologic conditions.

Five drainage and environmental tracer surveys were conducted along the LFCC and Rio Grande during the 2025 irrigation and monsoon cycle (February – December). Water samples were analyzed for major ions, trace metals, and stable isotopes of water (δ18O, δD). Groundwater fluxes to the LFCC were estimated using differential gauging and 222-Rn measurements. A preliminary multi-tracer Bayesian mixing model was developed to resolve the contributions of surface water, shallow alluvium, and deep basin groundwater.

Seasonal chloride and stable-isotope patterns reflect strong irrigation and snowmelt controls on the hydrologic system. δ18O values are depleted during pre-irrigation (February) and become progressively enriched by mid-monsoon and mid-irrigation (July and September), indicating a transition from snowmelt-dominated river inputs to increased contributions from irrigation-influenced shallow groundwater and return flow. At most LFCC sites, chloride concentrations were moderate in February (pre-irrigation) and decreased slightly in May (early irrigation) with the introduction of canal water, which consists of low-salinity surface water diverted from the river. Then, concentrations increased in July and September (mid-monsoon and mid-irrigation). In December (post-irrigation), chloride concentrations returned to their pre-irrigation levels. Sulfate showed a comparable seasonal pattern. This trend suggests an early-dilution signal followed by a shift toward greater influence of saline shallow groundwater, as cumulative recharge elevates the water table and enhances seepage to the LFCC, leading to higher salinity later in the irrigation season. Summer monsoon rainfall can temporarily dilute surface water but sustain elevated groundwater levels.

Major ion chemistry provides constraints on groundwater sources affecting the LFCC. The waters are mixed, but bicarbonate is the dominant anion, and the percentage of sulfate is greater than the percentage of chloride. Pre-, early-, and post-irrigation samples exhibit similar water chemistry, whereas peak and late irrigation seasons are marked by sulfate enrichment associated with irrigation return flow and reflect gypsum dissolution from monsoon runoff east of the Rio Grande. In the upper reach, calcium is the dominant cation, consistent with recharge from the Magdalena Mountains, while the lower reach waters are sodium dominated, reflecting ion exchange within the clays of the principal aquifer system and contributions from deeper basin

groundwater. These results show that LFCC water chemistry responds to seasonal changes in irrigation return flow, monsoon recharge, and basin-scale groundwater.

CRITICAL MINERALS POTENTIAL OF LEACHING MINE WASTES IN EUREKA, HILLSBORO, MCGHEE PEAK AND STEEPLE ROCK DISTRICTS IN NEW MEXICO, USA

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The growing demand for critical minerals and rare earth elements creates concerns for national security as these minerals are essential for many products needed to sustain our way of life and their supply chain susceptible to disruptions. This has resulted in exploring secondary sources such as mine waste and tailings for critical minerals. These mine wastes also pose environmental challenges. Weathering and oxidation of sulfide minerals dissolve and mobilize metals into the environment. This study aims to examine the distribution and mobility of critical minerals by leaching mine wastes with deionized water, using humidity cells following ASTM D5744 -18 method. The areas under study are known for their historic mining activities leaving behind significant amounts of mine waste and tailings. Mine wastes in Eureka, Hillsboro, McGhee Peak and Steeple Rock districts of Southwestern New Mexico contain significant concentrations of critical minerals since they were historically mined for base and precious metals and not critical minerals. Study areas include porphyry copper, skarn, epithermal gold and carbonate replacement deposits. The methods used in this research include, sample collection and preparation, mineralogical analysis using x-ray diffraction (XRD), Raman spectroscopy, petrographic analysis, column test, paste pH and Fizz test. Geochemical analysis includes specific conductance, pH and alkalinity test, sulfate measurements, Ion chromatography (IC), inductively coupled plasma mass spectroscopy (ICP-MS) and optical emission spectroscopy (ICP-OES) was conducted to determine the metal concentration in the leachate samples. Whole-rock geochemistry and XRD analysis indicates elevated levels of Cu, Zn, As, Pb, and Ag in these mine wastes from four mining districts in New Mexico compared to average crustal abundance. Concentrations of Cu from whole rock geochemistry data show 3944 ppm, 2387 ppm in Steeple Rock samples and 546 ppm, 576.5 ppm from Hillsboro samples. Concentrations of As and Zn range from 1470 ppm to 2490 ppm and 8530 ppm to 10300 ppm respectively in Eureka samples. McGhee Peak shows enrichment of Pb and Zn (2880 ppm, 12600 ppm) and (7880 ppm ,14700 ppm) respectively. Key findings show that mine waste are enriched in LREE and metal mobility is controlled by acid-generating or acid-neutralization potential of the area.

HE:N_2 RATIOS OF GASES AND WHAT THEY CAN TELL US ABOUT BASEMENT GENERATING CAPACITY OF HELIUM: CLUES FROM NEW MEXICO

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Helium (He) and Nitrogen (N_2) gases occur together in reservoirs but have different sources. He occurs as two isotopes, ^{3}He and ^{4}He. ^{3}He is primordial and is derived from the mantle. In gases in crustal reservoirs ^{4}He is dominant and is derived primarily from alpha decay of ^{238}U, ^{235}U and ^{232}Th. ^{4}He is generated primarily in granitic basement rocks. The ^{4}He utilizes deep-seated faults and fracture systems to migrate into crustal reservoirs. N_2 in crustal gases is derived from the mantle and also from sedimentary sources including maturation of sedimentary kerogens, maturation of coals, and from several processes in red-bed sequences. Mantle derived N_2 is introduced into the crust through plutonic magmatic activity and volcanism and utilizes the same migration pathways as helium to migrate into crustal reservoirs. It is possible to differentiate between Mantle-derived N_2 can be distinguished from sedimentary N_2 by cross plotting He vs N_2 contents of gases.

The ^{4}He sources can be directly assessed via the drilling of deep wells through thousands of feet of basement with U and Th concentrations measured either through analysis of continuous core or drill cuttings or with spectral gamma-ray logs. However, such deep wells are extremely rare and are prohibitively expensive to drill for He exploration. The work summarized in this talk investigates if the generative capability of the basement may be indirectly assessed through analysis of He and N_2 contents of gases. Concentrations of mantle-derived N_2 increase linearly with He concentrations. The ratio of He to mantle N_2 varies across New Mexico and can be determined by plotting He vs N_2 contents of reservoir gases. The He:mantle N_2ratio is determined by the slope of a best-fit linear regression line Areas with higher He:N_2 ratios indicate greater contents of He relative to mantle-derived N_2.

He:N_2 ratios and He contents of natural gases vary across New Mexico. In the commercially produced Abo (Lower Permian) gases in central Chaves County in the northwestern part of the Permian Basin, the slope of the He:N_2 plot is 0.076 and the average helium content of the Abo gases is 0.486%. In southeastern Chaves County Lower Pennsylvanian gases have an He:N_2 ratio of 0.034; average helium content of these gases is 0.036%. Siluro-Ordovician gases in this area have an He:N_2 ratio of 0.039 and an average He content of 0.037%. Further to the east in Lea County, the He:N_2 ratio is 0.014 in Lower Permian gases, 0.018 in Lower Pennsylvanian gases, and 0.039 in Siluro-Ordovician gases; average helium contents are 0.026% (Lower Permian), 0.027% (Lower Pennsylvanian), and 0.108% (Siluro-Ordovician). In northwestern New Mexico on the Four Corners Platform where He has been commercially produced since the 1940's, the He:N_2 ratio is 0.083 in Pennsylvanian reservoirs and 0.072 in Mississippian reservoirs; average helium contents are 3.23% (Pennsylvanian) and 4.21% (Mississippian).

He: mantle N_2 ratios vary substantially from area to area. The variation is considerably less among different stratigraphic intervals within a given area. Furthermore, higher He concentrations in the gases coincide with higher He:N_2 ratios. The larger He:N_2 ratios may be the result of enhanced He migration upward through

basement fractures and therefore increased generating capacity of helium in the basement. Alternatively, the higher He:N_2 ratios may be the result of subdued migration of N_2 from the mantle. That the larger ratios result from enhanced helium generating capacity in the basement is suggested by the substantially larger helium concentrations in the gases with larger He:N_2 ratios. This concept may aid in the indirect assessment of helium source rocks in helium gas systems.

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A Seismic-Hydraulic Approach to Monitoring Bedload Flux

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Bedload transport is notoriously difficult to monitor. Devices used to capture bedload can alter hydraulics or may quickly fill to capacity, while the high intensity flows that most effectively transport bedload can be dangerous and rare. Equations that rely on measurements of excess shear to predict bedload, such as the Meyer-Peter and Müller equation, typically give reasonable results, but may be orders of magnitude off from simultaneous direct bedload flux measurements. Broad grain size distributions, turbulent variability, local supply limitation, and rarified particle transport all contribute to the challenges.

Fluvial seismology provides a potential solution, by monitoring ground vibrations caused by bedload impacts. The direct relation between the process and the physical measurement gives a new, independent metric to include in analyses. We present here a methodology that leverages a moderate number of direct bedload flux measurements to train an empirical equation that predicts bedload flux using seismic power spectral density (PSD) and bed shear estimated from flow depth. Using this method, long-term bedload monitoring can be conducted with simply a bankside seismometer and a water level pressure transducer.

We provide a proof-of-concept example from the Arroyo de los Pinos, an ephemeral tributary of the Rio Grande in New Mexico. At our site, bedload is monitored with automatic Reid-type slot samplers, stage is measured with vented pressure transducers, and seismic data are collected with inexpensive stand-alone seismic nodes. The poorly-sorted and unarmored bed of this ephemeral channel produces very high bedload flux rates during flow events, with measured fluxes up to 16 kg m^-1 s^-1. The conditions of this test site make some aspects of the development of a bedload equation more challenging (e.g., wide range of interacting particle sizes, rapid changes in water stage), while other aspects become trivial (e.g., no armor, no supply limitation). At our site, the trained hydraulic-seismic equation performs better than classic hydraulic equations alone. Yet method testing in contrasting fluvial environments is necessary to determine if other factors that contribute to the failure of hydraulic bedload equations (e.g., armoring and grain packing) can also be overcome.

Keywords:

fluvial geomorphology, sediment transport, environmental seismology

IS NEW MEXICAN GYPSUM AN ANALOG FOR MARTIAN SULFATES? INSIGHTS FROM GEOCHEMICAL, MINERALOGICAL, AND DEPOSITIONAL SIGNATURES

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The Quebradas area, near Socorro, New Mexico, contains Paleozoic evaporite deposits, including massive gypsum in the Yeso and Atrasado Formations, which are accessible and abundant, providing a potential setting to study minerals that could serve as depositional analogs for sulfates found on Mars. In September of 2023, teams from NASA's Goddard Space Flight Center (GSFC) and Johnson Space Center sampled gypsum from the Yeso Formation, which was then analyzed for bulk mineralogy and organic preservation during an internship at GSFC over the summer of 2024. While small amounts of carbon were detected in some samples, it was not definitively clear whether this carbon was from an organic or mineral source (Carbonneau et al., 2025). We suspect that carbon found in Quebradas gypsum is likely from mineral sources rather than preserved organics, but that organic carbon would be found in higher abundance in associated clays. If this hypothesis is correct, sulfates may not be suitable targets for assessing organic preservation on Mars, but additional information is needed about the nature and occurrence of carbon in these and other analog sediments. Here, we further these efforts by constraining the mineralogy and depositional environments of sulfate minerals in the Quebradas by additional sampling from the Yeso and Atrasado Formations, as well as more recent lacustrine deposits from the central Rio Grande rift. Bulk mineralogy was determined by powder X-ray diffraction (pXRD) and thin section petrography, and depositional environment was constrained by stable sulfur isotope analysis. pXRD analyses of Quebradas samples found minor calcite, while similar analyses of Rio Grande rift samples found no carbon-containing minerals. Calcite was not observed in thin section. This result indicates that the carbon content of Quebradas samples collected in 2023 by teams from NASA may be influenced by mineral sources rather than residual organics. δ34S values of the Quebradas sulfates range from -3.5 to +17.6‰, while δ34S values of the younger rift sulfates range from +3.8 to +6.5‰, showing values overall consistent with an evaporitic depositional environment, although with some variability that could be due to differences in specific depositional or diagenetic conditions. This additional information will help contextualize the samples as they are analyzed for organics. Although it seems likely that the bulk sulfates have very little, if any, preserved organics, ongoing analyses will continue to explore other sulfate-associated minerals and evaluate spatial associations among geochemical, mineralogical, and depositional signatures in the older and younger sulfates.

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ORIGIN AND CLIMATE IMPLICATIONS OF SEDIMENTARY CHERT IN WESTERN PANGEA: MIDDLE PENNSYLVANIAN GRAY MESA FORMATION, PLACITAS, NEW MEXICO

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Although the source of silica for sedimentary chert is often attributed to siliceous organisms such as sponge spicules or diatoms, a postulated alternative silica source is eolian, quartz-rich dust. As noted by Cecil , late Paleozoic sedimentary chert is almost always associated with strata deposited under arid paleoclimates and almost always contains detrital quartz silt and sand suspended in a chert matrix. The detrital quartz grains (£ 20 mm) generally contain evidence of the dissolution (corrosion) of a disordered crystalline lattice induced by eolian abrasion.

Across much of New Mexico, the Gray Mesa Formation is a distinctive interval of ledge- and cliff-forming marine limestone, usually 100-200 m thick, in the middle of the Pennsylvanian succession. Most of the limestones of the Gray Mesa Formation are lime mudstones and fossiliferous wackestones and packstones that are characteristic of marine shelf environments. At many outcrops, the Gray Mesa Formation can be divided into three members (ascending): Elephant Butte Member, chert-rich Whiskey Canyon Member and Garcia Member.

We sampled limestones of the Whiskey Canyon Member at the Crest of Montezuma (also called Montezuma Ridge or Mountain) just northeast of the village of Placitas in southeastern Sandoval County, New Mexico. Fusulinids and conodonts from the strata we sampled indicate an early Desmoinesian age. All samples contained abundant chert, both massively bedded and nodular. The chert and limestone display abundant angular detrital quartz (£ 20 mm) and fine sand grains with corroded surfaces interpreted to have formed by the corrosion of a disordered crystalline lattice caused by eolian abrasion. The original angular quartz grains thus show morphological characteristics of eolian dust deposited in a marine environment. Microcrystalline quartz (chert) was re-precipitated following dissolution of all or part of the detrital quartz grains. Consequently, dissolution of the eolo-marine dust provided the source of silica for the enclosed chert. Homogenous detrital zircon U-Pb ages in the limestone suggest a local source of siliciclastic input, whereas a broad distribution of ages in the chert beds implies an expanded source region, consistent with sediment transport by wind. Therefore, we propose that chert in the Gray Mesa Formation in central New Mexico was derived from the dissolution of eolian dust. The presence of large amounts of eolo-marine dust in the Gray Mesa limestones indicates that the climatic changes accompanying the Atokan-Desmoinesian transition in central Pangea, indicated by changes in wetland floras and geological features, were widespread across the tropical region that stretched across central and western Pangea.

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WATER SALINITY AND TRACE ELEMENT COMPOSITION IN THE BOSQUE DEL APACHE

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The Bosque del Apache Wildlife Refuge in San Antonio, New Mexico, faces increasing challenges due to water scarcity and water-quality concerns, affecting both wildlife and supplemental grain farming. Yet, critical knowledge gaps related to water quality hinder the full addressing of these problems from a management perspective. This project examines concentrations of major and trace elements, as well as nutrient levels, in both surface and groundwater, and assesses how these relate to agricultural practices and wildlife needs.

To understand temporal water quality variations, which can better inform resource management, conductivity data loggers, which track changes in water salinity, were installed where the low flow conveyance channel (LFCC) diverts water into the refuge and also where water is delivered back to the LFCC from the refuge to provide high-resolution insights into seasonal salinity fluctuations. There are seasonal saline increases in the south as the refuge cleans soil units from the previous roosting year in the spring or prepares them for the upcoming winter months for roosting birds in the fall. The northern site shows a more consistent salinity throughout the seasons and is less saline than the southern boundary. In addition to the loggers, water samples were collected from the LFCC, moist soil units, and groundwater wells on the refuge at different times of the year to better understand the major and trace elements, including toxic elements that can affect wildlife, and the composition of the various water sources on the refuge. There are clear seasonal trends in the LFCC during the summer, such as higher arsenic concentrations in the south. The interior ditch shows clear trends influenced by the most soil units in the middle of the Refuge. Ultimately, this research aims to strengthen the long-term sustainability of the Bosque del Apache Wildlife Refuge.

Keywords:

LFCC, Trace Elements, Refuge, BDA

HYDROGEOPHYSICAL IMAGING OF AQUIFERS: BUILDING A STATEWIDE HYDROGEOLOGIC FRAMEWORK FOR NEW MEXICO

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Effective groundwater management in geologically complex basins requires accurate characterization of aquifer geometry, heterogeneity, and structural controls on groundwater occurrence and flow. In 2025, the New Mexico Bureau of Geology and Mineral Resources initiated a multi-year statewide aquifer characterization program focusing initially on using airborne electromagnetic (AEM) methods to improve basin-scale identification and delineation of fresh- and brackish-water aquifers. During the first year, six regional helicopter-borne time-domain AEM surveys were completed across groundwater basins in southern and central New Mexico in collaboration with state, local, and consulting-industry partners. AEM surveys produce resistivity models that can be used to interpret lithologic variability, detect faults, delineate basin geometry, and assess groundwater salinity variations to depths of up to a few hundred meters below land surface. Geologic mapping and hydrogeologic analyses provide essential context for interpreting resistivity patterns to improve aquifer characterization. Complementary subsurface datasets, including well summaries, borehole geophysics, groundwater-level data, and hydrogeochemical information are being systematically compiled to calibrate geophysical interpretations to aquifer properties. To further refine AEM interpretations, automated workflows have been developed to standardize an archive of ~170,000 historical driller's logs. Additional tools are being developed to visualize and analyze AEM results, enabling more rapid and consistent evaluation of resistivity data. This program aims to establish a statewide, scalable 3D geological framework that integrates geophysics with hydrogeology, significantly enhancing assessments of fresh-water aquifers, optimizing monitoring-well network designs, and supporting the exploration of brackish groundwater to benefit water resource management across New Mexico.

Keywords:

Geophysics, Groundwater, Electromagnetic, Alluvial basins

RECONCILING FAULTING, STRATIGRAPHY, AND PALEOCLIMATE IN LOW-SLIP-RATE BASINS: CLIMATIC MODULATION OF FAULT-CONTROLLED HANGING-WALL WEDGES IN THE NORTHWESTERN ALBUQUERQUE BASIN, NEW MEXICO

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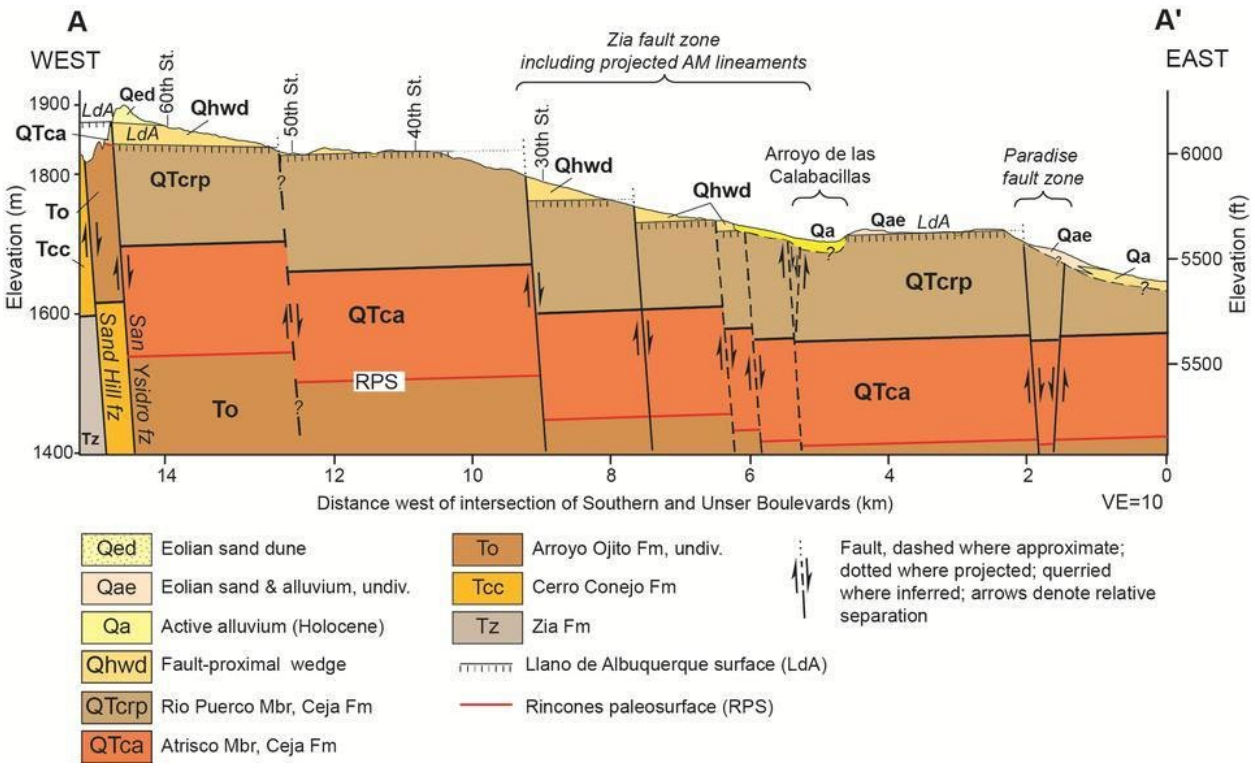
Faulting plays an important role in shaping the landscape and influencing the distribution, preservation, and post-depositional modification of syntectonic strata in the Albuquerque Basin, New Mexico. The Sand Hill and San Ysidro fault zones influenced sedimentation at two different scales. At the fault-block scale, normal faulting controlled the thickness, distribution, and preservation of synrift Santa Fe Group strata. At smaller scales, fault activity generated relatively narrow fault-proximal sedimentary wedges that record localized accommodation above the early Pleistocene Llano de Albuquerque geomorphic surface. These two scales of fault–stratigraphic interaction provide insights into Pleistocene landscape evolution and highlight challenges of reconstructing paleoseismic records in extensional basins experiencing low rates of deformation.

Along the Ceja del Rio Puerco, regional fault–stratigraphic relationships show strong structural control on the Plio–Pleistocene Ceja Formation. On the footwall of the Sand Hill fault zone, Ceja strata locally incised into Miocene deposits of the Arroyo Ojito and Cerro Conejo Formations, whereas thicker and more complete sections of Santa Fe Group strata are preserved on adjacent hanging walls of the San Ysidro fault zone. Along the proximal hanging wall of the Calabacillas segment of the San Ysidro fault zone, a fault-controlled wedge overlies the Ceja Formation and pinches out basinward within ~3 km of the fault trace.

The most continuously exposed of these fault-controlled wedges occurs along the Calabacillas segment, where a 26-m-thick hanging-wall wedge is exposed for nearly 1 km along fault strike. Detailed mapping and outcrop analysis document at least 18 laterally continuous, paleosol-bounded subunits formed between 1.8–1.3 Ma and before ~130 ka. This section consists predominantly eolian and sheetwash deposits with minor colluvium, all of which thicken toward the formative fault. These strata are interpreted to record repeated alternations between short-lived depositional pulses and prolonged intervals of geomorphic stability. Stacked, laterally continuous paleosols and low long-term net accumulation rates (~14–20 m/My) indicate that deposition was strongly modulated by climatically driven variations in sediment supply and pedogenesis. Low long-term slip rates (10–100 m/My) and long recurrence intervals (10–100 ky) overlap major modes of Pleistocene climatic variability. As a result, climatically driven variations in deposition and soil development may obscure rupture-related stratigraphic signals. The correspondence between paleosol stacking patterns and paleoclimate proxies further supports a strong climatic influence on wedge architecture. Improved geochronologic control coupled with a more comprehensive analysis of fault-controlled sedimentation can be used to improve rupture histories for low-slip-rate faults in semi-arid, eolian-prone basins.



Geologic cross section along the western end of Southern Boulevard, Sandoval County, New Mexico, illustrating the influence of intrabasinal faulting on stratigraphy. The Calabacillas fault wedge is the westernmost occurrence of unit Qhwd on this cross section.

PREDICTING REMOTELY SENSED BURN SEVERITY USING BAYESIAN STATISTICAL METHODS FOR PRE-FIRE HAZARD ASSESSMENT

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In recent years, fires in western US have increased in size and severity. The impact of wildfires on vegetation recovery, ecosystem services, erosion, and debris flow generation can depend on the severity of the burn. Post-fire debris flows threaten lives, infrastructure, and property at the Wildland Urban Interface, and their likelihood depends critically on the severity of the burn. Current hazard models rely on the differenced normalized burn ratio (dNBR) to characterize burn severity, yet pre-fire estimates of dNBR remain limited in their ability to capture landscape-scale uncertainty. We present a Bayesian statistical model that estimates the Weibull probability distribution of dNBR across 126 vegetation types that have burned throughout the Intermountain West over the last 13 years. We analyze forested and non-forested vegetation regimes that frequently experience fire to reveal patterns across physiognomy. Unlike deterministic approaches, our model explicitly incorporates uncertainty in burn severity predictions. Distribution parameters for each vegetation type are conditioned on vegetation density, annual climatic aridity, and topographic predictors selected through systematic model comparison. We find that the topographic controls on dNBR are vegetation-type dependent: aspect-derived solar radiation indices are the dominant topographic predictor for forested and grassland vegetation types, while the standard deviation of landscape elevation (a proxy for slope and ruggedness) is a powerful predictor over numerous vegetation types. Our model successfully reproduces the observed statistical distributions of dNBR across fire-prone landscapes of the Intermountain West, offering a probabilistic framework for pre-fire burn severity prediction that can be directly integrated into hazards mitigation planning.

Keywords:

Post-fire Debris Flow, Bayesian Statistics, dNBR, Burn Severity, LandFire, Wildfire

SYNTECTONIC DEPOSITION, PROVENANCE, AND GEOCHRONOLOGY OF THE AMERICAN FLAG FORMATION, ORACLE, ARIZONA: CONSTRAINTS ON LATE CRETACEOUS–PALEOGENE DEFORMATION

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To address questions about the distribution and timing of deformation and basin formation associated with the northern Mexican orogen in the southern United States, we investigated the American Flag Formation exposed near Oracle, Arizona, in the Catalina Mountains. The American Flag Formation has been interpreted as a synorogenic deposit related to Late Cretaceous to early Paleogene contractional deformation but remains relatively understudied.

We used field observations, measured stratigraphic sections, clast-count analyses, sandstone petrography, and LA-ICPMS zircon U-Pb geochronology to determine depositional environments, sedimentation patterns, depositional age, and sediment provenance. Lithofacies associations, including poorly sorted, matrix-supported conglomerate, interbedded volcaniclastic sandstone, and volcanic rocks, indicate deposition in proximal alluvial fan systems dominated by debris flows and episodic fluvial reworking near an active arc.

A prominent mega-breccia within the succession likely records earthquake-triggered debris flows and associated mass-wasting processes. Rapid vertical facies changes and up-section variations in conglomerate clast composition and detrital zircon U-Pb age populations suggest progressive unroofing of Paleozoic passive-margin rocks and crystalline basement. A rhyolitic tuff at the base yields a crystallization age of 76 Ma, and four volcaniclastic sandstones and one interbedded lithic tuff have maximum depositional ages of 73–71 Ma, constraining sedimentation.

We interpret the American Flag Formation as a syntectonic deposit formed in response to uplift, extension, and volcanism, which controlled sediment production, transport, and accumulation. In a regional context, these results suggest deformation becomes younger to the east, reflecting progressive growth of the orogen toward the interior of North America during Late Cretaceous to Paleogene time.

Keywords:

Syntectonic deposition, Alluvial fan systems, and Detrital zircon geochronology

HYDROGEOLOGICAL CONTROLS ON REDOX PARAMETERS IN ARID SHALLOW ALLUVIAL SYSTEMS

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Fluctuating redox conditions in alluvial aquifers exert fundamental control over contaminant and nutrient cycling, particularly in systems characterized by rapid stage fluctuations and seasonal recharge. Along the Rio Grande, shallow alluvial sediments experience repeated wetting–drying cycles driven by monsoonal recharge and intervening dry periods. These oscillations likely drive coupled carbon oxidation–reduction reactions that regulate iron and manganese phase transformations and, consequently, trace element mobility. However, the spatial distribution of redox fronts and the mechanisms governing element partitioning across the zone of intermittent saturation remain poorly constrained. This research investigates redox-sensitive element cycling in several sediment cores collected from alluvial deposits adjacent to the Rio Grande (New Mexico). We utilized micro- to bulk – scale geochemical approaches to quantify the hydrogeologic controls on trace element mobility. Electron probe microanalysis (EPMA) will be used to generate high-resolution elemental maps and identify microscale associations among Fe, S, Mn, and trace metals. X-ray diffraction (XRD) will constrain iron oxide, manganese, and carbonate mineral phases. A modified sequential extraction protocol will quantify operationally defined redox fractions and estimate sedimentary redox capacity.

We hypothesize that episodic saturation during monsoon recharge promotes reductive dissolution of Fe^{3+} and Mn oxides, releasing associated trace elements to porewaters, particularly uranium and arsenic, whereas subsequent oxic conditions favour re-precipitation and secondary mineral formation. The magnitude and rate of water level change are expected to control the extent of mineral transformation and trace element redistribution. Because the Rio Grande and its underlying aquifers supply drinking and irrigation water to regional communities, characterizing redox-driven element mobilization has direct implications for contaminant transport and groundwater vulnerability. By linking hydrologic variability to mineralogical transformations and trace element partitioning, this work aims to clarify how dynamic redox boundaries regulate contaminant and nutrient cycling in intermittently saturated alluvial systems.

Keywords:

Redox, trace metals, Rio Grande, hydrology

IMPROVED BEDROCK MAPPING AND ANALYSIS OF FAULT GEOMETRY IN THE SAN YSIDRO QUADRANGLE, NM

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Under a newly funded EDMAP Data Synthesis Project, we are working to produce a 1:24,000-scale digital geologic map of the San Ysidro Quadrangle in north-central New Mexico. This quadrangle is at the geologic *nexus* between the Colorado Plateau, Southern Rocky Mountains, and Rio Grande rift. Recent focus on this area during the New Mexico Geological Society 2024 Fall Field Conference highlights its new research and mapping importance. This project will synthesize 1930-1980s legacy mapping with new mapping, neotectonics, geochronology, and tectonic geomorphology studies. The mapping project is complementary with ongoing mapping of the New Mexico STATEMAP program and the USGS Earthquake Hazards Program. This project represents the first integrated surficial and bedrock mapping at this scale for the iconic San Ysidro area since the 1976 Woodward and Reutschilling map.

The mapping effort aims to answer questions about the extent and magnitude of Quaternary fault reactivation of Laramide and rift structures leading to a new understanding of fault segmentation on the margins of the Colorado Plateau and Rio Grande rift. We employ studies of river incision rates across proposed faults, as recorded by terrace flights with timing constrained by new detrital sanidine and luminescence (IRSL) geochronology to estimate differential rates across major structures. The mapping uses recently updated stratigraphic nomenclature for Paleozoic and Mesozoic strata and advances in Proterozoic geochronology to update bedrock geology of the quad. 1m lidar and aerial digital mapping enhance map accuracy and rectify multiple generations of mapping within the area. Outreach involves renewed UNM/NMBGMR interaction with the Pueblos of Jemez and Zia whose ancestral lands are within this and adjoining quadrangles. Geo-cultural engagement is guided by the understanding of this area as an interwoven cultural and geologic nexus and complimentary with place-based education efforts at UNM. This map synthesis fills a timely gap at the *nexus* of the margins of the San Juan basin, Rio Grande rift, and Southern Rocky Mountains amid a new generation of research to understand the margins of the Colorado Plateau and rift.

Keywords:

Geologic Mapping, Bedrock, Fault, Nexus

GEOMORPHIC IMPLICATIONS OF LATE PLEISTOCENE PEDIMENT-TERRACE DEPOSITS ON THE EASTERN CHUSKA MOUNTAIN FRONT IN THE CHACO RIVER WATERSHED, NAVAJO NATION AND MCKINLEY COUNTY, NEW MEXICO

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The San Juan River is a 616 km-long tributary to the Colorado River in Colorado, New Mexico, Arizona, and Utah, USA. Its incision history is complex, owing in part to baselevel fall at its confluence with the Colorado River at Glen Canyon, rapid uplift of its headwaters in the San Juan Mountains, and broad but variable epeirogenic uplift through its central section across the core of the Colorado Plateau. Recent studies have added data-rich constraints on incision rates along the main stem of the San Juan River and its largest tributary by discharge, the Animas River; both of which are heavily influenced by high elevation (>4 km) headwaters in the San Juan Mountains that underwent multiple Quaternary glaciations. The more areally extensive San Juan River-left tributaries draining the central Colorado Plateau, including Cañon Largo, the Chaco River, and Chinle Creek, which together comprise approximately 50% of the total drainage area of the San Juan River, have received far less study on their uplift or incision histories. Recent geologic mapping in the upper Chaco River drainage on the Navajo Nation allowed close inspection of complex geomorphic surfaces on the Chuska Mountain front. These surfaces suggest punctuated and repeating episodes of pedimentation, alluvial aggradation, and bedrock incision leading to a flight of pediment-terraces on the Chuska Mountains' eastern front. Here I present new ages acquired from optically stimulated luminescence (OSL) dating of alluvial sediment capping two of these pediment-terraces. A pediment-terrace whose strath is 48 to 52 m higher than local baselevel yielded OSL ages of 52.32 +/- 5.12 ka and 50.88 +/- 5.82 ka. A lower pediment-terrace whose strath is 10 m above local baselevel yielded an OSL age of 37.56 +/- 3.62 ka. Bedrock incision rates derived from the older surface equal 1051 m/My and 983 m/My. The younger surface yields a bedrock incision rate of 266 m/My. Previously published long-term bedrock incision rates across the southern Rocky Mountains Colorado Plateau through the Quaternary average from 50 to 160 m/My, but rates of ~255 m/My have been reported in the Animas River near Durango—attributed to uplift of the San Juan Mountains relative to the Colorado Plateau—and in the San Juan River near its mouth—attributed to rapid baselevel fall due to Colorado River incision. The high incision rates reported from the older surface here (~1010 m/My) are much greater than any reported in regional river systems and almost certainly do not reflect long-term bedrock incision rates but rather record rapid adjustment of a headwater system to local geomorphic and/or climatic changes. If the OSL ages reported here are accurate, then they perhaps should lead to a more careful consideration of widely-reported long-term bedrock incision rates elsewhere with regard to the inherent episodicity of landscape development. The mapping and ages reported here highlight the need for more and better basin-wide investigation of river incision histories in order better to understand the complex relationships among climate, tectonics, sedimentation, and erosion in the San Juan basin—a need first pointed out by Kirk Bryan in his 1954 *The Geology of Chaco Canyon, New Mexico*.

NEW PROBE, WHO DIS?

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The acquisition of a new JEOL iHP200F electron probe microanalyzer (EPMA) at New Mexico Tech represents a significant advancement in analytical capabilities for geoscience and materials research. Funded through a Major Research Instrumentation award from the National Science Foundation, the instrument has replaced the aging Cameca SX100 microprobe, enabling higher precision, faster analytical throughput, and expanded research applications. The newly installed EPMA features a state-of-the-art system with backscatter electron (BSE) and secondary electron (SE) detectors, five wavelength-dispersive spectrometers (WDS), an energy-dispersive spectrometer (EDS), and panchromatic cathodoluminescence (CL).

EPMA is an essential tool for micro-scale imaging and chemical analysis of any solid, natural, or synthetic material with elemental compositions from B to U. The new system has the flexibility to increase analytical throughput when needed, utilizing the 5 WDS spectrometers for minor and trace element analysis and the EDS for the major cation determination (e.g., Si and Al). Coupling this new configuration with Mean Atomic Number (MAN) background measurements, we have effectively cut analytical time in half (from 4+ minutes to <120 seconds for major rock-forming minerals). The WDS crystal configuration was specifically chosen to enhance trace-element detection. WDS spectrometers can be “stacked” (analyzing the same element on multiple spectrometers simultaneously) to increase counting statistics with the capability to analyze trace elements down to 10’s of ppm. This improvement is particularly important for critical mineral research and the characterization of rare-earth-element-bearing minerals, which are increasingly important for modern technologies.

Probe for EPMA is 3rd-party software purchased with the new microprobe to help with our data collection and reduction. This high-powered software is widely used in most EPMA labs worldwide. It can produce high-resolution, background-corrected element-composition maps. Essentially, turning each pixel of the map into a standardized geochemical determination, allowing for high-resolution mineral composition and chemical zonation maps to be produced overnight.

In the past, nearly 60% of all users of the NMT microprobe have been student researchers from NMT, other NM universities, or adjacent states, providing invaluable training and exposure to microbeam analysis. The new state-of-the-art microprobe will play a vital role in education and workforce development at NMT. It will continue to support student training through hands-on courses and research projects, helping to prepare the next generation of scientists in analytical techniques and instrumentation.

RESISTIVITY-TO-LITHOLOGY RELATIONSHIPS DERIVED FROM AIRBORNE ELECTROMAGNETIC SURVEYS AND WELL LOGS IN NEW MEXICO

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Airborne electromagnetic (AEM) surveys provide subsurface resistivity imaging over large areas at relatively low cost compared to similarly scaled ground based geophysical or geological surveying, making them attractive tools for mapping groundwater basins in New Mexico. To utilize AEM surveys for hydrogeologic purposes, a scalable transform is needed to convert resistivity-depth models into lithologic and hydrogeologic interpretations. To construct this transform, we developed a quantitative resistivity–lithology calibration workflow that integrates AEM data-derived resistivity with co-located lithology information from a large database of legacy driller's logs from the New Mexico Office of the State Engineer Water Rights Reporting System. Preliminary results from southwestern New Mexico, specifically in Hidalgo, Grant, and Luna County, show promising correlations between resistivity data and lithologic characteristics.

Legacy borehole logs (PDFs) from thousands of wells were compiled and processed using optical character recognition coupled with artificial-intelligence text-extraction and classification workflows. Lithologic descriptions were standardized into eleven classes. Across southwestern New Mexico, this workflow produced >20,000 classified lithologic intervals from 3,442 wells. Due to the impact of saturation on resistivity, separate transforms were developed for unsaturated and saturated conditions. Estimation of the water table in the region was done using two methods: (1) inverse-distance-weighted interpolation of trend-adjusted measured water levels; and (2) a constrained gradient-search method applied to AEM resistivity profiles guided by known water-level control points (Dewar and Knight, 2020). These surfaces were used to partition well-log intervals and AEM pixels into unsaturated and saturated populations.

The resistivity-to-lithology transforms were developed by treating lithologic intervals intersecting individual AEM pixels as resistors in parallel, such that pixel-scale bulk resistivity is represented by the thickness-weighted harmonic mean of component facies resistivities (Knight et al, 2018). Co-located well-log intervals and AEM pixels were assembled into systems of harmonic-mean mixing equations, with the resistivities of each distinct lithologic interval as the unknowns, and bootstrap resampling was used to estimate resistivity distributions for each lithologic class. Sensitivity to the definition of spatial co-location was evaluated using maximum well-to-AEM distances ranging from 50 to 1,000 m in 50 m increments (Kang et al., 2025).

Using a 350 m co-location threshold and interpolated water table, 1,565 well–AEM pairs yielded 2,260 mixing equations above the water table in southwestern New Mexico. Bootstrap analysis (n = 1,000) yielded distributions with unsaturated rock as the most resistive of the facies categories (geometric mean = 97 Ωm), whereas clay/fine and shale/fine are the least resistive (16 and 15 Ωm, respectively). Coarse-grained sediment exhibits an intermediate but distinct geometric mean of 30 Ωm. Below the water table, all facies shift to lower resistivity while preserving their relative separation (Figure 1). The geometric mean of distributions of

resistivity for selected lithologic classes include rock (41 Ωm), coarse-grained (18 Ωm), clay/mixed (13 Ωm), and clay/fine and shale/fine (9 Ωm). At the 350-m threshold, distributions for the principal hydrogeologic classes of interest were well separated.

These results highlight the effectiveness of combining legacy well logs with robust AEM calibration to provide a scalable framework for the transformation of AEM resistivity sections into lithologic probability models and provides a foundation for regional groundwater mapping and aquifer characterization across New Mexico.

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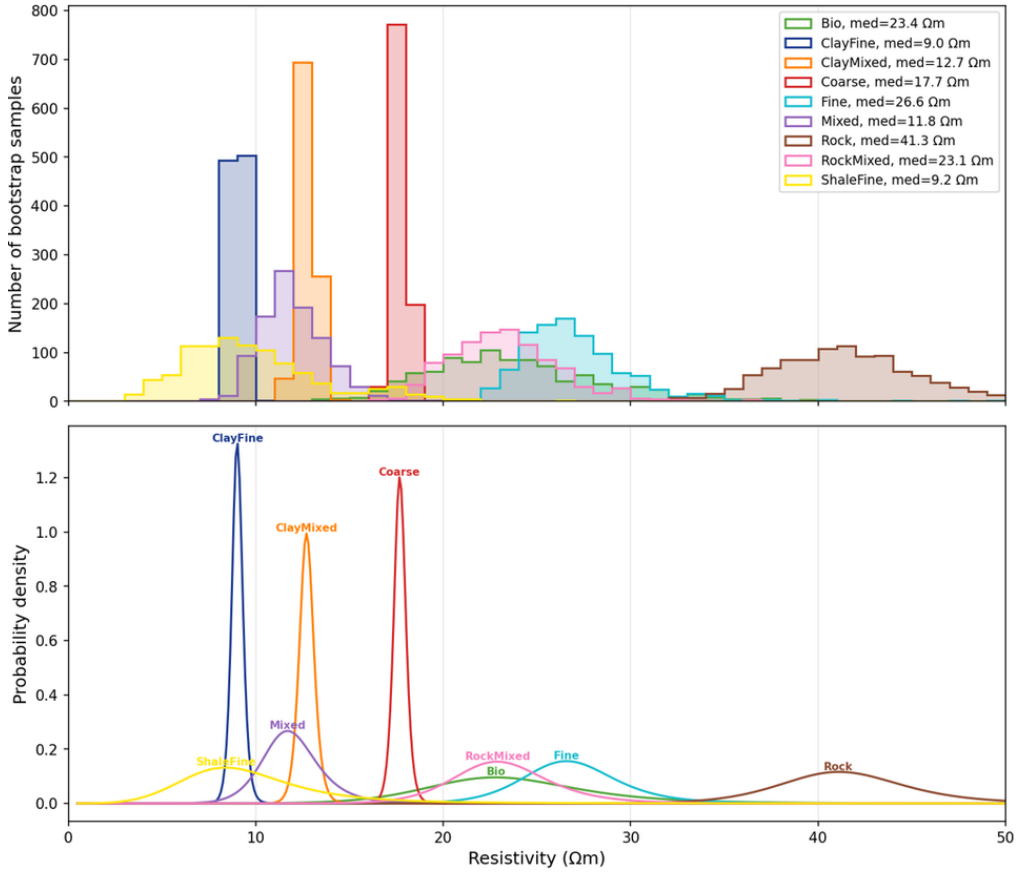

Figure 1. (Top) Bootstrap sampling results for resistivity of lithologic categories below the water table, with a maximum well-to-AEM co-location distance of 350 m. (Bottom) Distributions fit to the bootstrap sampling results.

MICROBIAL COMMUNITIES IN LEGACY MINE WASTE IN NEW MEXICO

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Critical minerals (CMs) are any non-fuel material that has a high risk of supply chain disruption. The United States is currently importing most of the CMs used in the country, which has led them to seek alternative sources. Alternative sources for critical minerals include non-traditional sources such as pre-existing mine wastes. New Mexico has a rich mining history with many historic deposits of waste rock and tailings, many of which may contain residual critical minerals that were left behind after the material was processed. For this project, we are using culture-independent methods to investigate the microbial communities that have developed since these wastes were emplaced, with the goal of characterizing waste-associated communities and exploring how microbes might be interacting with the residual minerals in the deposits. Previous evaluation of microbial communities in historic waste from five mines in three different mining districts in New Mexico showed that microbial communities vary based on waste type and geochemistry; however, the high proportion of unclassified microorganisms limited any inferences about microbial biogeochemistry (Best et al., 2025). Therefore, in this work, we are expanding our investigations to five new locations throughout New Mexico to represent more diverse regions and waste types, including tailings and waste rock from carbonate-hosted deposits. Our methods include a combination of cell counts, rRNA gene and transcript sequencing, whole rock geochemistry, and metagenomics to expand on the previous work by Best et al. (2025), and explore the genomic potential of novel populations in these wastes. rRNA gene libraries from the new deposits show that they contain diverse Actinobacteriota, Alpha-, and Gammaproteobacteria, as well as archaeal populations such as unclassified Nitrososphaeraceae and "Candidatus Nitrososphaera." Low coverage metagenomic libraries contain genes for carbon fixation, but there is little evidence for inorganic sulfur or iron oxidation. However, we recently obtained deeper metagenomic datasets, which may reveal more about the dominant microbial populations and the metabolic potential of the communities overall. We will present results from these new rRNA gene and metagenomic libraries and discuss the implications for the biogeochemistry of legacy mine waste and possible microbial approaches to critical mineral recovery.

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GROUNDWATER DISCHARGE BEHAVIOR AT GOVERNMENT SPRING, CENTRAL NEW MEXICO

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Government Springs is the complex perennial source of the lower Rio Bonito in central New Mexico with numerous ephemeral sources and a complex surface water – groundwater interface. Discharge from this karst spring is critical in maintaining downstream agricultural activities and communities.

We established 12 repeatable measurement sites for discharge, temperature, pH, specific conductivity, and turbidity. Data collected at a monthly interval provides a snapshot of surface water – groundwater interactions in the system. Results from this indicate that the spring is fed by two distinct sources: a more variable flow component with relatively high pH, low conductivity and temperature and another with more constant flow, more neutral pH, and higher temperature and conductivity. These two sources emerge in two distinct channels and combine partway through the spring run. These data suggest that the more stable discharge source is likely driven by discharge from the karst aquifer while the more variable source may be shallow flow through an overlying alluvial aquifer fed by the upstream ephemeral sections of Rio Bonito. Once these two upstream sources merge, there are surface water – groundwater interactions that vary in magnitude and direction, depending on flow conditions. While there are consistent losing and gaining reaches, there are a few reaches where these changes are dependent on flow level. Overall, during lower flow conditions, there is increased flow from upstream to downstream as more water emerges from the alluvium, with a 701% increase measured during lowest flow. During higher flow, the system shows a decrease of up to -26% indicating recharge to the shallow aquifer. For reaches that show increased flow in Rio Bonito, end-member mixing analysis, using specific conductance, suggests that this is likely a result of additional alluvial storage discharging to the river, rather than an additional karst source. These results suggest Government springs is an outlet for multiple groundwater systems, however there is likely only one primary outlet of the karst system. Additional flow is more likely driven by the overlying alluvial system with substantial surface water-groundwater interactions.

Keywords:

Hydrology, Karst, Surface water groundwater interactions

RIO GRANDE TERRACE STRATIGRAPHY AND AGES NEAR TRUTH OR CONSEQUENCES, NEW MEXICO

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Numerous Quaternary terrace levels of the Rio Grande are present at Truth or Consequences (TorC), New Mexico. The terraces are inset below the prominent Cuchillo geomorphic surface, which represents the culmination of Santa Fe Group aggradation ca. 800 ka. These terraces can also be correlated to terrace suites in tributary drainages of the nearby western Palomas Basin that include Cuchillo Creek, an ESE flowing drainage that enters the Rio Grande ~2.5 km north of downtown TorC. Building on the pioneering work of Lozinsky (1986), we map these terraces, refine their stratigraphic relations, and use eight IRSL samples and an electron microprobe analysis to determine their absolute ages. The combined dataset provides a "Rosetta stone" for correlating and mapping terraces across the larger Palomas Basin and southern Rio Grande rift. Terrace deposits are composed of sand and gravel unless otherwise noted. Tread heights are measured relative to the top of the modern Rio Grande floodplain (which lies 2–4 m above the modern channel).

The lower suite of terraces is notably gravelly, with cobbles being common. The youngest deposit in the study area (Qtr5) is relatively thin (~3 m thick) and has a tread height of 8–14 m, increasing upstream. It returned an IRSL age of 38.17 ± 3.87 ka. The deposit of the next older terrace (Qtr4b) is up to 20 m thick, and its strath height ranges from modern grade (lower than Qtr5's strath) to 4–5 m. Qtr4b has a 22–26 m tread height and returned two IRSL ages: 78.65 ± 6.89 and 74.08 ± 6.16 ka. Qtr4a has a 25–34 m tread height and a 19–20 m strath height. It returned an IRSL age of 124.31 ± 13.12 ka. An arroyo fill sourced from Mescal Canyon, inset into Qtr4b and sharing the same tread height, returned an age of 71.97 ± 7.68 ka. When compared to the marine oxygen-isotope stages, we find that aggradation of Qtr4a and 4b may have occurred during warmer, drier intervals of the MIS 5 interglacial (MIS5a and MIS5e–early 5e).

The higher suite is notable in that the terraces appear to correlate to broad surfaces in the western Palomas Basin. Qtr3 has a 42–48 m tread height, 2–3 levels of cobbly basal gravels (2–4 m thick) whose respective heights differ by 3–4 meters, and 10–11 m of silty to sandy fill overlying the basal gravel(s). At one locality, two levels of basal gravels are capped by the same thick fill. A sample from the upper, sandy part of the Qtr3 fill yielded an IRSL age of 217.42 ± 13.12 ka. The two higher terraces are each 1–4 m thick, composed of pebble-rich gravel, and have tread heights of 49–52 m (Qtr2) and 58–61 m (Qtr1). Terrace deposits inferred to correlate to Qtr2 exhibit two exposures of interbedded ash; this ash is geochemically similar to the 630 ka Lava Creek B ash. In Cuchillo Creek, the Lava Creek B terrace level lies ~55 m below the Cuchillo surface and 46 m above the floor of the valley.

Comparing strath and tread heights between these dated terrace sets illustrates how dynamic, wide swings in base level can complicate terrace mapping and correlation. We also use our mapping and dating to calculate

incision rates over 10^5 k.y. scales. These rates were high between 800 and 630 ka (0.25–0.28 m/ka), much lower between 630 and 220 ka (0.05 m/ka), and moderately high again (0.1–0.2 m/ka) between 220 ka and present. The lower rates at 630–220 ka promoted pedimentation and mid-level benches observed in cross profiles in Cuchillo Creek. Based on our mapping west of the Rio Grande, similar benches are inferred to also represent low incision rates at 630-220 ka and can potentially be used as a correlation tool.

Keywords:

Terraces, Rio Grande, Truth or Consequences, TorC, Rio Cuchillo

KEYNOTE ADDRESS: POST-FIRE HYDROLOGIC IMPACTS AND LESSONS LEARNED FROM THE HERMIT'S PEAK/CALF CANYON FIRE, SAN MIGUEL, MORA AND TAOS COUNTIES, NEW MEXICO

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The Hermit's Peak/Calf Canyon fire burned approximately 342,000 acres in San Miguel, Mora, and Taos Counties in northern New Mexico from April 6 through August 22, 2022. The fire started out as a US Forest Service controlled burn that quickly became uncontrolled. This uncontrolled burn resulted in the largest fire in New Mexico history, displaced hundreds of residents and livestock, and severely burned the Rio Gallinas watershed, the source of the City of Las Vegas, NM's drinking water supply. Hydrologic effects include increased frequency of flashy runoff, increased sediment and ash flowing into the Rio Gallinas, and debris flows derived from ungauged tributaries. The increased ash and sediment load results in unpredictable periodic turbidity spikes that prohibit the City's water treatment plant from diverting and treating water until turbidity in the river returns to treatable levels. Flash floods from intense localized storm cells over burned areas made the City's primary storage reservoir unusable for several months in the summers of 2022 and 2024. Reservoir sedimentation associated with these flash flood events has reduced available storage in the reservoir by approximately 8%. The loss of forest canopy has resulted in earlier snowmelt and runoff and increased sedimentation during monsoonal rains. Hydrologic effects are anticipated to last years.

How Beaver Occupation Influenced Burn Severity, Habitat Resilience, and Landscape Recovery from the Hermits Peak Calf Canyon Fire

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High severity wildfires are becoming increasingly common in western forests. Burned areas are prone to increased soil erosion, stream flooding, and water quality impairment. Proactive management strategies are necessary for watershed protection and recovery from forest fire. The > 341,000-acre 2022 Hermits Peak/Calf Canyon (HP/CC) fire severely affected multiple watersheds in northern New Mexico, including major, critical areas like the Upper Pecos, Gallinas, and Tecolote Watersheds, impacting regional water supplies and ecosystem services. Soil burn severity was high across significant portions, creating hydrophobic soils that directly led to major post-fire flooding and debris flows in the region.

This study reproduced methods used by Fairfax, et al. (2024) to examine the influence of beaver occupation on burn severity and post-fire sediment loads in the 2022 HP/CC burn scar. Beaver dams were located via satellite imagery throughout the HP/CC burn scar. Beaver dam capacity results calculated by the Beaver Restoration Assessment Tool (BRAT) were downloaded for the Gallinas, Sapello, and Mora watersheds and segmented into bundles (< 2; 2-5; 5-12; and >12 dams/km). Dam capacity is used as a measure of riparian characteristics that would influence fire severity regardless of beaver occupation. A Difference Normalized Burn Ratio (dNBR) was calculated throughout the HP/CC burn area then used to analyze the burn intensity in valley bottoms near dams compared to valley bottoms without dams but within the same dam capacity range. Additionally, turbidity was measured above and below two active and two inactive beaver dam sites on the Rio Pueblo near Sipapu downstream of the HP/CC burn area in Spring 2026.

Analyses showed that for river reaches with the same dam capacity, those with beavers had a statistically significantly lower dNBR than those without beavers ($p < 0.0001$). Analyses also showed that many of the beaver-occupied river valleys did not burn at all. At all sites, turbidity values tended to be lower below dams than above them. This study supports beaver reintroduction or beaver dam mimicry as a low-cost, low-technology, and nature-based fire mitigation and post-fire restoration tool.

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Fairfax, E., Whipple, A., Wheaton, J.M., Osorio, B., Miller, J., Kirksey, K., Perez, N., Gilbert, J.T., and Jordan, C.E., (2024), Impacts of beaver dams on riverscape burn severity during megafires in the Rocky Mountain region, western United States, in Florsheim, J.L., O Dowd, A.P., and Chin, A., eds., Biogeomorphic Responses to Wildfire in Fluvial Ecosystems: Geological Society of America Special Paper 562, p. 131–151, https://doi.org/10.1130/2024.2562(07).

Keywords:

wildfire, beaver, fluvial geomorphology, water quality

WATERSHED ASPECT AS THE DOMINANT CONTROL ON WATER BUDGETS: RESULTS FROM AN ELEVEN-YEAR PAIRED BASIN STUDY

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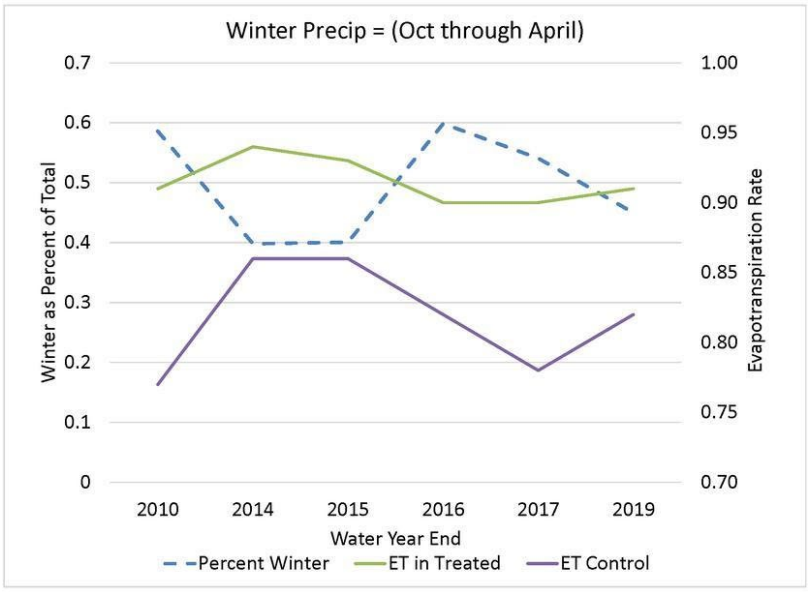
Results of an eleven-year paired basin study in the upper Santa Fe River watershed following forest thinning and prescribed burns successfully measured water budget components in a treated and an untreated basin. The study was established to investigate questions that have arisen regarding changes in water yield from forest treatments such as thinning and prescribed burns. Precipitation, stream flow, soil moisture, and chloride concentrations in precipitation and stream flow were measured to quantify the water budget components. The results from data collection and analysis have a high degree of confidence with respect to measuring the water budget components based on the mass balance of water and chloride. The differences in the geologic structure and topography between the two paired basins appeared to impact the water budgets more than the forest treatments, except during periods when winter precipitation and snowmelt represented a significant component of inflow. Variation in the chloride concentration of precipitation samples indicates that horizontal precipitation of chloride in the tree canopy (i.e., direct interception of cloud or fog moisture, also known as occult precipitation) is an important consideration when using the chloride mass balance.



Comparison of percent of winter precipitation to evapotranspiration (ET) in the treated and control basins.

THREE YEARS OF WATER QUALITY DATA AFTER THE 2022 HERMITS PEAK/CALF CANYON FIRE; AMOUNTS, TRENDS, AND IMPACTS

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Wildfires can have short- and long-term impacts on the health of a watershed. The loss of vegetation, abundance of charred materials, and destabilization of hillsides can increase stream sedimentation and degrade water quality. The 2022 Hermits Peak/Calf Canyon (HP/CC) Fire, the largest wildfire in New Mexico's history (>340,000 acres), impacted the Gallinas Watershed – the source water for the City of Las Vegas's drinking water supply, as well as a designated water resource for high-quality cold-water aquatic life, irrigation, livestock watering, and wildlife habitat (NMAC 20.6.4.215). Approximately 115,542 acres burned in the Gallinas River headwaters with 21% classified as high burn severity. This study assessed the HP/CC's bearing on water quality using data from USGS real time surface water gaging station 08380500 (Gallinas Creek at Montezuma). Amounts and trends in daily average values for dissolved oxygen, pH, specific conductance, temperature, and turbidity were assessed relative to discharge from September 01, 2022-August 31, 2025, to understand the fire's impact on potable supplies and ecosystem services. Dissolved oxygen, pH, and specific conductance remained within the NMAC's water quality standard ranges throughout the post-fire period. Dissolved oxygen ranged between 6.5-12.0 mg/L and stayed above the 6.0 mg/L threshold. Values of pH fluctuated between 7.4-9.0 and persisted above the 6.6 pH minimum. Specific conductance had a high of 309 µS/cm @ 25°C, low of 73 and an average of 221.64. Daily average values exceeded the 300 µS/cm maximum only 3 out of the 598 days of record (<1.0 %). Water temperature reached a high of 26.8°C intermittently during summer months, though daily average temperature values exceeded the NMAC 20°C threshold only 11 of 722 days of record (<2%). Turbidity values ranged from negligible to >3500 NTU. More than 25% of the 712 days of record exceeded 20 NTU, the City of Las Vegas' current water treatment plant limit and more than 50% exceeded the high-quality cold-water tolerance of 10 NTU (NMAC 20.6.4.900). Calculations showed that the average yearly turbidity values decreased from Y1 to Y3 with the yearly averages dropping from 61.80 (SD = 153.85) to 24.84 (SD = 66.45). A one-way ANOVA was performed to examine the differences in average turbidity across the three post-HP/CC years. Results showed that the average yearly data differences were statistically significant across time, F (2, 710) = 5.941, p =.003. We interpret the decreased turbidity averages and narrowed fluctuations in high and low turbidity values as indicating that the negative effects of the wildfire on turbidity are decreasing over time. Turbidity in the City of Las Vegas' current water system persists as a significant water quality issue, at times leading to mandatory boil water advisories and water supply challenges. Monitoring water quality remains imperative to manage fire sedimentation, protect water supplies, and inform adaptation strategies.

Eastward view of the Gallinas River downstream of the City of Las Vegas' drinking water diversion point one year after the 2022 Hermits Peak/Calf Canyon fire.

Keywords:

wildfire, Hermits Peak/Calf Canyon, water quality, turbidity, impairment

THE LATE PALEOZOIC PEÑASCO UPLIFT, NORTHERN NEW MEXICO

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In 1946, Wood and Northrop, in their map of the Sierra Nacimiento-Jemez Mountains-San Pedro Mountains (NJS), identified a late Paleozoic uplift in that area, and it came to be called the Peñasco uplift. This uplift has long been identified as a north-south elongate and east-west narrow (~80 km north-south and ~16 km east-west), basement-cored highland. However, detailed stratigraphic study reveals a series of fault blocks that moved intermittently during the late Paleozoic, not a single Peñasco uplift.

In the NJS, Mississippian marine deposits of the Arroyo Peñasco Formation covered a large area of a peneplained Proterozoic basement. The unconformity between the Arroyo Peñasco Formation and overlying nonmarine Log Springs Formation reflects a tectonic pulse near the Viséan-Namurian boundary that caused moderate local uplift and erosion. The Lower Pennsylvanian (Morrowan) Osha Canyon Formation in the NJS rests unconformably on the Log Springs Formation and documents a marine transgression. Coarse-grained sediments are rare to absent in the Osha Canyon Formation, indicating that a Peñasco uplift was not active during the Morrowan.

A tectonic event close to the Morrowan-Atokan boundary was the local onset of the Ancestral Rocky Mountain (ARM) orogeny, and drove deposition of the Sandia Formation on Morrowan and Mississippian strata, and Proterozoic basement rocks across the NJS. The complex facies and thickness distribution of the Atokan Sandia Formation identifies a source area for coarse siliciclastic sediments to the northwest. In the NJS, small local uplifts existed for a short time and were rapidly eroded and covered with sediments during the Atokan. The overlying early Desmoinesian Gray Mesa Formation is a thin but widespread limestone and mudstone unit that indicates the NJS was covered by a shallow sea during a period of little tectonic activity: the Peñasco uplift was not active during the early Desmoinesian.

The overlying late Desmoinesian-Virgilian Guadalupe Box Formation has high amounts of coarse-grained siliciclastic sediments and varies laterally in facies and thickness. The sudden onset of coarse-grained sediment derived from granitoid Proterozoic basement rocks marked a second tectonic pulse of the ARM. Locally, the Guadalupe Box Formation rests on Proterozoic basement (small local uplifts), and facies and thickness variation indicate strong tectonic activity. A third ARM tectonic event near the Virgilian-Wolfcampian boundary drove a change in deposition from mixed marine-nonmarine sediments of the Guadalupe Box Formation to nonmarine redbeds of the Abo Formation. Locally, in the NJS, the Abo Formation rests on Proterozoic basement rocks deposited across small uplifts (Jack Rabbit Flats, Camp Zia area).

Thus, a single Peñasco uplift in the NJS that was active during the entire Pennsylvanian did not exist; only local small uplifts existed for relatively short time intervals during three tectonic phases (Morrowan-Atokan, late Desmoinesian and Virgilian-Wolfcampian). These uplifts provided only small amounts of siliciclastic sediments and were rapidly eroded and buried. The main sources for siliciclastic sediments in the NJS were to

the north: the San Luis uplift during the Morrowan-early Desmoinesian and the southern Uncompahgre uplift during the late Desmoinesian-Wolfcampian.

ICHNOFOSSIL ASSEMBLAGE OF THE CAMBRO-ORDOVICIAN BLISS FORMATION, CABALLO MOUNTAINS, SOUTHERN NEW MEXICO: GREATER ICHNOIVERSITY THAN PREVIOUSLY RECOGNIZED

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The Bliss Formation of southern New Mexico and Trans-Pecos Texas is the oldest Phanerozoic stratigraphic unit in southern New Mexico. It represents shallow marine, siliciclastic deposition during the Sauk transgression. While the formation is generally regarded as fossil-poor, recent fieldwork in "Cable Canyon," Caballo Mountains, Sierra County, New Mexico, has yielded a significantly more diverse ichnofossil assemblage than previously reported, particularly from the lower Mud Mountain Member at the Sierrite Mine locality (Lucas and Krainer, 2018; Lucas et al., 2023). We document ichnotaxa from this unit and assess their behavioral and paleoenvironmental significance.

Field observation and surface collection of fallen slabs of wavy bedded fine grain sandstone and photographs of in-place outcrop specimens revealed multiple tiers of ichnoguilds within the lower member, as well as a slab from near the stratigraphic level where minute trilobites are reported that indicates the presence of much larger burrowers. The ichnoassemblage includes tubular grazing and burrowing traces: *Palaeophycus* (Hall); *Helminthopsis* (Heer); *Phycodes* (Richter), and *Arenicolites* (Salter); branching traces: *Chondrites* (von Sternberg) and *Thalassinoides* (Ehrenberg), consistent with previously reported fauna from the upper Cantrell Tank Member (Lucas and Krainer, 2018; Lucas et al., 2023). More significantly, the lower member yielded surfaces with numerous examples of trilobite locomotion traces: *Cruziana* (d'Orbigny); *Didymaulichnus* (Young); *Monomorphichnus* (Crimes); trilobite resting and hiding traces: *Rusophycus* (Hall). A notable specimen preserves a mollusk trail assignable to *Climatichnites* (Logan) (Hantzschel, 1975). From near the Cambrian–Ordovician boundary, one surface preserves *Palaeophycus*, sinuous horizontal burrows produced by animals larger in diameter than the largest trilobites reported from the formation (Taylor and Repetski, 1995).

This ichnoassemblage represents a typical *Cruziana* ichnofacies consistent with other unstable, shallow marine sandy substrate localities at the Cambrian-Ordovician boundary globally. These ichnofossils demonstrate that the Bliss Formation, and especially the lower Mud Mountain Member, supported a more ecologically complex benthic community than previously recognized, with evidence of diverse locomotion, feeding, and resting behaviors.

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MICROPLASTICS OCCURRENCE AND DISTRIBUTION IN FRESHWATER SYSTEMS OF AN ARID REGION: A CASE STUDY FROM THE FORT STANTON CAVE AREA, NEW MEXICO

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Freshwater systems in arid and semi-arid regions remain understudied in microplastic research despite increasing global concern regarding plastic pollution. To address this gap, we examined the occurrence and spatial distribution of microplastics in freshwater bodies surrounding the Fort Stanton Cave area in New Mexico. Bulk water samples were processed using a combined approach of direct vacuum filtration and density separation, and suspected microplastics were categorized by morphology and color. Microplastics were detected at all sampled sites, with microfibers comprising the dominant morphology, followed by fragments and pellets. Polymer characterization using Raman spectroscopy and attenuated total reflectance–Fourier transform infrared spectroscopy (ATR-FTIR) identified polyethylene terephthalate (PET; polyester) and low-density polyethylene (LDPE) as dominant polymers. PET was primarily recovered from directly filtered samples, whereas LDPE was more abundant in density-separated fractions, indicating density-dependent recovery and potential methodological bias. Sites with higher anthropogenic influence, such as Alto Lake, exhibited greater microplastic abundances relative to less impacted locations, including Eagle Creek. This study provides baseline data and highlights the importance of integrating complementary processing methods for comprehensive microplastic recovery in arid freshwater systems.

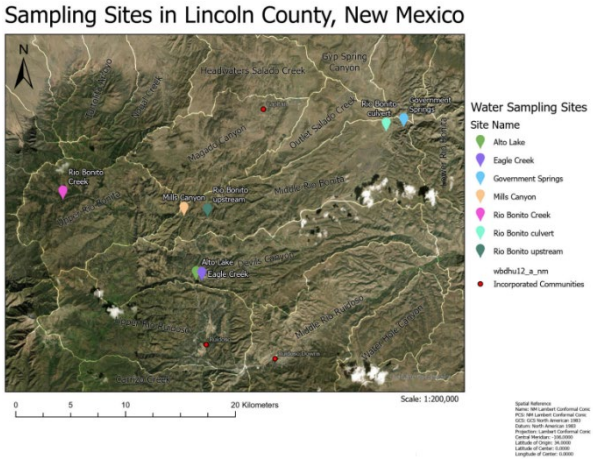

Figure 1. Map of freshwater sampling sites in the Fort Stanton Cave Area, New Mexico

Keywords:

microplastics, arid region

LESSONS LEARNED FROM THE DESERT SOIL-GEOMORPHOLOGY PROJECT, SOUTHERN NEW MEXICO

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The Desert Soil-Geomorphology Project was one of six such projects across the United States in the 1950s, 60s, and 70s during a period of active soil mapping. The purpose was to develop basic principles of soil genesis, soil-geomorphic relations, and Soil Taxonomy definitions that would increase the accuracy and usefulness of soil maps. The Desert Project was conducted in a 400-square-mile area in the Basin and Range of southern New Mexico where the effects of each of the five soil forming factors could be examined independently and in combination, and the results extrapolated to large areas of the arid and semiarid western states. The project enabled collaborations between the USDA-SCS, local universities, and the New Mexico Bureau of Mines and Mineral Resources that led to advances in the understanding of Quaternary stratigraphy, chronology, landscape evolution, hydrogeology, atmospheric additions to soils, soil mapping within the context of geomorphic surfaces, paleoclimate, and laboratory analysis of desert soils. Training tours and publications were an integral part of the Desert Project. The “Guidebook to the Desert Project” by Gile, Hawley, and Grossman (1981), for example, was awarded the Kirk Bryan award of the Geological Society of America in 1983.

Keywords:

soil-geomorphology, Quaternary geology, soil classification, hydrogeology

LOOKING TO THE PAST TO PREPARE FOR THE FUTURE: A SPATIOTEMPORAL LAND USE ANALYSIS OF THE IRRIGABLE ACREAGE OF LA ACEQUIA DEL FINADO FRANCISCO MARTINEZ DEL LLANO QUEMADO IN TAOS COUNTY, NEW MEXICO

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Urbanization of previously agricultural land decreases the utilization of acequia irrigation systems and alters how agrarian practices contribute to an ecosystem. Our current understanding of how urbanization influences acequia system utilization is limited, and existing data are sparse. This study quantified temporal land use/land cover (LULC) changes to a portion of the irrigable lands of the Acequia del Finado Francisco Martinez del Llano Quemado (Francisco Martinez Acequia) in Taos County, New Mexico. Spatiotemporal LULC analyses quantify changes in irrigable acreage over time and generate geospatial data which are visualized on maps then disseminated to stakeholders. Like most acequias in the Southwest, the Francisco Martinez Acequia Association struggles with development pressures and worsening drought, both of which make water resources less reliable and acequia flows less sustainable. As population has grown in the last quarter-century, the area has been parceled and developed, leaving behind a patchwork of residential lots interspersed with the remnants of agricultural land. To quantify the types and amount of land use change between 1969 and 2024, we conducted a comparative LULC analysis using GIS techniques. Map sections from the Rio Grande del Rancho Hydrographic Survey, published by the New Mexico Office of the State Engineer in 1969, were used as the historical dataset. We collected aerial imagery in April 2024 using a WingtraOne fixed-wing drone. We then digitized and orthorectified the historical maps, delineated land use classes based on Hydrographic Survey classifications, and quantified the total acreage of each class. For the modern imagery reference, we established parameters to define land use classifications, used visual inspection to delineate land use classes, and summed total acreages for each class. Total irrigated acreage for both historical and modern datasets were calculated and compared, determining a 44.03% reduction in irrigated land coverage since 1969. These results have implications for the integrity of the acequia irrigation system and the ecosystem services they provide.

The workflow developed for this study will be used as the foundation of a graduate thesis by the primary author. To gain deeper insight into the ecological relationship between acequias and the landscape, the planned research will entail a comprehensive LULC change analysis throughout all the irrigated lands associated with the Francisco Martinez Acequia. Vegetation surveys and soil sampling will be conducted in a randomly selected subsection of land parcels to provide supporting data for the comparison of ecological conditions between irrigated and non-irrigated areas. Flood irrigation practices maintain riparian- and pasture-associated vegetation by providing seasonal water to areas that otherwise have no consistent access to surface water. Based on prior data, we predict that areas that were once irrigated but no longer receive inputs because of land use change will likely have altered and/or diminished plant communities and modified soil characteristics. The vegetation and soils field data will be used to determine whether significant variation occurs between actively irrigated parcels and parcels where irrigation has ceased since 1969. Combined with the LULC analysis results,

these data will allow us to generate a comprehensive picture of how modern land uses are affecting the functionality of the Francisco Martinez Acequia and the ecological conditions of acequia-associated lands.

GEOLOGICAL EVOLUTION AND MINERAL DEPOSITS OF THE EUREKA AND SYLVANITE DISTRICTS IN THE LITTLE HATCHET MOUNTAINS

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Understanding the timing of mineralization pulses within southwestern New Mexico mining districts is necessary to determine where and how critical minerals can be targeted for exploration. New Mexico lies at the eastern edge of a well-known metal-bearing province, hosting numerous Laramide and Paleogene mineral deposits. Southwestern NM contains two spatially overlapping mineralization events; the Laramide porphyry copper (±Mo, Au) deposits (80-45 Ma formed during the subduction of the Farallon plate) and Paleogene Mo-W deposits (40-25 Ma formed during basin and range extension). Porphyry deposits are generally large, low-grade deposits containing Cu, Mo, Au sulfides and exhibit characteristic alteration styles. Porphyry mineral systems are centered on the porphyry stock and encompasses an area of hydrothermally altered rock (volumes of 10 to 100km3), that may also include precious metal mineralization involving several other deposit types; polymetallic veins, skarn and carbonate replacement deposits. In contrast to porphyry copper deposits, Mo-W deposits were formed during extensional magmatism, tend to be of smaller scales and lie proximal to porphyry copper deposits. However, all these deposit types have the potential to host various critical minerals, including Cu, Ag, Zn, Bi, Co, Ni, rare earth elements (REE), Re, Te, and W along with hosting significant gold and molybdenum resources. The LHM have two metal producing districts; the Eureka district (northern section) and the Sylvanite district (southern section), the range itself contains numerous plutons, dikes, and lava flows. For the Little Hatchet Mountains (LHM), previous research has also shown confusing and overlapping ages, as well as inaccuracies using the K-Ar method. Now, with new 40Ar/39Ar geochronological data and mineralogical assessments, there is clearer evidence for both Laramide and Paleogene magmatism in Eureka and Sylvanite districts. Unaltered igneous rock samples were sampled for geochemistry and a selected group of those samples were analyzed using 40Ar/39Ar geochronology. The NM Laramide porphyry copper deposits and Paleogene Mo-W deposits have been constrained using current 40Ar/39Ar dating methods into three mineral-producing magmatic pulses: 1) 78-71 Ma Laramide pulse, 2) 59-50 Ma, Laramide pulse, and 3) 40-25 Ma Paleogene Mo-W pulse.

For the Eureka district, four drill core samples from the Oro Southern Silver drill core project were sampled for 40Ar/39Ar geochronology. There is also previously recorded U-Pb dating for the Eureka district as well. All this data has now assisted in a determined general age of mineralization for the Eureka district to be within Laramide Pulse 2. LHM-010 and LHM-013 were the two samples collected for geochronology in the Sylvanite district. These samples were able to produce a preferred age of cooling and now a confirmed general age for the Paleogene pulse of mineralization within the Sylvanite district. The geochronological results show a complex evolution of the LHM due to the diverse development of multiple metal producing districts and different pulses of magmatism. Geochemical results also showed deposits of similar ages share similar mineralogical characteristics, such as Paleogene Mo-W deposits are elevated in Te (36.4ppm in LH710) and are of smaller scales compared to the Laramide porphyry copper deposits.

Keywords:

Laramide Porphyry Copper - Critical Minerals - Paleogene Mo W - 40Ar/39Ar Geochronology - Geochemistry

MINERAL CHEMISTRY, ARCHITECTURE, AND FLUID EVOLUTION OF THE VICTORIO W–MO–BE–F MAGMATIC–HYDROTHERMAL SYSTEM

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The Victorio project in the Gage Mining District in southwestern New Mexico hosts a vertically extensive magmatic–hydrothermal system, including carbonate replacement (CRD) style Pb-Zn-Ag (Mine Hill) deposits and separate porphyry style Mo, CRD and skarn/vein hosted W-Be-Mo-F mineralization (Victorio deposit). Victorio currently contains the largest known W resource in the United States. This research will utilize a subsurface foundation provided by over 230,000 feet of drill core sourced from at least 138 drill holes to reconcile system architecture and genesis, while building mineral chemistry vectors for practical exploration, district scale targeting, and fingerprinting fluid sources. Preliminary analyses of helvine group minerals ($Be_3(Mn^{2+},Fe^{2+},Zn^{2+})_4(SiO_4)_3S$) indicate they are important targets for analysis that can link Be mineralization, typical skarn Fe-Mn zonation, and fluid source fingerprints. This research will also assess the deposit style, whether it is a single magmatic–hydrothermal system expressed at different structural/stratigraphic levels, multiple telescoped pulses, and/or separate mineralizing events that reused the same structures and reactive carbonate units. Prior district-scale work emphasized that critical questions remained unresolved regarding emplacement of intrusives, timing of hydrothermal alteration and mineralization, and whether systematic hydrothermal mineralization zoning exists across the district.

PRELIMINARY DATA ON FLOW AND SEEPAGE FOR ASSESSING SURFACE WATER–GROUNDWATER EXCHANGE IN THE LOW FLOW CONVEYANCE CHANNEL, MIDDLE RIO GRANDE

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The Low Flow Conveyance Channel is a deep drain channel constructed parallel to the Rio Grande in the Socorro reach of central NM. Its management uses have varied over the decades, and the Interstate Stream Commission (ISC) would like future operations to be based on an improved scientific understanding of the hydrologic system. Several preliminary assessments, based on the data obtained to date, provide initial insights into the spatial and temporal variation of the flows within the LFCC from San Acacia to San Marcial. First, three discharge time series were generated by applying stage-discharge rating curves to recorded water levels at three locations within Bosque del Apache Nation Wildlife Refuge (BdA). These rating curves are based on manual measurements collected from June 2024 to February 2026, with a power-law fit that captures the relationship between water level and discharge well (R^2>0.93). The seasonal pattern of irrigation activities from March to October noticeably influenced the relative values and variation in monthly discharge within the LFCC, while the elevated discharges from November to February remained consistent. An average discharge gain of approximately 1.5 m^3/s was observed monthly across the 18-km reach from the north border to the south border of BdA. Moreover, the inflow-outflow measurements conducted in May, July, and September 2025 reveal a linear correlation between increasing seepage gains and higher flows in LFCC, likely associated with higher flows in the Rio Grande. While this trend was observed at 5 of 8 reaches on the LFCC, farther upstream and downstream of BdA, the remaining reaches showed seepage gains at lower flow rates but increasing losses as the flow rate rose. These integrated results indicate that seepage gains and losses do not only vary seasonally (e.g., greatest gains during high flow in May) but also spatially within LFCC (ranging from 0.02 to 0.4 $m^3 s^{-1} km^{-1}$).

Keywords:

LFCC, Seepage, Inflow-outflow measurement

GEOCHEMICAL ASSESSMENT OF CRITICAL MINERALS IN MINE WASTES IN CENTRAL AND SOUTHERN NEW MEXICO

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Critical minerals are essential for modern technologies, renewable energy systems, and national security, with demand expected to increase as global economies transition toward low-carbon energy systems. However, supply chain vulnerabilities have driven efforts to identify alternative domestic sources within the United States. Mine wastes represent a potential secondary resource that could supplement critical minerals supply while reducing environmental impacts associated with legacy mining. This study evaluates the critical minerals potential of mine wastes from six mining districts in central and southern New Mexico: Magdalena, Caballo, Carbonate Hill, Lake Valley, Eureka, and Nacimiento.

Geochemical analyses indicate that tailings and waste rock are enriched in several critical minerals relative to crustal abundances, reflecting incomplete recovery during historical mining. The Magdalena district exhibits the highest potential, with mean tailings concentrations of Zn (26,543 ppm), Pb (19,556 ppm), Cu (2,373 ppm), and Ag (15 ppm), all exceeding exploration-grade thresholds (15,400 ppm Zn, 10,500 ppm Pb, 1,400 ppm Cu, and 10 ppm Ag). Waste rock piles show even higher concentrations, including Zn (38,240 ppm), Pb (24,590 ppm), Cu (2,343 ppm), and Ag (43 ppm). With an estimated tailings mass of ~189,500 tonnes, calculated endowments include ~5,030 tonnes Zn, ~3,706 tonnes Pb, ~450 tonnes Cu, and ~2.8 tonnes Ag, indicating strong polymetallic recovery potential.

The Carbonate Hill district represents a secondary target, with tailings Pb concentrations (11,642 ppm) exceeding the exploration threshold and Zn concentrations (12,519 ppm) approaching threshold values. These concentrations correspond to estimated endowments of ~3,927 tonnes Pb and ~4,222 tonnes Zn, suggesting moderate recovery potential.

The Nacimiento district contains elevated Cu concentrations (3,454 ppm) above the exploration threshold (1,400 ppm), with an estimated endowment of ~1,318 tonnes; however, limited sampling and lack of multi-element enrichment introduce uncertainty. In contrast, the Eureka district shows moderate enrichment of Zn (6,456 ppm), Pb (7,732 ppm) and As (1,908 ppm), but concentrations remain below exploration thresholds.

The Lake Valley and Caballo districts exhibit relatively low concentrations of critical minerals. Lake Valley tailings contain Zn (1,470 ppm), Pb (1,560 ppm), V (399 ppm), and Cu (55 ppm), all below exploration-grade thresholds, while Caballo tailings show Rb (189 ppm), Zn (135 ppm) and Pb (33 ppm), indicating minimal enrichment. These low concentrations suggest limited potential for economic recovery.

Rare earth element concentrations across all districts are low, with a maximum total rare earth element (TREE) concentration of 137 ppm, far below the exploration threshold of 16,800 ppm, indicating negligible recovery potential. Acid rock drainage assessment indicates that most samples are non-acid forming, although one

sample from the Eureka district plots in the potential acid-forming field, and some Magdalena samples fall within uncertain zones.

Overall, results demonstrate that while most mine wastes in the study areas are not economically viable sources of critical minerals, the Magdalena district, and to a lesser extent Carbonate Hill, represent promising targets for further investigation. These findings highlight the importance of integrating grade and tonnage in evaluating secondary resources and contribute to efforts to strengthen domestic critical mineral supply chains.

HYDROTHERMAL CALCITE-FLUID REE PARTITIONING EXPERIMENTS AT 200 °C AND SATURATED WATER VAPOR PRESSURE

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Rare earth elements (REE) are critical minerals essential to high-tech and green energy industries. Economic concentrations of REE occur within carbonatites and alkaline deposits, where hydrothermal alteration is a key process in the evolution of these deposits (Gysi & Williams-Jones, 2013; Moore et al., 2015). Calcite is a common gangue vein mineral in these hydrothermally overprinted systems and incorporates trace elements via several possible coupled substitutions. The REE signature of calcite records fluid evolution and provides a powerful tracer of hydrothermal processes in ore-forming systems (Perry & Gysi, 2018). Hydrothermal experiments offer a controlled approach to replicate this partitioning behavior and study the underlying mechanisms of calcite-fluid REE partitioning. However, to date very few experiments have been conducted at hydrothermal conditions.

Here, we present batch-type hydrothermal experiments conducted at 200 °C and saturated water vapor pressure. Calcite was synthesized with variable initial REE concentrations (~200-750 ppb) using a method similar to Perry and Gysi (2020). Experiments were performed in a 600 ml stirred titanium Parr reactor with *in situ* fluid sampling over 1-2 weeks, followed by quenching and recovery of precipitated calcite. Quenched fluids were analyzed using IC, ICP-OES, and ICP-MS. Acid-digested calcite was analyzed using ICP-OES and solids were characterized by SEM-EDS. Thermodynamic calculations were conducted using the GEMS code package and the MINES thermodynamic database at New Mexico Tech (Gysi et al., 2023).

Precipitated calcite displays 25-100 µm rhombohedral crystals. The recovered calcite is enriched in light REE, as reflected by a positive slope in a mole fraction-ionic radius diagram. This results from the similar ionic radius of Ca^{2+} and the trivalent light REE^{3+}. Measured light REE (e.g., La, Pr, Nd) concentrations range between ~100-950 ppm, and heavy REE concentrations (e.g., Dy, Ho, and Yb) between ~50-950 ppb. Yttrium is commonly considered a heavy REE and has an ionic radius similar to Ho. However, the concentrations of Y in the synthesized calcite are much higher (i.e., 0.0011-0.0103 mol/kg) than Ho (i.e., 0.0006-0.0056 mol/kg) or other REE. Similarly, Y exhibits the greatest relative mole fractions in calcite across experiments (1.10×10^{-4} to 1.02×10^{-2}), followed by light REE such as La, Pr, Nd, and Ce ($7.84x10^{-5}$-$6.62x10^{-4}$), while heavy REE, including Dy, Ho, Yb, and Lu, have lower mole fractions ($3.63x10^{-5}$-$5.67x10^{-4}$).

The compositions of the quenched experimental fluids indicate that the REE concentrations decrease systematically with time, consistent with progressive partitioning into calcite. In experiments with ~200 ppb initial REE, total light REE concentrations decline from $1.38x10^{-6}$ to $8.80x10^{-8}$ mol/kg, whereas heavy REE concentrations decline from $1.89x10^{-6}$ to $2.13x10^{-8}$ mol/kg. In ~750 ppb initial REE experiments, total light REE concentrations decrease from $5.85x10^{-6}$ to $1.15x10^{-7}$ mol/kg, and heavy REE from $8.04x10^{-6}$ to $6.32x10^{-8}$ mol/kg. The most pronounced decreases occur in heavy REE after 7-8 days in the ~750 ppb initial REE experiments.

Partition coefficients (KD) for REE partitioning between the hydrothermal fluid and calcite were calculated for each REE. Y consistently exhibits the highest KD values across all experiments. In ~200 ppb initial REE experiments, KD values remain <1, indicating a preference for the hydrothermal fluid. In contrast, experiments

with ~750 ppb initial REE concentrations indicate a preference for calcite with KD values > 1 within four days of reaction for Y and light REE, and within 10 days for other REE. A plot of partition coefficients vs. ionic radius of the REE3+ defines parabolic trends which can be fitted to the lattice strain model, similarly observed in fluorite-fluid partitioning experiments by van Hinsberg et al. (2010).

Ultimately, these experiments show that REE partitioning into calcite at hydrothermal conditions evolves as the system approaches equilibrium and depends strongly on the starting REE concentration. The calculated KD values shift from fluid-dominated to calcite-dominated behavior with increasing initial REE concentrations and time. Overall, we see a preferential incorporation of light over heavy REE into calcite. However, Y consistently exhibits higher KD values than Ho and the other REE, despite Y and Ho typically behaving similarly in geological systems. Nevertheless, these results are consistent with natural systems such as the Lemitar carbonatite, where hydrothermal calcite is light REE fractionated with high concentrations of Y, Ce, Nd, and La over other REE (Obringer et al., in preparation). Future work will focus on developing a thermodynamic model for REE partitioning into calcite that can better account for factors impacting partitioning other than the lattice strain model, such as REE complexation in the hydrothermal fluid, that can be applied across a wider range of fluid compositions and temperatures.

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Keywords:

Rare earth elements, mineral-fluid interaction, hydrothermal ore-forming processes

QUANTIFYING ARROYO-DERIVED SEDIMENT INPUTS TO THE MIDDLE RIO GRANDE

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The many flood control and water resource management dams on the Rio Grande have greatly impacted the river, influencing its sediment transport capacity as well as the patterns of erosion and sediment deposition. This has a large effect on river morphology and the availability of habitat for endangered species such as the silvery minnow. This study aims to identify sediment sources and estimate the flux of sediment delivered to the Middle Rio Grande. To do this, we applied the BQART model to each arroyo watershed that flows into the Rio Grande, beginning with the Cochiti Reach. This empirical model predicts the long-term fluvial suspended sediment flux from river basins based on basin area (A), relief (R), river discharge (Q), temperature (T), and geological/human factors (B). To check the accuracy of this model in a semi-arid ephemeral stream context, we will compare the estimated values to the sediment quantities measured at downstream gauging stations. Quantifying sediment sources and load will help improve our understanding of the effects of sediment transport on river morphology, ultimately providing insight into ecosystem management strategies for preserving habitat for endangered species.

UPPER CRETACEOUS SELACHIANS AND TELEOST FROM THE SEMILLA SANDSTONE MEMBER OF THE CARLILE SHALE, SOUTHEASTERN SAN JUAN BASIN, NEW MEXICO

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A diverse selachian-fossil dominated assemblage of Turonian age has been collected (and is currently being studied) near the Pipeline Road in the Ojito Wilderness area southeast of San Ysidro, Sandoval County, New Mexico. Approximately 35 kg of sediment was collected from three adjacent Western Harvester Ant (*Pogonomynex occidentals*, Cressen) hills, located within 100 meters of each other. The fossils are allochthonous, hydraulically concentrated. Since the fossils are collected from ant hills, the size of the fossils are also sorted by what the ants could carry. Because of the nature of the deposit, the fossils are almost all damaged.

The anthills are on clay-dominated strata of the lower Carlile Shale, but the teeth in the anthills are coming from the Semilla Sandstone that caps the cuestas that are above the valley above the anthills. Selachian teeth in the Semilla Sandstone near the anthills are of the same preservation as and in the size range of the teeth on the anthills, so we conclude the source of the anthill teeth is the Semilla Sandstone.

The vast majority of the fossils from the anthills are teeth that belong to the order Lamniformes, with three genera contributing to the bulk of the sample:*Cretalamna, Scapanorhynchus,* and *Squalicorax.* As the sorting is completed, an attempt will be made to determine which species can be assigned to each genus. The fourth most common fossil teeth belong to a batoid, *Ptychotrygon*. Based on the ornamentation of the ptychotrogonid fossils, more than one species of this family is likely present. Some of the rarer selachians include *Chiloscyllium, Ptychodus,* possible *Pseudohypolophus,* and an unidentified orectolobid. In addition to the selachians, at least four teleosts, several different gastropod species, inoceramid clams, and juvenile remains of one species of ammonite have also been found.

THE PEMADA CANYON DIKE, AN EXTENSION OF PREVIOUSLY IDENTIFIED VOLCANIC FIELDS WITHIN THE COLORADO PLATEAU OR A UNIQUE, STANDALONE MAGMATIC EVENT?

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The Pemada Canyon dike (PCD) is an isolated dike that is situated close to the center of the San Juan basin (SJB) in the southeastern Colorado Plateau, New Mexico. It has evaded any prior attempts to understand its provenance and role in what it potentially preserves about the region's geologic past. Knowledge of the PCD is limited to the facts that it is a lamprophyric dike that intrudes siliciclastic sedimentary rocks of the Eocene San Jose Formation and that preliminary geochronologic analyses suggest that it dates back to the Miocene. Other preliminary results yielded that the PCD is composed of ultramafic material, with a low silica content (SiO_2 27.8-37.7%) and higher than normal alkaline content (Na_2O 0.313-1.72%, K_2O 0.453-2.02%) for an ultramafic lamprophyre; thin section analyses demonstrated a trachytic, fine-grained matrix of kalsilite, clinopyroxene, magnetite ± ilmenite, calcite, and phlogopite. In addition, 1–2 cm grains of coarse faceted calcite, euhedral clinopyroxene, phlogopite, and sparse kalsilite (±nepheline) appear, with olivine being noticeably absent. What we could acquire from conducting research on the PCD could offer a glimpse into an understudied episode that may have occurred throughout the SJB's geologic history.

This project intends to address some of its unknown constituents, particularly by mapping out its extent, attempting to constrain the time of emplacement, note its mineral modal abundance and composition, determine its magmatic genesis, and ascertain if there is a relationship between other dikes in the region. Additionally, further research involves scoping out and logging its physical extent, analyzing its stress regime/joints, settling a correlation between the dike and the stresses occurring throughout the basin, and ultimately, resolve if the PCD was a single event or if it was episodic and if the latter, the temporal and/or compositional separation between emplacement events. Field research involves the collection of an appropriate amount of rock samples, recording geographic coordinates, and scaling the feasible length of the PCD. Laboratory analyses entail $^{40}Ar/^{39}Ar$ dating, bulk-chemical, major and trace elemental analyses and thin section microscopy. Mapping will be conducted with ArcGIS Pro, following USGS guidelines. Research into the PCD wouldn't just yield information regarding itself and the SJB, rather, its status as a lamprophyre warrants additional investigations for economic potential.

THE UTILITY OF TRACK WIDTH IN DINOSAUR TRACKWAY STUDIES

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Measurements of dinosaur track widths are often underutilized, sometimes appearing in the literature as a component of length/width ratios of no great importance. However, if length/width ratios are confidently known, they have great utility.

Many published studies of dinosaur tracks and trackways have used track length, a surrogate for foot length, to estimate the size and speed of the trackmaker. This is because most size and speed equations are based in part on foot length (e.g., Alexander, 1976). Importantly, foot length is not actually preserved at tracksites, and foot length is very often not the same as track length. Compounding this problem, measurements of track length are often subjective due to a lack of reliable landmarks from which to measure. Overestimating foot length from a track will produce a larger, slower individual. Underestimating foot length will produce a smaller, faster dinosaur (Alexander, 1976; Lucas et al., 2024).

At the Clayton Lake Dinosaur Tracksite, we found width measurements were often more objective and unvarying than length measurements (Lucas et al., 2024). In forward-moving animals, the side of the foot experiences less interaction (insertion, loading, removal of foot) with the substrate than the front and back of the foot. At Clayton Lake, deeply impressed tracks produced steep walls on the sides that minimize differences obtained by different measurement strategies (Falkingham, 2016; Lucas et al, 2024). Track length measurements, on the other hand, suffered from sloping heel regions, toe withdrawal dynamics, metatarsal impressions, and a general lack of reliable landmarks. An average of the best-preserved tracks (undertracks) of ornithopods at Clayton Lake yield a length/width ratio around 1.0. If length/width can be established from elite tracks, width can be substituted for length in dinosaur size and speed equations.

Track width (or length/width) places a useful check on track length measurements. Significant discrepancies may be the result of preservation, measurement error, substrate consistency, gait, improper taxonomic identification, and extramorphological variation. Though providing important information, length measurements out of line with width should not be used for size and speed estimates.

Track widths provide a check on measured track lengths, gaits, and taxonomic identification. In partially-registered or poorly preserved tracks, track widths may provide a better substitute for track length in size and speed equations.

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URANIUM IN-SITU RECOVERY (ISR) IN NEW MEXICO

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Uranium In-Situ Recovery (ISR) was first tested on an experimental basis in Wyoming in the early 1960s, with the first commercial ISR operation beginning in Texas in 1975. Today, more than 60% of global uranium production is derived from ISR, including operations in Australia, Kazakhstan, Russia, and the United States.

ISR is well-field technology that requires no excavation. Instead, a series of wells, similar to those used by local ranchers and farmers for water are installed to access the resource. These wells are engineered and sealed at specific depths to ensure fluids remain confined within the designated production zone, preventing migration into controlled or unmonitored areas.

Surface and subsurface disturbances are temporary and are subject to strict regulatory bonding requirements to ensure full reclamation. Following extraction, groundwater is restored, wells are decommissioned, and the land is returned to its original use.

The Clean Energy Association of New Mexico (CLEAN) advocates for a safe, environmentally responsible, and cost-effective nuclear energy industry—supported by In-Situ Recovery (ISR) uranium extraction. Our mission is to ensure that the people of New Mexico can benefit from the resources within their land in a sustainable and informed manner, while emphasizing cultural understanding and knowledge sharing.

In-Situ Recovery (ISR) is a proven, low-impact method of uranium extraction that safeguards groundwater and allows the land to be restored to its original state and use after operations conclude.

GEOCHEMICAL CHARACTERIZATION OF CRITICAL MINERALS IN MINE WASTE IN THE CARLSBAD POTASH DISTRICT, AND AT THE QUESTA MINE, NEW MEXICO

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This study evaluates critical mineral enrichment and acid generation potential in mine waste from the Carlsbad potash district and the Questa molybdenum district, New Mexico. The objectives are to quantify critical minerals concentrations, estimate mineral endowment within mine wastes, and assess associated environmental risks, particularly acid rock drainage (ARD). A total of 35 composite samples from Carlsbad potash tailings were collected, 572 samples from the Questa Project (https:geoinfo.nmt.edu/staff/mclemore/projects/environment/home.html), and selected drill core (n = 6) and host rock samples (n = 12) were collected and analyzed using whole-rock major and trace element geochemistry, supported by paste pH, specific gravity, petrography, and volumetric calculations.

Total mine waste volumes exceed 340 million tonnes in Carlsbad and 540 million tonnes in Questa, highlighting their significance as both potential secondary resources and potential environmental liabilities. Carlsbad tailings are characterized by Mg concentrations averaging 2.51 wt.% (near crustal abundance), while K is depleted (0.48 wt.%) due to historical recovery. Trace elements including Cu (44 ppm), Zn (155 ppm), and total rare earth elements (43 ppm) show no enrichment and remain below economic thresholds. Paste pH results indicate that Carlsbad tailings are predominantly non-acid forming, suggesting low ARD potential.

In contrast, Questa waste rock piles exhibit elevated Cu (mean 210 ppm; up to 1,820 ppm) and Pb (mean 100 ppm; up to 900 ppm), reflecting sulfide alteration. Potassium is enriched (average 3.9 wt.% K_2O), consistent with potassic and sericitic alteration. However, Mo and Re are largely absent in waste rock. ARD potential in the Questa waste piles is variable, with certain rock piles showing elevated ARD.

Drill core data confirms a Mo-rich porphyry system, with Mo averaging 1,682 ppm and reaching 25,400 ppm, and low Re (2.99 ppm) associated with molybdenite. Although some elements exceed crustal abundance, most remain below current economic cut-off grades. Overall, while both districts contain large total waste rock endowments, critical minerals concentrations are low and their economic potential is presently limited.

Keywords:

critical minerals, mine waste, acid rock drainage, Carlsbad Potash District, Questa Molybdenum District, mineral endowment

LATE CRETACEOUS (CENOMANIAN-CAMPANIAN) AMMONITES AND INOCERAMIDS FROM THE HAGAN BASIN, SANDOVAL COUNTY, NEW MEXICO

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Upper Cretaceous strata exposed in the Hagan basin in Sandoval County, north-central New Mexico, contain ammonites and other marine molluscan fossils that span middle Cenomanian to early Campanian time. The fossiliferous formations and members (ascending order) are: Cubero Member of Dakota Formation; Greenhorn Limestone, Carlile and Semilla Sandstone, Juana Lopez, D-Cross, El Vado and Satan members of Mancos Formation; Hosta-Dalton Sandstone and Point Lookout Sandstone. Previously, the mollusks from these units in the Hagan basin have been little studied. Ten ammonite and/or inoceramid zones are indicated by moderately to well preserved marine invertebrate fossils recovered from these strata.

The *Acanthoceras amphibolum* Zone in the Cubero Member of the Dakota Formation establishes a middle Cenomanian age. The inoceramid zonal taxon *Mytiloides mytiloides* (Mantell) in the Greenhorn Limestone indicates the ammonite zone of *Mammites nodosoides*, and thus a latest early Turonian age. The *Prionocyclus hyatti* Zone in the Carlile and Semilla members establishes a latest middle Turonian age. The upper Turonian *Scaphites ferronensis* Zone in the Juana Lopez Member is established by that eponymous taxon. The occurrence of *Prionocyclus novimexicanus* (Marcou) and *Scaphites* (*Scaphites*) cf. *S. whitfieldi* Cobban in the approximate top of the Juana Lopez Member identifies the middle upper Turonian *S. whitfieldi* Zone. *Forresteria* (*Forresteria*) sp. and cf. *Prionocyclus* sp. from the D-Cross Member indicate a late Turonian age. *Inoceramus undabundus* Meek and Hayden high in the El Vado Member indicates a late Coniacian age and may further identify the lower upper Coniacian *Magadiceramus subquadratus* inoceramid zone. The *Clioscaphites choteauensis* Zone in the lower Hosta-Dalton establishes an earliest late Santonian age. The associated ammonites *Placenticeras syrtale* (Morton) and *Baculites codyensis* Reeside, also present in the Hosta-Dalton, further indicate a Santonian age. *Desmoscaphites* cf. *D. erdmanni* Cobban together with *Scaphites leei* I Reeside identify the upper Santonian *D. erdmanni* Zone in the Satan Member. The *Scaphites leei* III Zone near the base of the Point Lookout Sandstone establishes an earliest Campanian age. *Haresiceras* (*Haresiceras*) *montanaense* (Reeside) and *Baculites aquilaensis* Reeside indicate the lower Campanian *Scaphites hippocrepis* I Zone and also establish an early Campanian age for the Point Lookout Sandstone.

Very few Cretaceous ammonites or inoceramids have previously been documented from the Hagan basin. Lee (1912) listed fossils from measured sections in the Hagan coal field. They included the ammonites *Placenticeras sancarlosense* Hyatt, *P. whitfieldi* Hyatt, *P. intercalare* Meek and Hayden, *P. planum* Hyatt and *Scaphites* sp. related to *S. hippocrepis* Dekay and the nautiloid *Nautilus dekayi* Morton and other mollusks from the "Mesaverde Formation"; *Prionocyclus wyomingensis* Meek, inoceramids and gastropods from the Mancos; *Prionotropis* [*Collignoniceras woollgari*] and *Placenticeras* sp. from the "Cephalopod Zone" and *Inoceramus labiatus* Schlotheim from the Greenhorn Limestone. *Placenticeras whitfieldi* (a junior synonym of *P. meeki* Böhm) is too young of a species to occur in the reported unit. Reeside (1927) illustrated a specimen of *P. sancarlosense* from the lower part of the "Mesaverde Formation" at the Hagan Coal Mine. He also

illustrated a specimen of *Scaphites leei* var. *parvus* Reeside [*S. leei* III] from near the base of the "Mesaverde" at the same location (Reeside, 1927; Cobban, 1969). Harrison (1949), in an unpublished master's thesis on the geology of the Hagan coal basin, mentioned fossils in his measured sections of the Mancos and "Mesaverde" formations. He also stated that a 6-ft-thick calcareous zone 487 ft above the Mancos base contained a well-preserved ammonite fauna. Black (1979) mentioned fossiliferous marine limestones in the Hosta-Dalton and fossiliferous, crossbedded and lenticular marine-bar sandstones of the Semilla Sandstone in the Hagan basin. Ingersoll and Kelley (1979) mentioned common marine fossils in the Mancos Formation similar to those of the "Mesaverde" that included Bivalvia, Gastropoda, Cephalopoda and the trace fossil *Ophiomorpha*. Fleming (1989) proposed a reference section for the Semilla Sandstone in the Hagan basin and stated he collected the index fossil *Prionocyclus hyatti* (Stanton) from that unit. Lucas et al. (1998) briefly described the Hagan basin Cretaceous section and illustrated two fossils, including a *Prionocyclus*. Cather et al. (2002) published a geologic map of the Hagan quadrangle listing localities and mollusks from mostly the Mancos and Dakota formations. Most of the ammonite and inoceramid taxa and zones reported here have not previously been reported from the Hagan basin.

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USING DETAILED FLASH-FLOOD SEDIMENT TRANSPORT DATA TO VALIDATE HYDRAULIC MODELS

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Extreme runoff events across the southwestern U.S. deliver large sediment loads that can cover infrastructure and alter the landscape. Predicting how this sediment moves during these flash floods can reduce uncertainty in sediment predictions and better support planning for infrastructure, reservoir management, and flood risk, thereby helping communities prepare for extreme sediment events. This prediction can prove difficult because water levels rise quickly and unpredictably, making it hard to collect data from this environment.

This study aims to address a gap in model validation by testing the AdH model, along with the sediment transport library (SEDLIB), using detailed field data from the Arroyo de los Pinos (ADLP). This ephemeral stream flows into the Rio Grande in central New Mexico. The ADLP has collected continuous bedload and hydrologic data since 2018, which enables thorough model testing. While models like AdH, in theory, can predict sediment transport, they are usually used for large coastal rivers and aren't often utilized in dry, sand-rich gravel-bed channels. The main goals of this study are to assess whether AdH, when configured for dry, sand-rich gravel-bed channels, can accurately predict bedload transport during monsoon flash floods and to establish standards for sediment transport modeling throughout the Southwest.

TOWARDS A RETURN TO STEWARDSHIP: LESSONS LEARNED FROM WATERSHEDS AND COMMUNITIES UNDER STRESS IN THE EASTERN NAVAJO NATION

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Communities and watersheds in the eastern Navajo Nation (northwest New Mexico) have undertaken many changes to its landscapes including clear-cutting of pinon-juniper forests, overgrazing, erosion and drying of river beds, drought, extraction of resources, and importation of water resources. The jurisdictional complexity of this area has caused challenges in management of these watersheds and communities through these changes. The changes in landscape have political, social, economic, and cultural underpinnings. Strategies to address these changes require approaches informed by multiple disciplines and by the communities who have had longstanding relationships with these watersheds and landscapes. In this talk, I will highlight key lessons, current efforts, and potential pathways forward in addressing environmental changes in the eastern Navajo Nation from my perspective and experience as an earth scientist/hydrologist, planner, former Navajo Nation Water Rights Commissioner, and community member of Na'Neelzhiin (Torreon, NM).

A Play Fairway Techno-Economic Analysis of Enhanced Geothermal Systems (EGS) Resources Potential in the Southern Albuquerque Basin Under Private Surface and Minerals Ownership Status

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A potential for 1.0+ GWe geothermal base power exists for a 20,000+ acre site west of Interstate 25 (I-25) between Belen and Bernardo in the southern Albuquerque basin of the Rio Grande rift (RGR) under NATD Holdings ownership. The play fairway is a continental rift with a conductive geotherm and at least four vertically-stacked sedimentary targets for development as discrete EGS reservoirs with horizontal drilling and hydrofracturing. Reported heat flow for the area ranges from 82 and 110 *m*W/m^2 (Reiter and others, 1986). A precise stand-alone equilibrium temperature log in NAT#1 shows 375 °F (190 °C) at 12,160 ft (3,706 m) and 93 days after well completion (Figure 1). Target temperatures are estimated using nominal estimated thermal conductivity for subsurface lithology and a heat flow of 100 *m*W/m^2 in the immediate vicinity of the exploratory well, NAT#1. Preliminary techno-economic analysis suggests levelized cost of energy (LCOE) at $60 to $90 per MW-hr when applying recent drilling rates and learning curves. Fluid production rates between 1,000 and 1,500 gpm (63 L/s and 100 L/s) are estimated by using a Gringarten model with sufficient EGS fracture volumes to sustain nominal production for 30 years. NATD Holdings is traversed by major high-voltage transmission lines up to 500 kV; and the minerals and surface ownership is private which eliminates lengthy permitting issues and competitive lease sales. The NATD Holdings is adjacent a regional fiber-optic line, I-25, and the Atchison Topeka and Santa Fe Railroad.

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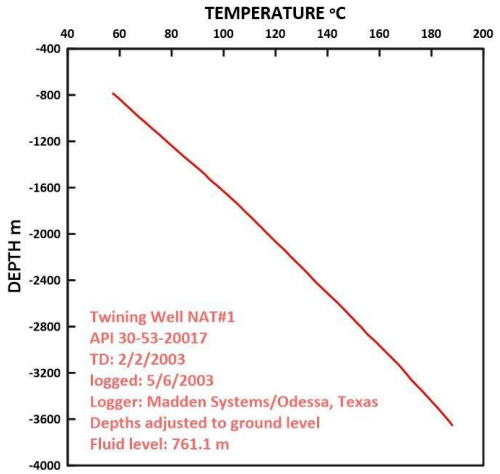

Figure 1. Equilibrium temperature log of NAT-1 well