New Mexico Geological Society

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in:
, , New Mexico Geological Society 75 th Annual Fall Field Conference Guidebook, 227 p.
https://doi.org/10.56577/FFC-75

This is a section from the 2025 NMGS Fall Field Conference Guidebook.

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Every fall since 1950, the New Mexico Geological Society (NMGS) has held an annual Fall Field Conference that explores some region of New Mexico (or surrounding states). Always well attended, these conferences provide a guidebook to participants. Besides detailed road logs, the guidebooks contain many well written, edited, and peer-reviewed geoscience papers. These books have set the national standard for geologic guidebooks and are an essential geologic reference for anyone working in or around New Mexico.

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Classic sedimentary rock sequences, enigmatic Quaternary deposits, deformation structures of nearly every scale imaginable, and a complex sedimentary-tectonic history combine in the eastern San Juan Basin to make the region a perfect venue for the NMGS's 75th Fall Field Conference. The first NMGS Fall Field Conference was held here in 1950, and the society has returned to the San Juan Basin five times in the interim, in 1951, 1977, 1992, 1997, and 2010. This 2025 conference guidebook builds on the incredible foundation of knowledge provided by earlier NMGS conferences in the area and showcases new advances in mapping, paleontology, geochronology, tectonics, hydrology, and sedimentology in more than 100 pages of detailed road logs and sixteen peer-reviewed technical papers authored by experts in industry, academia, and government. The field conference includes a stop at 1.7 Ga intrusive rocks, a thorough investigation of a relatively complete Cretaceous section, consideration of the structural complexity of the basin's margins, a survey of the beguiling syn-Laramide Paleogene sedimentary record, and a visit to the Nacimiento Mine site where hydrologists and geochemists were tasked with remediating the contamination that mining left behind. Much of the conference takes place in the headwaters of the Rio Puerco, whose alluvial terraces and associated pediments present a case study in neotectonic landscape development that is evident at nearly every one of the conference's eleven stops.

This is the 75th in a series of annual guidebooks produced by the New Mexico Geological Society. These guidebooks cover large regions of New Mexico and adjacent states. Collectively, they provide the most comprehensive library of geologic literature for New Mexico.

NMGS
75th

EASTERN SAN JUAN BASIN

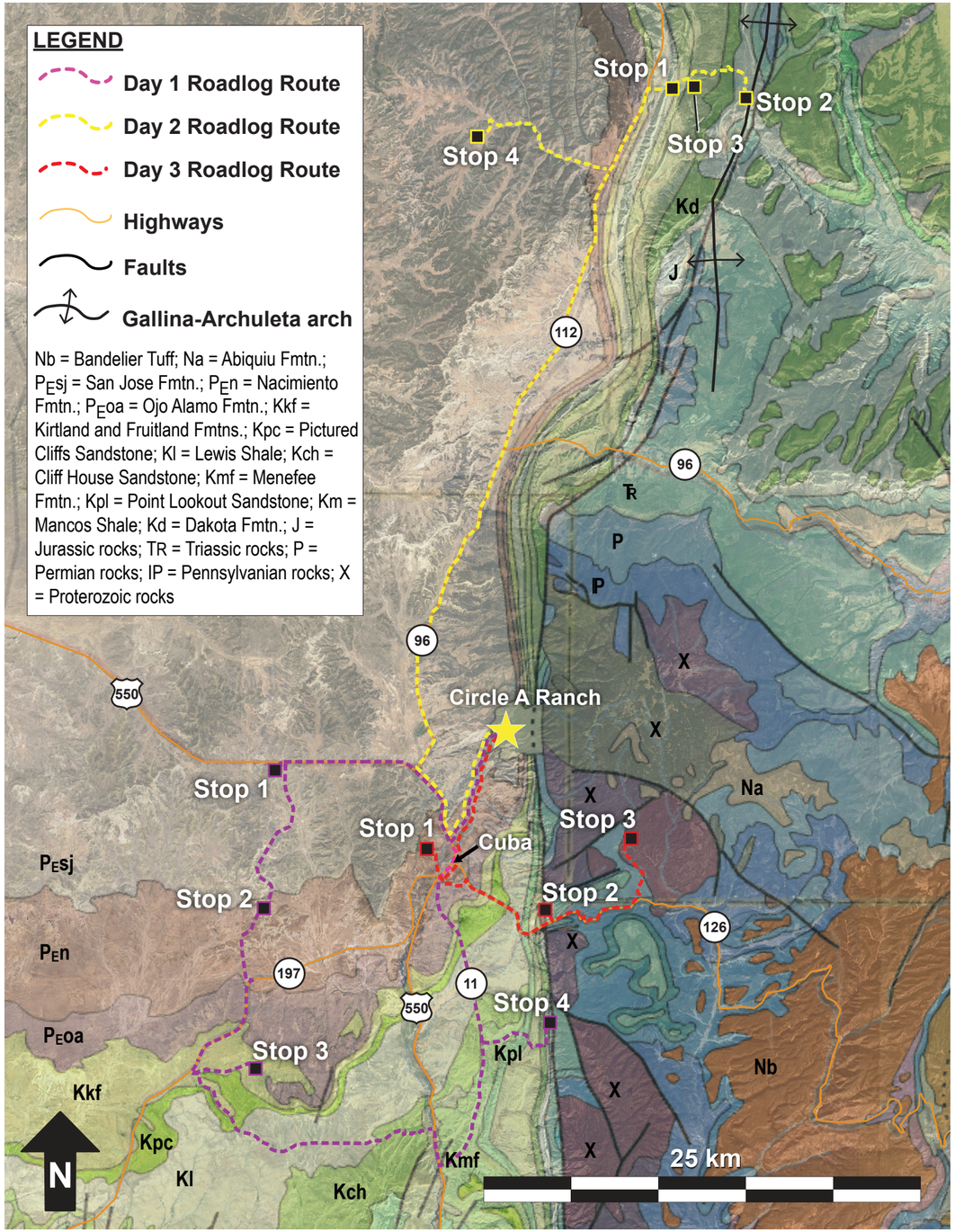
2025



GEOLOGY OF THE EASTERN SAN JUAN BASIN

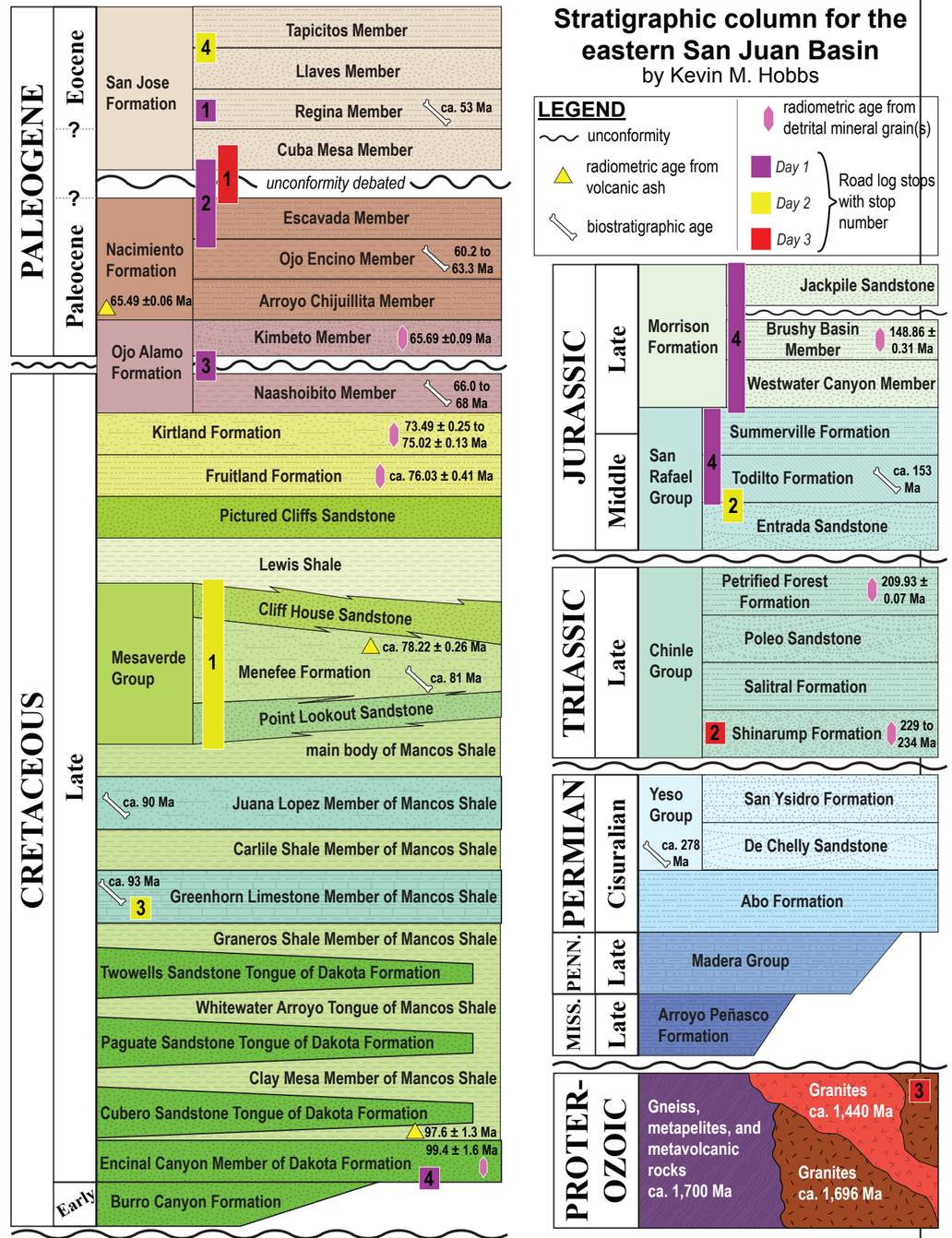
New Mexico Geological Society
2025

75TH FFC
1950 2025



Stratigraphic column for the eastern San Juan Basin

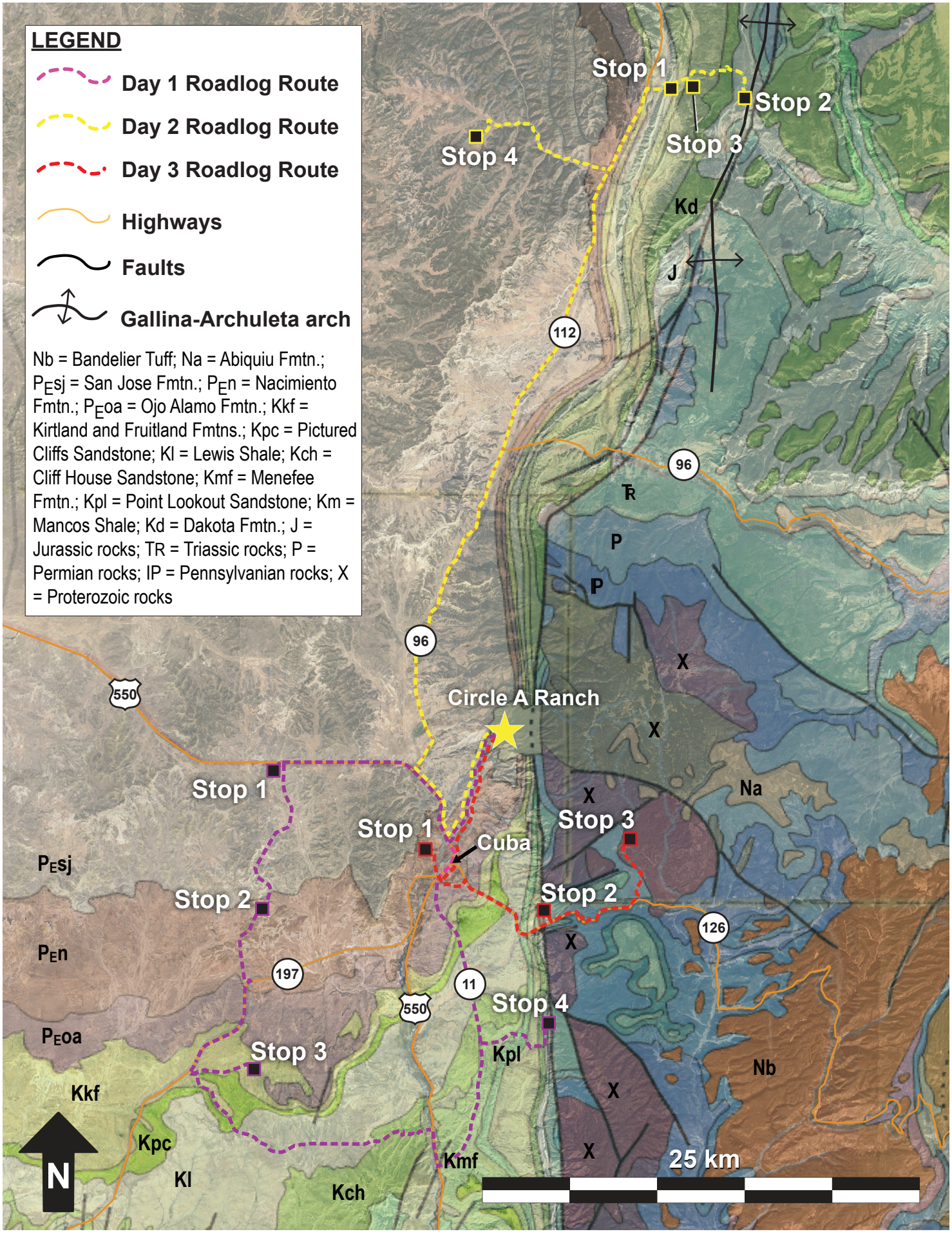
by Kevin M. Hobbs





GEOLOGY OF THE EASTERN SAN JUAN BASIN

New Mexico Geological Society
2025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Day 1 Roadlog Route
Day 2 Roadlog Route
Day 3 Roadlog Route
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Faults
Gallina-Archuleta arch
Nb = Bandelier Tuff; Na = Abiquiu Fmtn.; PEsj = San Jose Fmtn.; PEn = Nacimiento Fmtn.; PEoa = Ojo Alamo Fmtn.; Kkf = Kirtland and Fruitland Fmtns.; Kpc = Pictured Cliffs Sandstone; Kl = Lewis Shale; Kch = Cliff House Sandstone; Kmf = Menefee Fmtn.; Kpl = Point Lookout Sandstone; Km = Mancos Shale; Kd = Dakota Fmtn.; J = Jurassic rocks; TR = Triassic rocks; P = Permian rocks; IP = Pennsylvanian rocks; X = Proterozoic rocks
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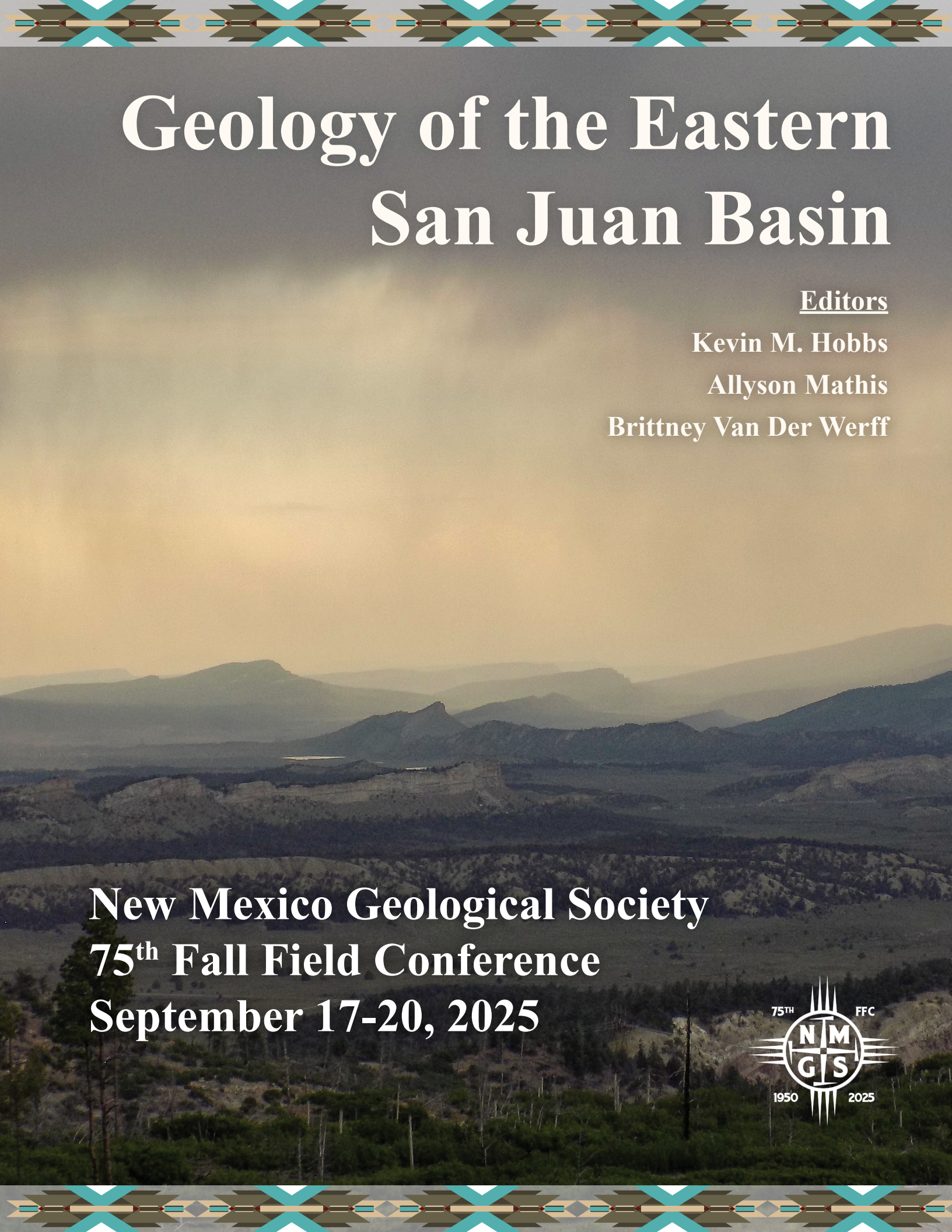
Geology of the Eastern San Juan Basin

Editors

Kevin M. Hobbs

Allyson Mathis

Brittney Van Der Werff



New Mexico Geological Society
75th Fall Field Conference
September 17-20, 2025

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The New Mexico Geological Society is a tax-exempt corporation registered in the State of New Mexico that promotes interest in geology and associated sciences, fosters scientific research and publications, encourages cooperation among its members, and stimulates interest in New Mexico geology. These goals are met through annual fall field conferences held in different locations in New Mexico or adjoining states and annual spring meetings, generally held in Socorro, New Mexico, where oral and poster presentations on different aspects of New Mexico geology are given.

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CONFERENCE ORGANIZER'S MESSAGE

The 75th New Mexico Geological Society Fall Field Conference (FFC) is a homecoming of sorts for the society. Friday, November 3, 1950, the first day of the inaugural FFC, brought attendees through Cuba, where the guidebook instructed drivers to refuel at one of Cuba's eight (!) filling stations, as there were no others until reaching the day's destination at Pagosa Springs, Colorado. The routes traveled and the outcrops observed by those geologists 75 years ago are much the same now as they were then (although present-day Cuba has far fewer gas stations). However, the science of geology has advanced considerably in the intervening three-quarters of a century. As we explore the geology of the eastern San Juan Basin, let us remember the scientific foundations laid by pioneering New Mexican geologists—many of whom attended the 1950 and subsequent FFCs—as we contemplate what they could not have imagined. We are well-served to remember that the plate tectonics revolution did not happen until 18 years after that first FFC. In 1950, radiometric dating was in its infancy but was rapidly advancing due to the post-war influx of expertise, materials, and curiosity. (Late 1940s lead-isotope radiometric dating attempts calculated Earth's age at around 3.3 billion years old. The argon-argon dating technique that has so benefitted New Mexico geology wouldn't be developed until the 1960s. The 1950 guidebook does not reference a single radiometric date). Digital capabilities in mapping, subsurface analysis, and communication have revolutionized the way that geology is performed. In spite of paradigm-shifting changes since the first FFC, the observations, interpretations, and questions that it brought to light are no less relevant today, and they have the same intent: to satisfy our curiosity for a more beneficial understanding of our planet's geologic history. The search is not over; it never can be. The New Mexican geologist of 2100 will learn about, challenge, and come to know scientific wonders that we denizens of 2025 cannot yet imagine.

This year's conference focuses on the eastern San Juan Basin. This margin of the basin is easily defined in some places, but difficult to locate in others. It is my hope that this ambiguity drives the curious mind to questioning over the next few days. Last year's conference in Bernalillo introduced the idea of a geological nexus: it explored the region where three major physiographic provinces meet (the Colorado Plateau, the Rio Grande rift, and the Rocky Mountains). That concept can be carried into this year's field areas. While we mostly observe Colorado Plateau- and Rocky Mountains-style geological features, the Rio Grande rift creeps westward from the eastern horizon. The eastern San Juan Basin's world-class stratigraphic section adds another dimension to consider in this year's nexus: time. The biotic, tectonic, climatic, and eustatic changes preserved in the stratigraphic section here allow contemplation on deep time. It is my hope that this conference provides a complement to last year's (2024) and next year's (2026) conferences, all of which investigate the complex relationships in north-central New Mexico's geologic history.

I found it intimidating to organize a conference in a region that the NMGS has visited several times: the 1st (1950), 2nd (1951), 28th (1977), 43rd (1992), 48th (1997), and 61st (2010) FFCs all focused upon the San Juan Basin. Each of those conferences produced a guidebook that is, at times, dizzying with the breadth and depth of knowledge displayed by the contributing authors. If this year's guidebook can provide even a fraction of the utility as those preceding it, then it will be a success. The fundamental knowledge established by and explained in earlier guidebooks has provided not only a foundation upon which I attempted to build the scientific contributions in this year's volume, but also an inspiration for the years of curiosity and satisfaction that I have derived from San Juan Basin research. To be able to share it with you is one of the highlights of my career.

Kevin M. Hobbs

DEDICATION



Steve Cather and Rojo, mapping in the Rio Grande Valley

In his geologic career, Steve Cather has notably advanced our understanding of the stratigraphy of the San Juan Basin. But the San Juan Basin is just one of his many interests. Over his career, Steve has tackled significant stratigraphic and structural problems in the Rio Grande rift, Colorado Plateau, and southern Rocky Mountains. Moreover, he eagerly engages these issues in his many publications.

Steve Cather came from Woodland Hills north of Los Angeles. While growing up, Steve developed an appreciation for science and how it explained the natural world. In the San Fernando Valley, he formed a cadre of friends that have remained close since their childhood years. Steve enjoyed going to the Mojave Desert region and local lakes (like Lake Havasu), often camping there with his family and later his friends. Perhaps in part to escape the crowds of Los Angeles, Steve liked the solitude of California's mountains and desert, an affinity that would suit him well in mapping the vast open spaces of New Mexico.

Outside of geology, Steve is known for his willingness to explore numerous pursuits and hobbies. He and his wife Martha spent many years building their house and the many outbuildings on their 15 acres of land near San Antonio, New Mexico. Hobbies have included riding and packing horses for field work and game hunting, becoming knowledgeable about optical equipment such as binoculars and telescopes, and collecting and repairing guns. Although no longer a bird hunter, he has always had a German Shorthaired Pointer as a canine companion. Steve also has long had a passion for music. Over the past two decades, he has been the lead singer and rhythm guitarist for the band Why Knot in Socorro, accompanied by his wife Martha on guitar and keyboards. Steve and Martha also enjoy dancing to western swing music and have polished dance floors all over New Mexico and Texas. In the past several years, Steve has also developed an interest in gardening.

In regards to his education and early career, Steve began college at California State University-Northridge (1971–1974) before transferring to New Mexico Tech, where he obtained a BS in geology in the summer of 1976. After graduating, Steve worked briefly in the private sector. He first worked with Kerr-McGee Corporation as a uranium grade-control geologist (6 months) before working as a uranium exploration geologist for a couple of months with Houston Oil Minerals Corporation.

Steve then returned to school for several years as a graduate student at the University of Texas in Austin. He graduated with a MA in geology in 1980 followed by a PhD in geology in 1986. As a protégé of R.L. Folk, Steve's research interests remained in New Mexico even while he "studied abroad" in Texas. His master's thesis focused on the sedimentology and stratigraphy of the Baca Formation on the Alamo Navajo Reservation, and his PhD dissertation explored the sedimentology and related tectonic implications of the Datil and Spears Groups (approximately 40–32 Ma volcanic and volcaniclastic sediment in the northern Mogollon-Datil

volcanic field). It was in 1980, while in Austin, that Steve met his wife Martha. They spent much time taking in the Austin music scene and two-stepping at the legendary Broken Spoke and other dance halls in the Austin area. Steve obtained a job at New Mexico Tech after completing his PhD, and has been in Socorro ever since. His first job was a Sabbatical Leave Replacement (for Dr. J. MacMillan) and then he worked a short stint in the Petroleum Recovery Research Center (PRRC). Between September of 1987 and February of 2019, Steve worked full-time at the New Mexico Bureau of Geology and Mineral Resources (NMBGMR), specializing in sedimentology-stratigraphy issues and tectonism.

Steve's curiosity and energy drove him to explore complex geologic questions and resulted in several important publications. His papers center around topics that include Phanerozoic tectonics (Ancestral Rocky Mountain, Laramide, and Eocene-modern extension); Cenozoic erosion and depositional history; the stratigraphy of the Santa Fe Group; and late Eocene volcanism and sedimentation in central and northern New Mexico and Arizona, including the Baca Formation, the Mogollon-Spears Group, and the Chuska erg. Relatively novel issues that have piqued his interest include the Cenozoic uplift history of the Rocky Mountain region, climate forcing by iron fertilization, the geologic history of the San Juan Basin, and the magnitude of dextral slip on major fault systems in central New Mexico. In 1994, he teamed up with Randy Keller to produce Geological Society of America Special Paper 291, *Basins of the Rio Grande Rift: Structure, Stratigraphy, and Tectonic Setting*—a key resource for anyone interested in the Rio Grande rift. His 2004 manuscript "Laramide orogeny in northern New Mexico and southern Colorado" remains the go-to reference for those working in Cretaceous–Paleogene tectonism in the Four Corners, with an average of around one new citation per month as it enters its third decade of existence.

Steve has been involved in twenty 1:24,000 geologic mapping efforts across New Mexico. His "STATEMAP trail" began in the northern Albuquerque basin (Santo Domingo basin) and quickly turned to the Socorro basin and Quebradas to the east. In the Quebradas, Steve was lead-author on five 7.5-minute quadrangles and did much of the work on horseback. He also has authored three quadrangles in the southeastern Colorado Plateau and San Juan Basin.

Through the careful and rigorous application of sedimentology, geochronology, and structural geology methods to basin-scale problems, Steve's research in the San Juan Basin serves as a model and inspiration for those wishing to understand complex basin histories. By combining methodical field observations, cautious analysis of subsurface data (no doubt aided by his background in industry and at PRRC), and collaboration with analytical specialists, Steve has shown us that the Laramide orogeny proceeded with three episodes of uplift, that the fluvial response to basin tectonism is far more complex than previously assumed, and that stratigraphic trends can be used to track phases of strike-slip movement across multiple generations of faulting. His collaborations with geochronologist Matt Heizler (NMBGMR) and paleontologist Tom Williamson (New Mexico Museum of Natural History and Science) led to the most comprehensive understanding of the sedimentary-tectonic effects of the Laramide orogeny yet produced in New Mexico. Steve's outcrop-to-subsurface correlations also elucidated the Chuska erg, an Oligocene eolianite surpassed in size only by the Navajo Sandstone of the Jurassic. In his emeritus status, Steve remains a sought-after source of advice and critical reviews for topics relating to the sedimentology, structural geology, and tectonics of the San Juan Basin, including for this volume's road logs and manuscripts.

In the Socorro area, Steve is an expert on the stratigraphy and structures of the Quebradas region, visited in the 2022 Fall Field Conference. His recently released memoir (NMBGMR Memoir 51 *Geology of the Quedradas Region, Socorro County, Central New Mexico*) epitomizes Steve's skill in relating stratigraphy and geologic mapping to understand paleotectonics and paleolandscapes. In addition, this memoir showcases how he and Gary Axen interpret the nature and genesis of a unique system of low-angle detachment faults. We are confident this memoir will serve as an essential resource for those interested in Paleozoic–Mesozoic stratigraphy, Phanerozoic tectonism in central New Mexico, and the mechanics of low-angle detachment faulting.

Steve Cather's career will long be remembered in the San Juan Basin, in New Mexico, and throughout the larger Rocky Mountain West. It is with great pleasure that we dedicate this year's guidebook to our colleague and fellow field geologist.

Daniel Koning and Kevin Hobbs

PRESIDENT'S MESSAGE

Welcome all to the 75th Annual Fall Field Conference (FFC)! I am excited to join you for this diamond anniversary of the New Mexico Geological Society (NMGS) FFC; although, unfortunately, I do not think we will see any diamonds out in the field. The tradition of world-class geologic teaching and learning continues once again this year with opportunities to see old friends and make new ones while seeing New Mexico geology up close.

This year's conference will build on knowledge gained from the 2024 Bernalillo FFC and extend our knowledge to the eastern margin of the San Juan Basin near Cuba (for the first time since 1992). The geology discussed in this year's conference will serve as an excellent foundation for the 2026 FFC, which will return to Albuquerque, a location that last hosted an FFC in 1999. Together, the 2024, 2025, and 2026 FFC will provide a broad understanding of the geology and interconnectedness of these three regions.

We owe a debt of gratitude to the numerous volunteers who make all our FFCs successful. Without your help, we could not continue to host these amazing events. I am eternally grateful to Kevin Hobbs, the leader of this year's conference, who has been an amazing steward of the society and its conferences. In addition, Kevin's tremendous knowledge of the San Juan Basin is unmistakable. This year's conference is sure to be another fantastic experience for everyone.

Additionally, I extend a heartfelt thank you to Bonnie Frey, the leader of the 2025 Spring Meeting. Bonnie's vision and dedication to the success of the meeting was palpable and was another fantastic gathering of scientists in New Mexico. None of the NMGS meetings or conferences would be a success without the amazing contributions of Connie Apache. Connie assists in every aspect of these events, and we could not do them without her. I also thank the NMGS Foundation for acting as stewards for the society finances and helping to ensure a sustainable organization for years to come.

One of the most important aspects of NMGS is the student scholarships and awards granted. In the past year, the Society has awarded over $50,000 to New Mexico's geology students in the form of scholarships, competitive grants, registration for Spring and Fall Conferences, and book awards. I thank the numerous donors who help make many of these scholarships possible and contribute to the next generation of New Mexico geoscientists. Special thanks to Scholarships Committee Chair Susan Lucas Kamat, whose unselfish dedication to the scholarship organization and planning has helped deliver a years-long succession of student support.

Finally, I thank all of you, the attendees to 2025 FFC, for your engagement and interest in the geology of New Mexico. Now let's go see some rocks!

Johanna M. Blake

2025 NMGS President

NEW MEXICO GEOLOGICAL SOCIETY FOUNDATION

I recently read some insightful excerpts from the "History of the New Mexico Geological Society, 1947–1968" by Stuart A. Northrop (NMGS Special Publication 2, 1969). The Geological Society of New Mexico (as it was originally known), an entity created by Vincent Kelley, Caswell Silver, and Gordon Wood Jr., first met in Albuquerque in 1947 with 89 geologists in attendance. In 1950, the first Fall Field Conference was held in the San Juan Basin, with accompanying road logs for the area. In 1954, a revised constitution was written and the name of New Mexico Geological Society (NMGS) was adopted. From T.F. Stripp's "History of the Society, 1955" remarks, five specific goals were described for the future of the NMGS: (1) NMGS will represent all branches of the profession, (2) such interests will be represented in the NMGS annual meeting, (3) Fall Field Conferences will continue, (4) monies will be available to help students, and (5) the NMGS will recognize its responsibility to the general public and advise on legislation of natural resources in the state of New Mexico. With this introduction, I would like to update members with regard to these goals and the overall financial state of the NMGS.

On the 75th anniversary of the society's Fall Field Conference, I would like to first thank our members and volunteers for all their support in making the NMGS the premier state geological society in the nation. I joined the NMGS Foundation 13 years ago with Tony Benson, Laura Crossey, and John Shomaker as Foundation board members. At the time, I had participated in Spring Meetings and Fall Field Conferences, but had little knowledge of the activities or even the existence of the "sleepy" Foundation Board. Much has changed since. The NMGS Foundation is responsible for the generation of revenues that support all activities of the society. The foundation, as a 501(c)(3) corporation, also serves to protect the society's assets against liability claims and preserves the tax-deductible status for donations.

The main source of NMGS revenues are royalties generated from oil and gas wells in the Farmington area gifted to the NMGS from the Pipkin family. Originally these monies were used to support current activities of the NMGS, but a portion was saved to build an investment portfolio that could generate long-term revenues. The foundation was established in 2003 to oversee revenue and asset generation, with the NMGS Executive Committee remaining as a separate entity tasked with spending monies to support NMGS activities.

As president of the board for the last 12 years, I have seen the board respond to many challenges. The first of these was the declining price of natural gas in the United States. This started around 2010 and had an enormous impact on the capacity of the foundation to generate revenues. Within a four-year span, royalties for NMGS gas wells had dropped over 75%. As a result, NMGS budgets were slashed and we struggled to support ongoing operations. The environment posed a challenge for many NMGS officers, especially for those on the Foundation Board. In 2015, we established a new normal for operating budgets and focused on supporting critical NMGS activities such as the NMGS Spring Meeting, NMGS Fall Field Conference, and providing funding for student registration/membership fees for these events and student Grants-in-Aid. Within these tighter budgets, the Foundation Board set out to build a larger and more reliable revenue stream rather than relying on the fluctuating price cycles of natural gas. Thus, we decided to expand and restructure our investment portfolio with the goal of achieving sustainable yearly budgets for the long term.

In 2015, the balance of the NMGS investment portfolio dropped below $1.0M, even with smaller budgets being approved. These budgets still required us to spend >6% of our investment account balance, which was an investment extraction rate that would not be healthy for the long term. We began with a long-term target of building an investment portfolio of $2.0M, which would allow the 2015 budget to reflect a ~3% extraction amount. Thus, we maintained trimmed budgets and directed any additional revenues to our investment portfolio. In 2016, we also expanded our board to five permanent members to include a gift officer. We found James Cearley to fill this role and a gift program was implemented the next year. Since 2017, gifts to the NMGS Foundation have climbed steadily, with 2024 amounts exceeding $40k. Since 2016, the investment portfolio has grown to over $2.0M, with yearly NMGS budgets now representing just over 3% of the balance of the investment portfolio, which is a very healthy rate of extraction for a 501(c)(3) that intends to exist for the long term.

The board is currently composed of six members: John Shomaker, Bob Newcomer, James Cearley, Kate Zeigler, Bonnie Frey (rotating ex officio NMGS EC member), and myself. All are highly committed to the NMGS with between 7 and 18 years experience on the board. Although we sometimes forget it, the NMGS is operated by volunteers and I would like to thank all active and previously active members of the NMGS including those serving on the Executive, Scholarship and Publication Committees, and those involved in organizing Spring Meetings and Fall Field Conferences. I would also like to thank all previously serving Foundation Board members and those with whom I have had the honor to serve with since 2012. After 13 years, I will be stepping down knowing that the foundation is financially positioned to continue its mission into the foreseeable future just as T.F Stripp had envisioned back in 1955. With the strength of current and future members, the NMGS will continue to reign as the premier state geological society in the nation.

Frank C. Ramos
President, NMGS Foundation Board