Leveraging New Mexico's Legacy Subsurface Data Archive for Geothermal Exploration and Development

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ABSTRACT

New Mexico has well-developed petroleum and mineral resources across the state, generating a vast archive of subsurface data through drilling, exploration, and production. With the growing urgency of the energy transition and state-level incentives for renewable energy, geothermal resources are now a priority. The New Mexico Bureau of Geology and Mineral Resources' (NMBGMR) Subsurface Library archives subsurface exploration information from fossil fuels, mining, geothermal, and groundwater resources and serves as an incredible resource for advancing geothermal development. The New Mexico Bureau's Subsurface Library serves as a central repository for a wide variety of subsurface data, including continuous and skeletal core, drill cuttings, physical and digital geophysical and temperature well logs, as well as petrochemical and geochemical analyses, from wells across the state. Subsurface data has already been used extensively in various research projects involving critical mineral, groundwater and oil & gas exploration and emerging low-carbon technologies such as carbon sequestration. Additional information relevant to geothermal exploration resides with partner agencies, and together, these collections represent an excellent resource for geological and engineering insights relevant to geothermal exploration, and for building out a more extensive geothermal database for New Mexico.

This paper serves as an update of nearly two decades of new data from new wells and acquisitions, updates to workflows for accessing, integrating, and interpreting these publicly available data sets specific for geothermal exploration and research. Resources covered include the NMBGMR's Subsurface Library and Geothermal database, OCD's digital hub, and state-level efforts to expand geothermal databases. Case studies—such as updated thermal and heat flow maps of New Mexico and updated subsurface interpretations—demonstrate practical applications of this data repository for identifying and de-risking geothermal exploration opportunities. By synthesizing these resources into a coherent guide, we aim to support developers and researchers in leveraging New Mexico's extensive subsurface record with recommendations for improving accessibility, identifying gaps, and fostering collaboration to enhance geothermal exploration and development across the state.

1. INTRODUCTION

Geothermal development requires extensive geological information about a region. Researchers and developers approach a project with the same question - "what data already exists?" Answering this question is essential for reducing the risk of exploration costs and strategies, especially when trying to characterize the subsurface. Developers rely on high-quality subsurface data—including well logs, temperature records, lithologic information, and geophysical surveys—which collectively guide decisions about resource potential and project feasibility. Data repositories are essential public infrastructure, providing crucial data storage, access, and sharing services to support exploration companies, researchers, state agencies, and land managers who depend on accessible and reliable information. In New Mexico, several departments and entities hold key pieces of the subsurface record, including the Oil Conservation Division (OCD), the Office of the State Engineer (NM OCE), and the NMBGMR Subsurface Library (Geoinfo).

Various natural resource research groups within the NMBGMR are collectively aiming to make geological data more open and user-friendly by creating a more robust, standardized, and accessible database with coherent data updating processes. Data can then be requested or directly accessed by researchers and agencies that carry out exploration or feasibility studies with greater confidence. This paper specifically focuses on the subsurface geological information housed at the NMBGMR's Subsurface Library relevant to geothermal exploration, as an ongoing effort is to increase both the visibility and usability of related data resources.

Currently, the state possesses strong datasets, but they are dispersed across multiple platforms, have inconsistent accessibility and formatting standards, and often lack clear guidance for practical use. This fragmentation underscores the need for deliberate cataloging and transparent access, which are crucial for organizing data efficiently, facilitating exploration processes, and attracting investment. The following work is guided by a clear intent: to take stock of the resources that already exist, identify gaps, acknowledge what remains unorganized, propose a roadmap, and outline steps toward a standardized, comprehensive geothermal data catalog for New Mexico.

By breaking down data silos and creating a standardized central repository for geothermal data in New Mexico, both the public and stakeholders can easily access and utilize valuable information for decision-making and project development. This initiative will streamline processes and foster collaboration and innovation within the geothermal energy sector in the state.

2. EXTRACTIVE RESOURCES OF NEW MEXICO

Historic hydrocarbon development, mining, and groundwater exploration have collectively produced an extensive subsurface data record in New Mexico. Early extraction of base metals, precious metals, and stones, followed by coal mining in the late nineteenth century (Anderson, 1957; Callaghan, 2025), and widespread oil and natural gas development beginning in the early twentieth century have played a role in New Mexico's economic development (Fonquergne et. al. 2025). These activities required increasingly sophisticated geological, geophysical, and drilling investigations, resulting in the collection of stratigraphic logs, core samples, geochemical analyses, geophysical surveys, and well completion records. Parallel expansion of groundwater development to support agriculture, industry, and population growth further contributed to subsurface characterization efforts. Many state agencies and regulatory frameworks were established around resource development, and the organization, distribution, and stewardship of archived subsurface data reflect decades of coordinated exploration and extraction.

Prior to 1953, more than 13,000 wells were drilled in New Mexico, and since 1973 an additional 139,221 wells have been drilled. There are an additional ~98,000 drilling permits dating back to 2004, issued for various activities ranging from oil and gas, water, mining and CO_2. This forms the foundation of a large and spatially diverse subsurface dataset. This legacy of data collection is increasingly critical as New Mexico transitions toward a diversified, low-carbon energy portfolio. The state has significant potential to become a leader in geothermal energy, with concentrations of elevated heat flow and development favorability along the Rio Grande Rift, and northern petroleum basins (Roberts, 2018; Aljubran & Horne 2024), leveraging existing subsurface knowledge to reduce exploration risk and accelerate development. In 2024, the New Mexico State Legislature enacted tax credits for geothermal power and allocated $12.5 million in geothermal grants to tribal governments, state agencies, and universities, $2.5 million in low-interest loans for the geothermal industry, and $1.5 million over three years to support the geothermal program at New Mexico Tech (HB 91, NM Taxation and Revenue). The availability, accessibility, and integration of historical and modern subsurface datasets are essential to evaluating geothermal resources, identifying favorable reservoir conditions, and supporting both industry investment and academic research. In this context, New Mexico's subsurface data archive represents a critical asset for informed resource assessment, responsible development, and innovation in energy exploration.

3. SUMMARY OF THE SUBSURFACE LIBRARY

The New Mexico Bureau of Geology and Mineral Resources (NMBGMR) maintains an extensive subsurface library that serves as a centralized repository for subsurface geologic materials and related information across the state. The library houses over 100,000 drill cuttings, core and well records, geophysical logs from over 50,000 wells, and associated metadata that support a broad range of research, regulatory, and industry applications. By consolidating these materials in a single facility, the NMBGMR provides long-term preservation and public access to critical subsurface data.

The subsurface library is designed to require little to no ongoing maintenance, effectively minimizing facility-related overhead and keeping access costs low for researchers, industry users, and the public. Core and cuttings from up to five wells may be examined on site at no charge, while additional materials can be requested through mail order at the requester's expense. Most well logs and related documents are available via digital delivery. Data requests typically include an API number and/or operator name, well name, and location information (section–township–range and county). In addition, geospatial maps and related resources are accessible through the Bureau's website.

While the NMBGMR subsurface library functions as a comprehensive and non-selective archive of subsurface materials, additional state agencies maintain complementary databases. The New Mexico Energy, Minerals and Natural Resources Department (EMNRD) houses several datasets relevant to geothermal exploration, including those managed by its geothermal division. The New Mexico Oil Conservation Division (OCD), operating under EMNRD, maintains one of the most extensive subsurface data archives in the state as part of its regulatory oversight of oil and gas development. OCD collects and curates well production data, permits and tracks drilling activity, enforces state oil and gas statutes, oversees plugging and abandonment operations, and ensures responsible site reclamation. The division maintains detailed records for more than 82,000 oil wells and over 40,000 gas wells statewide.

A comparative summary of bureau-hosted and state regulatory data is demonstrated in Figure 1 and 2 to demonstrate the spatial distribution of the NMBGMR subsurface library relative to NMOCD's records. Unlike agency-specific databases that reflect regulatory or operational priorities, the NMBGMR subsurface library collects and preserves subsurface materials broadly and without restriction. When appropriate, information is shared or directed to other state or bureau departments, ensuring wide accessibility while maintaining the library's role as a comprehensive, long-term repository for New Mexico's subsurface geologic data.

3.1 Geothermal Database

The Geothermal Database is a NMBGMR-hosted database that compiles relevant information for geothermal resource potential. The database is built from several sources such as groundwater and spring chemistry data, and data taken from the subsurface library. Wireline temperature logs that are acquired either shortly after drilling, or later in cased holes, bottom hole temperature (BHT) data, and other surface and subsurface information is housed in this database. Comparable geothermal temperature information for Colorado was integrated from publicly available sources, including the Colorado Geological Survey (e.g., Dixon, 2004) in the NM Bureau Geothermal Database. Collectively, these datasets provide critical inputs for geothermal prospecting, regional heat-flow studies, and basin-scale thermal modeling.
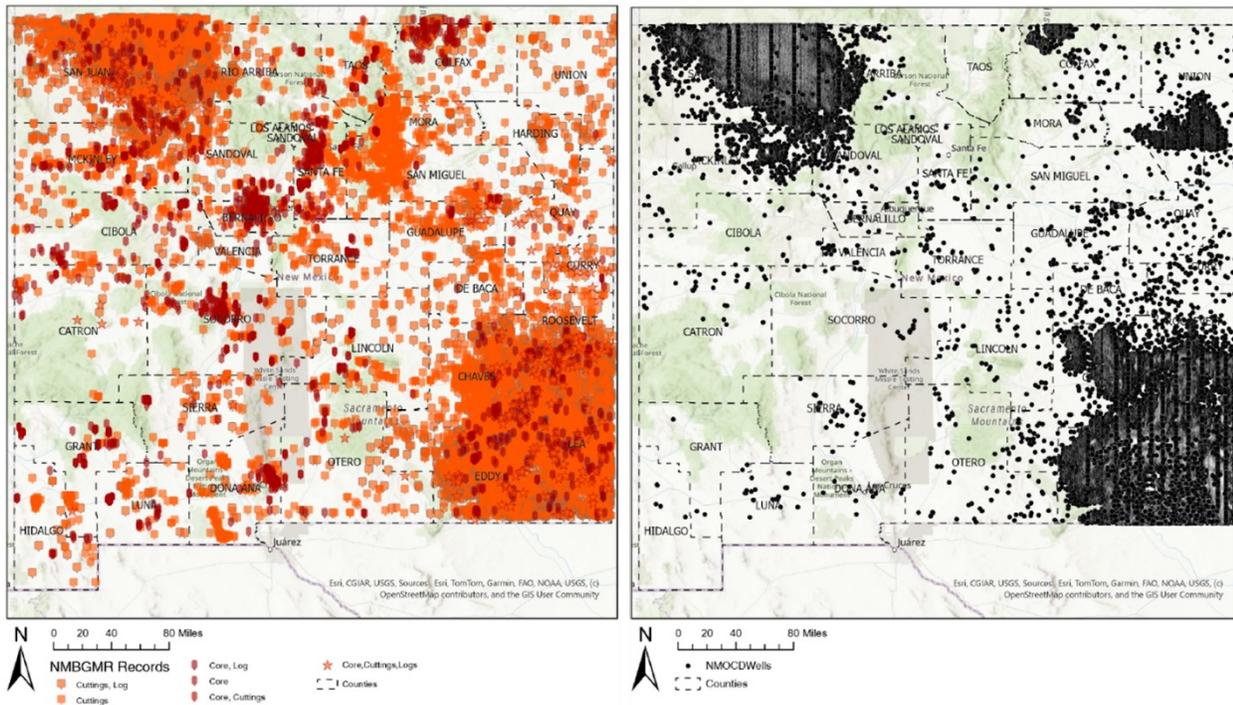

Figure 1: Comparison of NM Subsurface Library Data Repository (left) versus NM OCD repository (right).
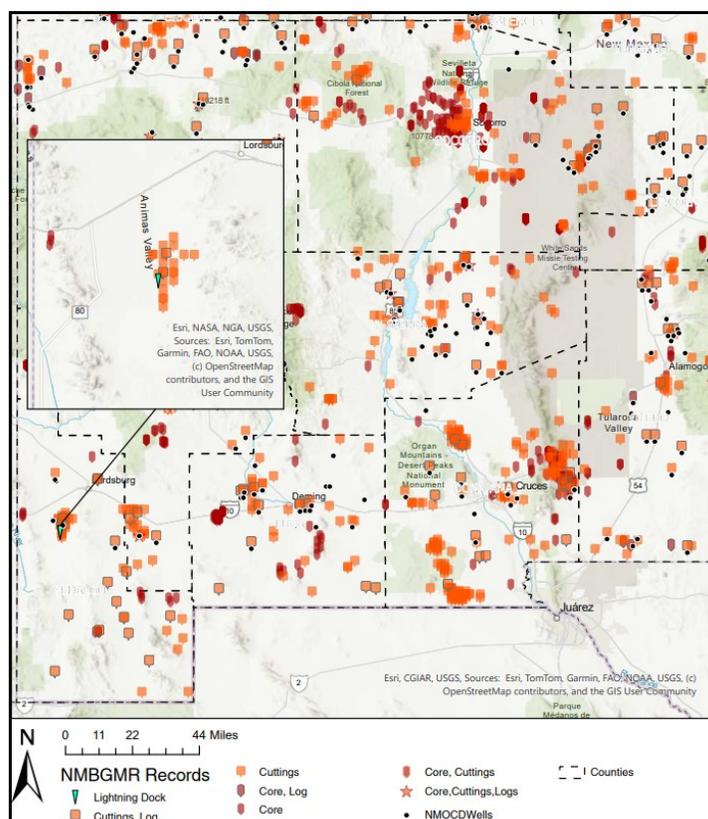
Figure 2: Comparison of NMBGMR (orange and red), and NMOCD (Black) data spread in the "bootheel" New Mexico demonstrating the density and breadth of data hosted at the subsurface library. The "bootheel" is the only region in New Mexico with an active geothermal power plant.

4. CASE USES OF THE SUBSURFACE LIBRARY

4.1 Subsurface Well Data for Basin Modeling

Digitized well data housed within the subsurface library have been used to support both basin-scale and site-specific geothermal studies. These datasets include a wide range of digital logs that enable basin characterization efforts, such as those conducted in the Rincon Valley (e.g. Kelley, 2015). Bottom-hole temperature (BHT) measurements extracted from archived geophysical logs maintained by the New Mexico Bureau of Geology and Mineral Resources and the NMEMNRD–Oil Conservation Division were compiled and reanalyzed to estimate regional geothermal gradients. Using these legacy datasets, Kelley (2015) concluded that the Raton Basin has limited geothermal power potential at a regional scale. Using corrected BHT-derived geothermal gradients average approximately 52°C/km in the Raton Basin and 34°C/km in the adjacent Las Vegas–Tucumcari basins, with the 150°C isotherm occurring at depths of roughly 3 km and greater than 4 km, respectively. A similar study by Kelley et al. (2016) looked at the Acoma Basin, where temperature, water chemistry, geologic, and geophysical datasets were compiled and analyzed in a GIS framework to identify potential blind geothermal systems. Oil and gas well BHT data were obtained from well headers on geophysical logs archived at the NMBGMR subsurface library for heat flow and gradient models. Estimated geothermal gradients in the study area range from approximately 48 to 74 °C/km, and further analysis of BHTs indicated a spatially complex thermal regime.

More recent studies utilized uncorrected bottom-hole temperature measurements from petroleum wells to estimate thermal gradients across New Mexico's three major conductive basins. Calculated gradients include 2°F/100 ft (37°C/km) for the Raton Basin, based on nine stations with a 48.2°F (9°C) surface temperature intercept; 1.6°F/100 ft (29°C/km) for the San Juan Basin, based on sixteen stations with a 50°F (10°C) intercept; and 0.9°F/100 ft (16°C/km) for the Delaware Basin, based on ten stations with a 60°F (16°C) intercept (Kelley et. al. 2025).

These studies demonstrate how historical oil and gas data archives can be repurposed to constrain subsurface thermal conditions, reduce exploration uncertainty, and inform geothermal resource assessments without the need for new exploration drilling. The extensive BHT dataset supports cross-basin comparisons and integration with stratigraphic, structural, and lithologic interpretations derived from wireline logs. When combined with modern reprocessing and interpretation techniques, these digital records continue to support refined thermal models and improve confidence in subsurface temperature predictions. The longevity and diversity of datasets within the subsurface library further enable historical data to be evaluated alongside newer studies, ensuring continuity and consistency in basin-scale geothermal assessments.
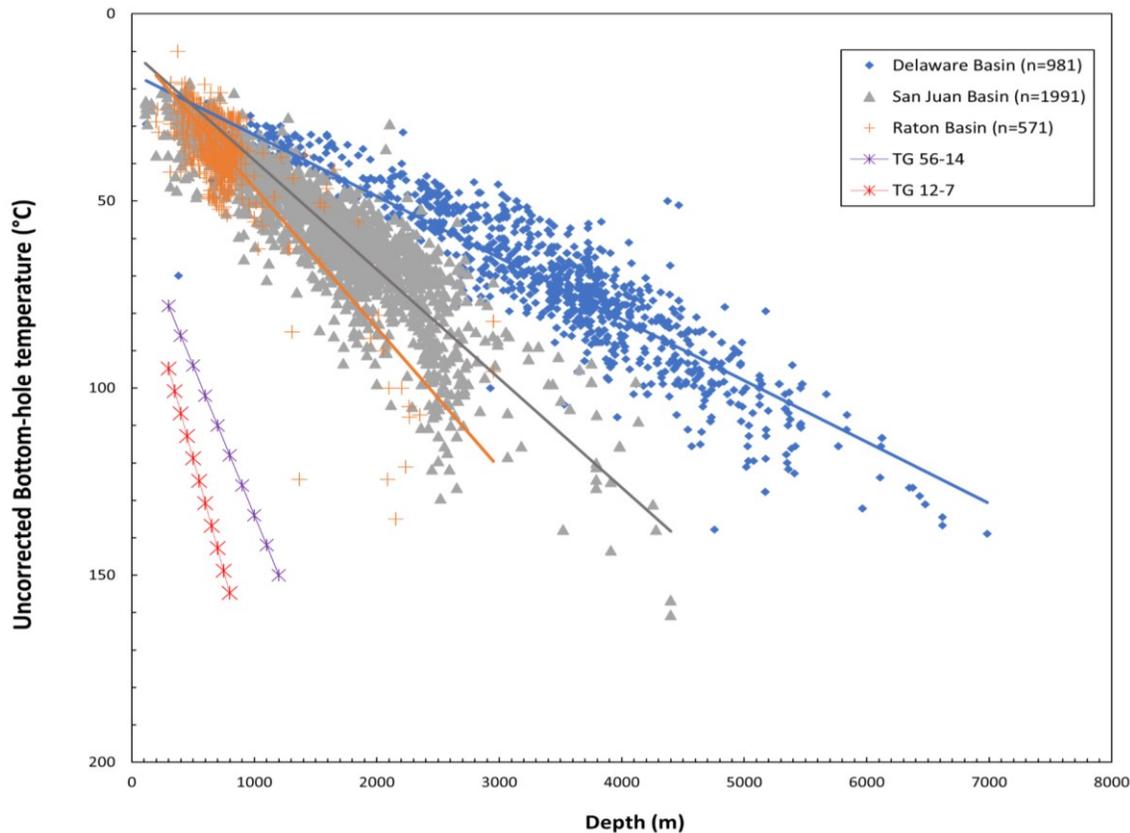
Figure 3: Uncorrected bottom-hole temperature measurements for the conductive, oil-producing Raton (orange), San Juan (grey), and Delaware (blue) Basins using data from the NMBGMR Subsurface Library. Temperature gradients of wells TG 56-14 (purple) and TG 12-7(red) from Animas Valley - where Lightning Dock Geothermal Power Plant is located. Temperatures for Lightning Dock are extrapolated from Cunniff & Bowers, **2003 . Figure adapted from Kelley et al, 2025.**

4.2 Physical Samples for Geological Characterization

In addition to digital data, physical samples preserved in the subsurface library play a critical role in detailed geological evaluations for early to mid-stage exploration. A geologic prognosis of expected lithologies and structures to approximately 20,000 feet below known geothermal resources for the Eavor Deep well, drilled in Lordsburg, NM, relied on physical samples from the subsurface library, complemented by field mapping and other exploration datasets (Liston et. al. 2023). These samples provided direct constraints on lithology, alteration, and basement characteristics that could not be resolved from logs alone. Wells that contributed to this analysis include the Steam Reserve well and the Cockrell wells (Witcher, 2008), each of which penetrates slightly more than 7,000 feet of stratigraphy. Existing borehole data from these wells have been reprocessed to improve subsurface interpretations, providing guidance on casing decisions, potential zones of permeability.

Planned and ongoing studies to further build on the characterization of deep basement rock will utilize cuttings recovered from the Eavor Deep Well and include infrared (IR) spectroscopy and geochronologic age dating of preserved samples. While IR spectroscopy is a relatively new and emerging tool in geothermal applications, it shows promise for mineralogical and alteration studies and targeting areas. Regardless of analytical approach, continued access to physical samples remains essential for advancing borehole characterization, refining basement rock models, and improving confidence in deep geothermal resource assessments.

5. SUMMARY AND FUTURE WORK

The utilization of the subsurface library in the energy transition supports the mission of the New Mexico Bureau of Geology and Mineral Resources (NMBGMR) by distributing accurate, accessible information to scientists, decision makers, and the public regarding New Mexico's geologic infrastructure. By serving as a long-term repository for subsurface datasets, and by expanding both physical and online access to these resources, the enhanced library can strengthen research, inform policy and investment decisions, and support responsible development of New Mexico's geothermal resources. The data preserved in the New Mexico subsurface library, along with datasets held by partnering agencies, represent decades of oil, gas, mineral, and groundwater development and provide a strong foundation for advancing geothermal exploration in New Mexico. Modern analytical approaches such as 2D and 3D basin modeling, geostatistics, and other data-driven methods can leverage these extensive archives to more effectively identify and characterize geothermal resources.

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Efforts to enhance and expand the geothermal database are ongoing. Current and planned activities focus on improving the accessibility, integration, and usability of subsurface datasets with hopes to digitize nearly the entirety of the subsurface library within the coming years. Additional initiatives aim to develop region-by-region inventories of geothermal-relevant data, providing a structured accounting of available temperature measurements, lithologic logs, geophysical data, and other data. Future collaboration with the Energy, Minerals, and Natural Resources Department (EMNRD) will include cataloging existing geothermal records and systematically digitizing, organizing, and preserving data for easier discovery and retrieval for researchers, regulators, and industry users.

Finally, plans are underway to develop a user-friendly, citable interface for the database that supports tracking of data usage, publications, and inquiries over time. This functionality will facilitate broader adoption of the database, enhance research and exploration outcomes, and support sustained funding, confidence, and long-term investment in New Mexico's geothermal data infrastructure.

6. ACKNOWLEDGEMENTS

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