Association of American State Geologists

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AASG

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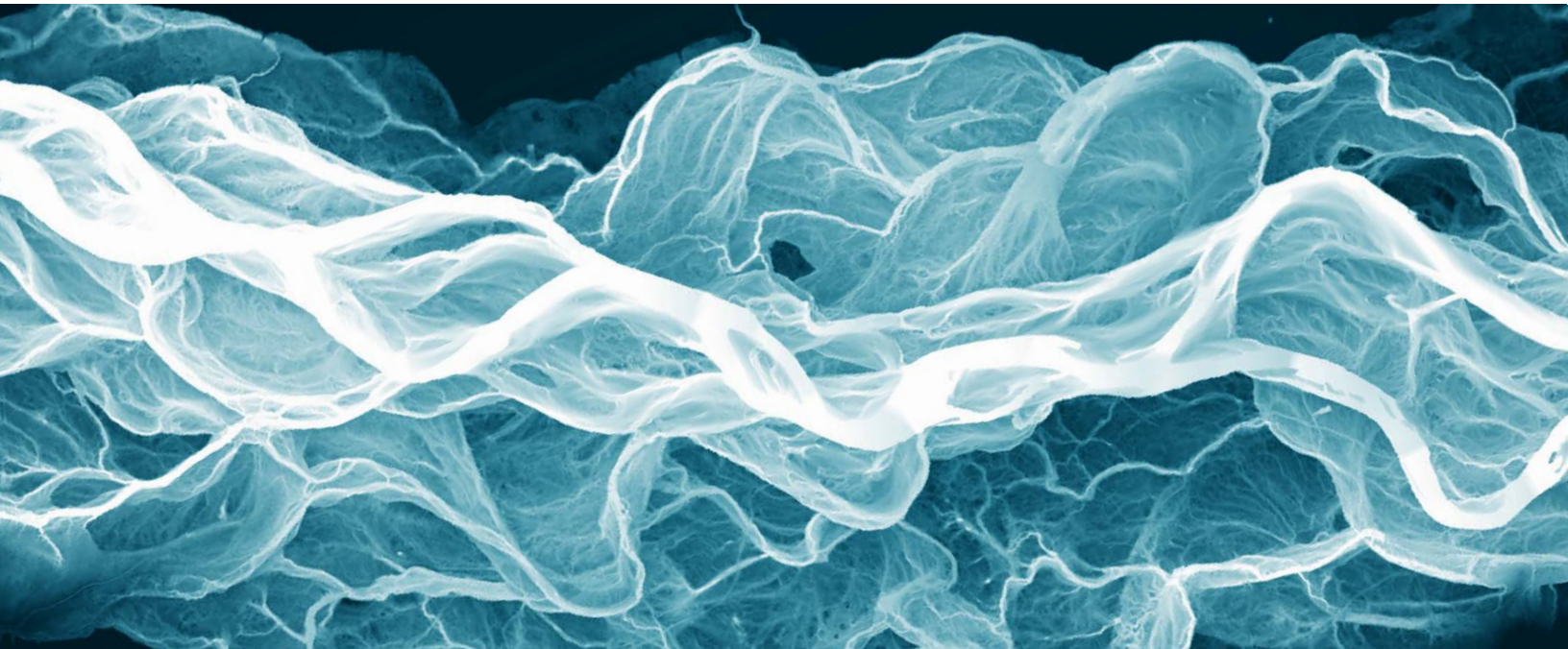
Front Cover Photo: Alaska Division of Geological and Geophysical Surveys Coastal Hazards Program manager Nora Nieminski investigates coastal erosion in Kaktovik, Alaska. *Credit: Alaska DGGS*.

Contents Page Photo: Lidar-derived image of the Suak River, Washington.
Credit: Daniel Coe, Washington Geological Survey.

CONTENTS



PRESIDENT'S LETTER

John J. Metesh

The 2023–2024 year will likely be noted as the start of the new generation of AASG; in the past five years, AASG has welcomed 30 new State Geologists (60% turnover), 17 in just the past 3 years—with new ideas, new challenges, and 116 years of history to be learned. The average time-in-service has dropped from 10+ years to less than 7, the median dropped from 7+ years to 1. AASG will change a great deal in the coming years and the first steps toward an updated strategic plan led by David Wunch (DE) and Erin Campbell (WY) will prove valuable in the coming years. A quick review of the AASG Statistician's report demonstrates a diverse and rapidly changing association that, rooted in tradition, must be ready to adapt to new ideas within new challenges without.

The past year saw continued high funding levels for Federal infrastructure programs; the result has greatly increased funding from USGS for State Map, Data Preservation, and Earth MRI (mapping and AIM)—all heavily invested by AASG member states. Similarly, many state surveys have received increased funding from DOE, BOEM, and OSM to name a few. Of course, we need to be prepared for the "fiscal cliff" of Fiscal Year 2026 and beyond. That challenge will be well met by AASG, our profile is strong and widely recognized in DC as a direct result of our Liaison activities as well as our year-round interaction with our Congressional Members.

Vice-President Jessica Moore (WV) and Host Bill Keach (UT) led an excellent AASG Annual Meeting at Park City, Utah in June. There were 36 State Geologists, their Associates, and family in attendance along with our colleagues with the U.S. Geological Survey, Bureau of Ocean Energy Management, American Geosciences Institute, National Association of State Boards, American Institute of Professional.

The AASG Executive Committee, Past President Jim Faulds (NV), President-Elect Jessica Moore (WV), Vice President Clare Falcon (LA), Treasurer Claudio Berti (ID), and Secretary Harley Means (FL) were a great pleasure to work with and I very much appreciate their wisdom and support. The support from state geologists throughout the year and throughout the many issues is much appreciated.

The State Geologists Journal presents the many and varied activities of state surveys and demonstrates the strength of the AASG. The Journal provides an excellent source of information for new State Geologists wanting to reach out for expertise in anything and everything geologic. So, please enjoy and utilize this State Geologist Journal.

Respectfully submitted,

John J. Metesh

AASG President

ALASKA

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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INTRODUCTION

Mission

Determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources, the locations and supplies of groundwater and construction material, and the potential geologic hazards to buildings, roads, bridges, and other installations and structures (AS 41.08.020).

Background

The Alaska Division of Geological & Geophysical Surveys (DGGS) is part of the Alaska Department of Natural Resources and is organized into eight program sections: Energy Resources, Mineral Resources, Geologic Hazards, Hydrology & Surficial Geology, Volcanology, the Geologic Information Center (GIC), the Alaska Geologic Materials Center (GMC), and the Alaska Geospatial Office (AGO). The total fiscal year 2024 expense budget for the division was $11.67 million, consisting of $4.26 million in state general fund receipts, $2.77 million in federal receipts, $2.10 million in capital improvement projects and interagency receipts, and $2.54 million in designated general fund and publication sales. DGGS maintains a website at dggs.alaska.gov, which provides access to its publications (68 new in fiscal year 24) and petabytes of digital data. DGGS also administers websites for the Alaska Volcano Observatory (avo.alaska.edu), the Alaska Seismic Hazards Safety Commission (seismic.alaska.gov), and the Alaska Geospatial Council (agc.dnr.alaska.gov).

MAPPING

Detailed geological and geophysical maps of Alaska at scales needed for resource exploration, land-use management, and geologic-hazards assessment are scattered geographically and currently available for only about 22 percent of the state, but our field programs are increasing this coverage gradually each year. The survey prioritizes the selection of new mapping areas in consultation with other state agencies, appropriate state boards and commissions, its Geologic Mapping Advisory Board, industry resource-interest groups, and other stakeholders. The survey is committed to delivering the results of its extensive field mapping programs to the public in a timely manner. The total area of published mapping in fiscal year 2024 was 2,904 square miles, with an annual average area of 3,500 square miles of published, peer-reviewed geologic mapping over the last 10 years.

Major mapping efforts included a total of 380 person-days of helicopter-supported fieldwork in the Yukon-Tanana Upland, 30 days of helicopter-supported fieldwork on the central North Slope to collect two stratigraphic test cores, preliminary mapping of 500 square miles west of Anchorage for the West Susitna STATEMAP project, and sand and gravel mapping on the North Slope for the Arctic Strategic and Transportation Resources (ASTAR) project.

Geophysical Surveys

Much of Alaska's lands with high mineral-resource potential have poorly exposed geology due to tundra and tree cover. Airborne geophysical survey data are invaluable for guiding subsequent ground-based geologic mapping, sampling, and associated mineral-assessment work, and DGGS is committed to acquiring data in areas of the state that have high mineral-resource potential, subject to availability of funding. Enabled by Earth MRI funding, in fiscal year 2024, geophysical surveying focused on the Kuskokwim mineral belt, a large area of prospective geology in the western portion of the state. Products include the 11,200-square-mile northern Kuskokwim Mountains and 3,100-square-mile Sischu Mountains datasets. DGGS is also participating in a USGS mineral assessment focused on the critical mineral graphite on the Seward Peninsula.

OTHER PROGRAM HIGHLIGHTS

The Geologic Information Center (GIC) continues to provide IT, GIS, and publication support to DGGS, and facilitated the release of 68 publications and distribution of over 30 TB of information from the division's website (dggs.alaska.gov) and geoportals. The Alaska Geologic Materials Center houses an archive of geologic data with an estimated $35 billion replacement value. The 90,000 square foot facility saw 650 visitors, including industry, lawmakers, the public, academic institutions, and other state and federal agencies. The Alaska Geospatial Office (AGO) continues to coordinate closely with the Alaska Mapping Executive Committee to modernize Alaska's spatial data infrastructure.

DGGS Alaska Volcano Observatory (AVO) staff visited 122 volcano monitoring stations across Alaska, flew 105 helicopter days, and responded to volcanic unrest at Kanaga, Gareloi, Spurr, and Cleveland volcanoes and eruptions at Great Sitkin, Atka, and Shishaldin volcanoes. The Landslide Hazards Program responded to a major landslide event in Ketchikan and released the Alaska Landslide Reporter App. The Coastal Hazards Program continues community-specific hazard exposure assessments for Alaska's coastal communities and made strides to connect with coastal community members through their new Alaska Flood Observations Facebook group, the Alaska DGGS Culvert Inventory, and in-person visits. The Climate and Cryosphere Hazards Program made strides in snow distribution and avalanche research and released multiple lidar surveys, including a survey of the Municipality of Anchorage. The Earthquake and Tsunami Hazards Program conducted 35 presentations around the state and played a critical role in the Tsunami Operations and Maritime Guidance workshops in Seward and Valdez, respectively. The Geological Health Hazards

Program continued outreach to raise awareness of geological health hazards like radon gas in Alaska (517 homes were tested for radon by the program in 2024) and administering the Alaska Groundwater Quality Program.

Figure 1. DGGS Coastal Hazards Program manager Nora Nieminski investigates coastal erosion in Kaktovik, Alaska.

Figure 2. Augustine Island with the Jurassic Naknek Formation above the far shore of Oil Bay, lower Cook Inlet, Alaska.

Figure 3. DGGS Mineral Resources geologist Jamshid Moshrefzadeh examines an outcrop in Interior Alaska.

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ARIZONA GEOLOGICAL SURVEY

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INTRODUCTION

The Arizona Geological Survey (AZGS) and its predecessors have been providing critical geologic information to the people of Arizona since 1893. The AZGS is part of the College of Science in the University of Arizona in Tucson; it is supported by an annual base funding appropriation from the state legislature and external grants and contracts. We pursue diverse funding opportunities and cooperative partnerships with federal, state and local agencies and the private sector to address the diverse needs for geologic research, investigations, and information across Arizona. The AZGS increased our budget and personnel in 2024 in response to expanded funding opportunities for geologic mapping, mineral resources research, geologic hazards research, and basin / subsurface analyses. Because of these enhanced funding opportunities paired with our wide range of staff expertise in geologic mapping, geologic resources, geologic hazards, and digital geologic data, we are conducting more research and investigations into Arizona geology than ever before.

GEOLOGIC MAPPING

The AZGS conducted integrated bedrock and surficial geologic mapping at detailed (1:24,000) and intermediate (1:100,000) scales in several areas across Arizona during 2023–2024. In addition, we began an ambitious, multi-year effort to develop a new 1:500,000-scale state geologic map. In the past 3 years our geological mapping efforts have increased substantially in response to increases in available federal funding; we have been able to allocate state funding to provide needed match for the federal funding. Nearly all our geologic mapping in 2023-24 was conducted as part of the STATEMAP Program. Geologic mapping completed in 2023-24 complemented previous STATEMAP mapping projects as part of a multi-year effort to map the geology along the Phoenix-Las Vegas transportation corridor. In addition, we completed mapping related to an Earth MRI project to understand the framework of lithium-rich deposits in northwestern Arizona. We have also continued efforts funded by the Arizona Dept. of Water Resources to map young alluvium along perennial streams to assist with the adjudication of ground and surface water rights.

We worked closely with our technically diverse and supportive State Mapping Advisory Committee (SMAC) to set our STATEMAP mapping priorities. SMAC members work in the metallic and aggregate resource industries, water resources, environmental geology, and geologic hazards; public sector geologists represent state and federal agencies and academia. In 2023 we held a hybrid meeting with our SMAC in October to receive their feedback and guidance before we prepared the STATEMAP proposal submitted at the end of 2023. We discussed the increasing emphasis given to intermediate-scale mapping and solicited their recommendations for compilation mapping areas. Based on the proposal we submitted to the USGS at the beginning of 2024 we received our largest STATEMAP 2-year award ever.

In 2023–2024 we released final versions of five 1:24,000 geologic maps in northwestern Arizona in our Digital Geologic Map (DGM) Series, from mapping done in several STATEMAP cycles (Fig. 1). AZGS staff members led an Arizona Geological Society field trip to this area, discussing mineralization, basin development, and structural geology. We also completed and released two 1:100,000-scale maps from central and southeastern Arizona, also as DGMs. All these products are compliant with current Geologic Mapping Standards (GeMS). We made substantial progress toward completing another 1:100,000-scale map in central Arizona and three 1:24,000-scale maps in northwestern Arizona and four in southeastern Arizona. Substantial progress was made to digitize legacy geologic maps using funding from the National Geological and Geophysical Data Preservation Program. Thirty such GeMS-compliant maps were slated for release in the DGM Series later in 2024. We are beginning to assemble a new 1:500,000-scale geologic map of Arizona; we estimate a 2028 publication date for the new state map.

OTHER PROGRAM HIGHLIGHTS

Geologic Hazards

Post-wildfire hazards are of particular importance in Arizona given the size and frequency of wildfires in the past few decades. In the past 30 years flooding and debris flows from burned areas have caused substantial damage in Arizona (Fig. 2). AZGS research in collaboration with colleagues in the Dept. of Geosciences in the University of Arizona and the USGS has focused on understanding triggering mechanisms for post-wildfire debris flows, factors that influence where debris flows may occur, how large they might be, and the impacts of repeated burns in mountainous watersheds. Building on this research, we are cooperating with state and local emergency managers to model how runoff from forested areas may change after future wildfires, with the focus on identifying potential hazard areas before fires occur.

The AZGS is the primary entity addressing seismic hazards in Arizona. We maintain and collect data from a 13-station network of broadband seismometers. We are working with scientists from the Bureau of Reclamation to study several Quaternary faults in central Arizona that could impact dams. Finally, we utilize funding from FEMA to work with the Arizona Department of Military and Emergency Affairs and local government officials to promote understanding of earthquake hazards in the state.

Critical Minerals

In 2024 we worked on four Earth MRI projects focused on various aspects of critical mineral potential in Arizona, two of which are joint projects with adjacent state geological

surveys. (1) Geologic mapping of an area in west-central Arizona to better understand the genesis of 2 known sedimentary lithium deposits; (2) Geochemical sampling of Laramide porphyry systems to enhance understanding of the potential for recoverable critical minerals associated them (joint with New Mexico); (3) Investigation of mine waste sites in northwestern Arizona, considering geology, past production history, and volume of mine waste to estimate how much additional resources may remain in the legacy mine waste sites; (4) Reanalysis and reassessment of NURE data collected from the Colorado Plateau (joint with New Mexico, Utah, and Colorado), and mine tailings.

Deep Subsurface Resources

The AZGS is participating in the Carbon Utilization and Storage Partnership (CUSP) led by New Mexico Tech to characterize, catalog, analyze and rank carbon capture, utilization and storage options for Arizona. We have analyzed several deep sedimentary basins in central and western Arizona and relatively thick Mesozoic and Paleozoic strata on the Colorado Plateau in more detail to characterize their potential for carbon storage and other subsurface resources (Fig. 3). Based on our work with CUSP, electric power utilities in Arizona and private sector companies committed to providing substantial match for an ambitious proposal to the DOE CarbonSAFE Program to investigate the potential for carbon sequestration and underground gas storage in a deep sedimentary basin west of Phoenix.

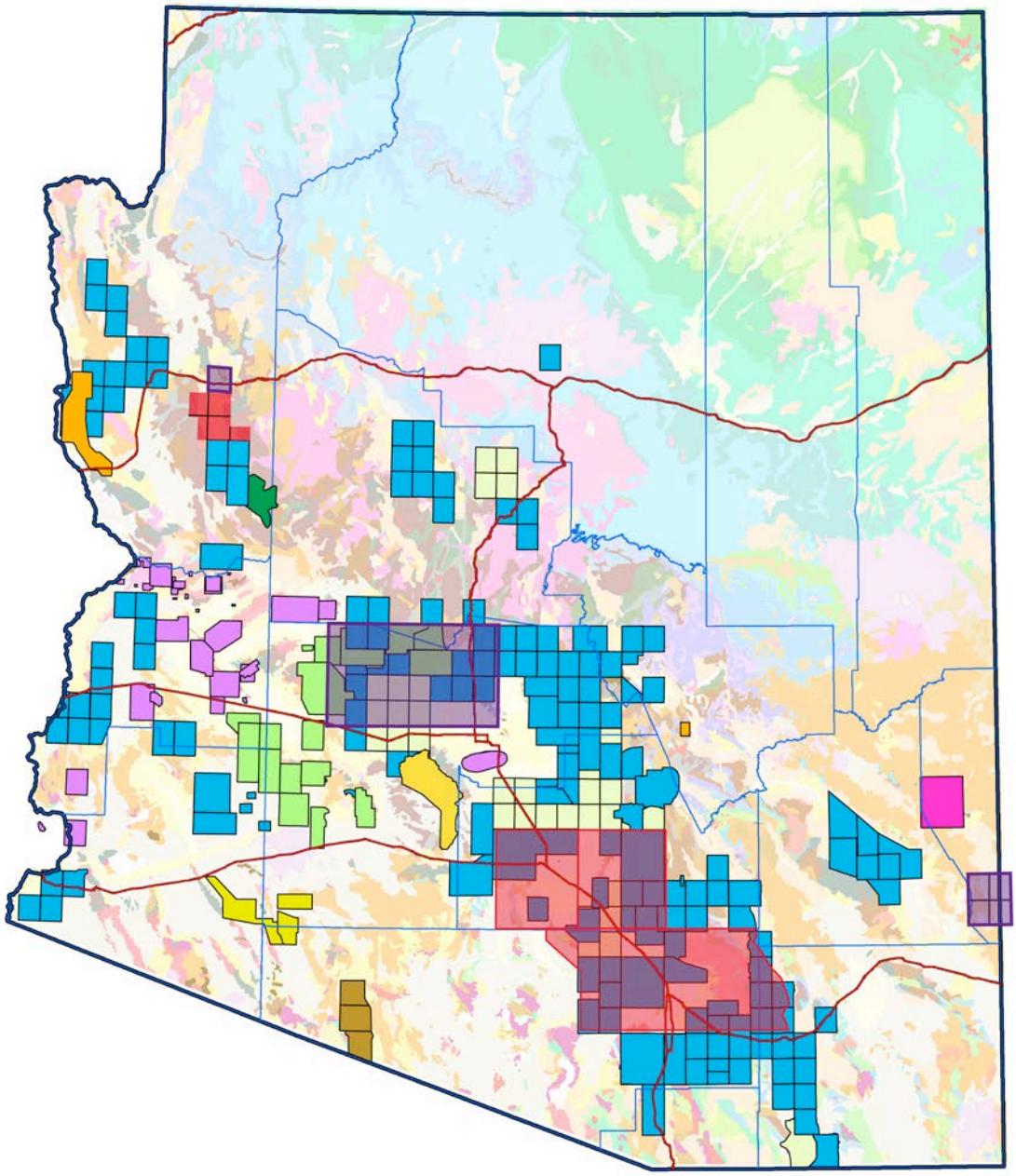

Figure 1. Map showing AZGS maps completed in 2023–2024 (light orange shading) and maps in progress as of mid-2024 (light blue shading). Also shown are the footprints of 1:24,000-scale mapping completed by the AZGS since the early 1980s.

Figure 2. Large rocks and trees transported by a large post-wildfire debris flow in July, 2022, north of Flagstaff, Arizona.

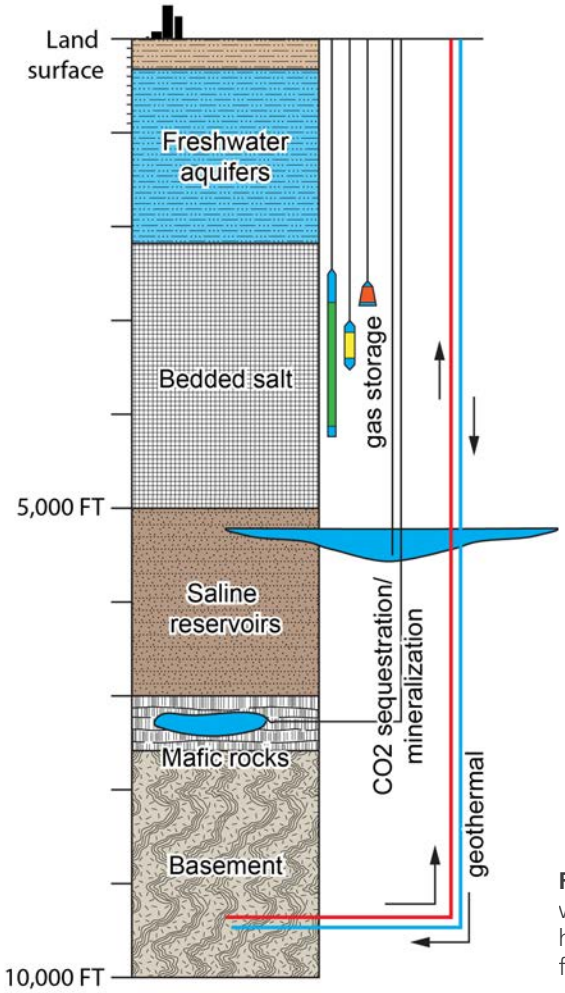

Figure 3. Known and potential subsurface resources in Arizona include groundwater, bedded salt where various types of gas (for example, liquid petroleum gas, hydrogen) can be safely stored, deep saline aquifers and mafic volcanic rocks suitable for CO_2 sequestration, and enhanced geothermal systems in hot crystalline rock.

ARKANSAS

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OFFICE OF THE STATE GEOLOGIST

INTRODUCTION

The Arkansas Office of the State Geologist (AOSG), previously the Arkansas Geological Survey, is a non-regulatory agency that has been responsible for the collection and dissemination of unbiased and sound geologic data and information pertaining to the State of Arkansas since 1857. In April of 2019, Governor Asa Hutchinson signed the Transformation and Efficiencies Act of 2019 that authorized the reduction of the number of cabinet-level agencies from 42 to 15 and accomplished the largest reorganization of state government in almost 50 years. At that time the Arkansas Geological Survey was merged into the Division of Energy and Mineral Resources of the Department of Energy and Environment. In July of 2023, Act 697 abolished the Arkansas Geological Survey and reconstituted it as the Office of the State Geologist under the direction of the Oil and Gas Commission. Our headquarters are now located with the Arkansas Oil & Gas Commission and the Arkansas Department of Environmental Quality at the recently designated E&E building in North Little Rock, Arkansas.

Our staff consists of the Director and State Geologist, Assistant State Geologist, two map sales personnel, three GIS staff, nine staff geologists, and two grant-funded mapping geologists, one being a new hire.

GEOLOGIC MAPPING

The AOSG conducted two federally funded geologic mapping projects in North Arkansas during 2023-2024: EMRI and STATEMAP. The Earth Mapping Resources Initiative (EMRI) is a three-year project, with $100,000 per year which started in July of 2023. It focuses on producing detailed geologic maps of the historical Mississippi Valley Type Mineral District in north Arkansas (Figure 1). The STATEMAP project was completed in June 2024 by mapping two 7.5-minute quadrangles in north-central Arkansas.

The Mississippi Valley Type Mineral District is divided into two focus areas: the Northeast District, located northeast of the Batesville Manganese District and the North Central District located in north-central Arkansas from the Buffalo National River north to the Arkansas-Missouri state line. In the past, the proposed area has been found to host critical mineral deposits associated with the basin brine deposit type and the potential is there to find additional principal mineral commodities and critical minerals. The first year of mapping completed the Northeast District which consisted of geologic maps of the Smithville 1:24,000-scale quadrangle and portions of the Poughkeepsie, Eaton, Black Rock, and Imboden 1:24,000-scale quadrangles.

The STATEMAP project received $106,729 for fiscal year 2023 to complete geologic maps of the Drasco and Marcella 7.5-minute quadrangles (Fig. 1). These quadrangles are located in northern Arkansas on the Springfield and Boston Mountains Plateaus within the Ozark Plateaus Province. The mapping involved 101 days in the field with extensive ground truthing and data collection at 1805 field locations. The geologists identified and separated Mississippian and Pennsylvanian units that are not present in other parts of northern Arkansas.

OTHER PROGRAM HIGHLIGHTS

The AOSG, in partnership with the Arkansas Oil and Gas Commission, began a project to determine if depleted gas wells in the Arkoma Basin have potential for underground natural gas storage capacity. This came about because of a historic winter storm in February of 2021 that disrupted fuel supplies and electricity generation forcing utility companies to issue rolling power outages throughout the state. This caused thousands of homes and businesses to lose electricity for short periods of time and prompted the governor to create the Arkansas Energy Resources Planning Task Force. There are currently two active underground gas storage units in the state and gas injection and withdrawal volumes have stayed relatively high since 1993 averaging approximately 4900 million cubic feet per year. The task force generated a recommendation to determine whether there were mature natural gas fields suitable for storing additional reserves of natural gas.

For this project, geologists looked at thirty-eight gas fields to determine if they were considered nearly depleted and warranted further examination Using a calculated ratio, they were able to identify thirteen nearly depleted natural gas fields with potential available void space and favorable trapping mechanisms. Among these fields, 66 wells either produced greater than 5 Bcf of gas in a single unit or were situated on the same trap with other highly productive wells. These wells warrant future investigation for underground gas storage projects. Future work also includes investigating depleted oil fields in south Arkansas for gas storage projects.

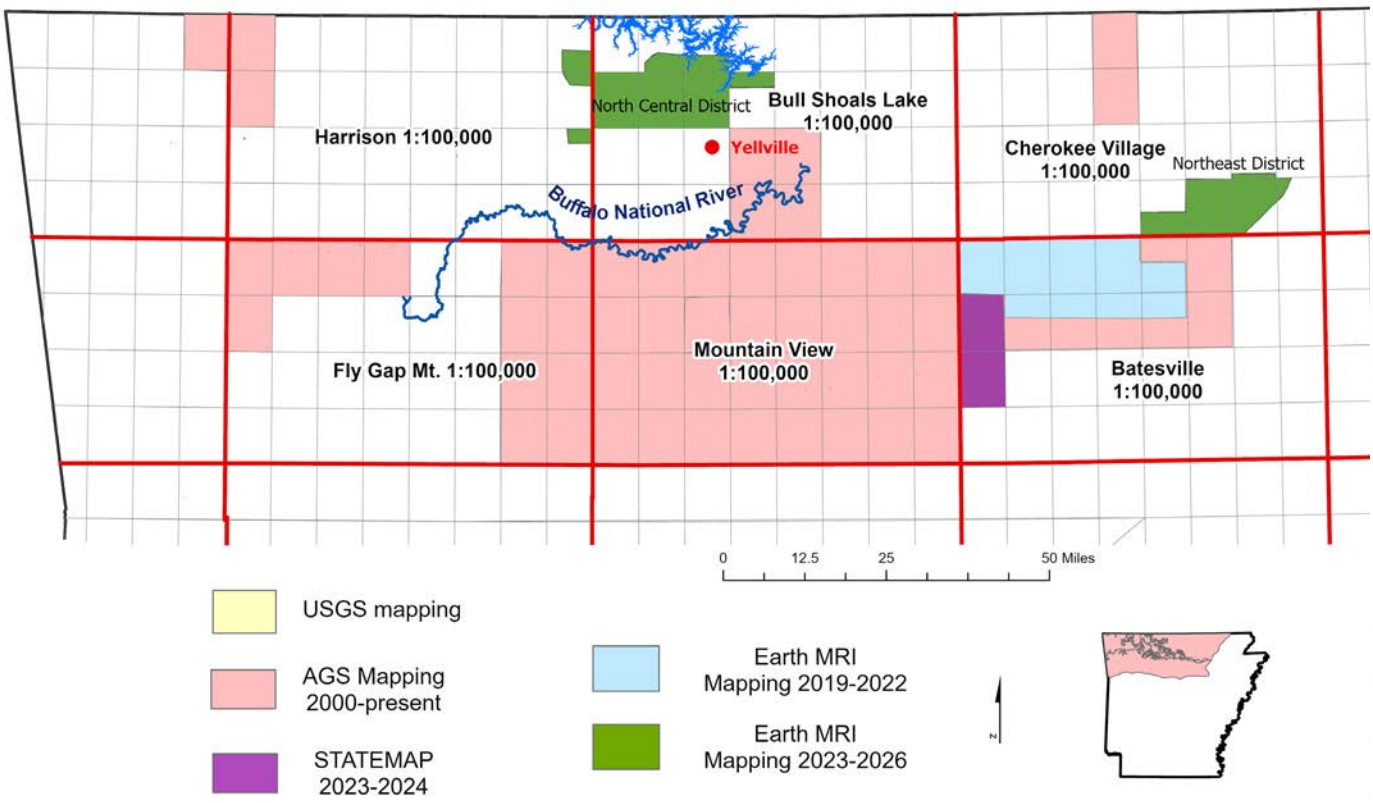

Figure 1. Location of geologic mapping initiatives.

CALIFORNIA

CALIFORNIA GEOLOGICAL SURVEY

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California Geological Survey

INTRODUCTION

The mission of the California Geological Survey (CGS) is to provide scientific products and services about the state's geology, seismology, and mineral resources, including their related hazards, that affect the health, safety, and business interests of the people of California.

The Office of the State Geologist was created in 1851, and the CGS was established by the State Legislature in 1860. The CGS is a division within the Department of Conservation, which is under the umbrella of the Natural Resources Agency. The CGS has its headquarters in Sacramento and five field offices throughout the State. The CGS employs 150 geologists, engineers, seismologists, GIS cartographers, seismic field instrument technicians, a geohazards climatologist, and administrative staff.

In 2024 the CGS formally combined our existing programmatic based GIS and publications staff into the GIS and Publications Program. With this new addition, the CGS now consists of seven (7) programs: Burned Watershed Geohazards, Earthquake Engineering, Forest and Watershed Geology, GIS and Publications, Mineral Hazards and Resources, Regional Geologic and Landslide Mapping, and Seismic Hazards. Additionally, in 2024 the CGS welcomed Dr. Wendy Bohon as Branch Chief of Seismic Hazards and Earthquake Engineering. Wendy also leads the CGS's newly expanded external outreach and communications initiative.

GEOLOGIC AND HAZARDS MAPPING, MODELING, AND MONITORING

Geologic mapping is completed by the **Regional Geologic and Landslide Mapping Program**, the **Mineral Resources Program**, and the **Forest and Watershed Geology Program**.

The CGS completed eleven new 7.5' geologic maps, converted five existing maps to GeMS compliant databases, and compiled two 30'x60' geologic maps from existing 7.5' maps. The CGS also completed work on the Sierra Nevada Digital Earth Science Atlas (the SN Atlas). This project was initiated by the USGS in 2018 as a collaborative effort with the CGS and consists of a 1:400,000-scale, 42,000 sq. mi. digital compilation of geologic mapping, geophysical data, metallogenic belts, carbonate bodies, geochronology, and neotectonic features.

The CGS is actively mapping landslides on a 7.5' quadrangle basis, as well as mineral resources, and mineral hazards such as radon (Figure 1). Landslide data are presented in a statewide landslide inventory geodatabase. Minerals resource mapping projects include evaluating felsic Tertiary volcanic units in the Salton Trough as an important source of lithium in closed basin brine deposits, and evaluating lithium hosted in the Miocene Barstow Formation which is a sequence of lacustrine carbonates, conglomerates, sandstones, and mudstones.

The **Burned Watershed Geohazards Program** deployed watershed emergency response teams (WERT) to 16 fires in 2024 (Figure 2) to help communities prepare for post-wildfire geologic hazards. The program is also developing a statewide pre-fire hazard model to support post-wildfire geologic hazard mitigation planning. The map will support communities in identifying areas that are most susceptible to debris-flow hazards and provides information that can used to plan for and mitigate postfire flood and debris-flow hazards before an area is burned.

The **Seismic Hazards Program** continues to be active in its mission to produce products that protect the lives, property, and enhancing resilience against the threat of earthquakes and tsunamis. Notable accomplishments include the release of new Seismic Hazard Zones for liquefaction and earthquake-induced landslides in Contra Costa County, covering thirteen 7.5' quadrangles. New and revised Alquist Priolo Earthquake Fault Zone maps were released for parts of the San Andreas fault in Los Angeles, San Mateo, and Santa Clara Counties. Preparation of new seismic hazard zones has also begun in Sonoma County with new maps being released in 2025.

The **Earthquake Engineering Program** has been upgrading its Statewide Strong Motion Instrumentation Network to replace obsolete instrumentation with state-of-the-art equipment. Between July 2023 and June 2024, 180 stations in the network were upgraded, and three high-rise buildings were re-instrumented. Additionally, to accommodate a growing demand for real-time seismic data, a real-time data center has been established. Between July 2023 and June 2024, 197 ground response stations and two hospitals were added to the real-time data center. As of June 2024, real-time operation has been completed on 426 stations. Of those stations 149 contribute to the earthquake early warning system in California. The real-time seismic data center's capabilities have allowed the CGS to become more involved in structural monitoring activities. A structural monitoring notification system has been operationalized to alert Golden Gate Bridge engineers when thresholds of predefined response parameters have been exceeded at the bridge. Additionally, this real-time data is used to quickly determine important structural response parameters for the two instrumented hospitals.

OTHER PROGRAM HIGHLIGHTS

Outreach, Education, and Communication are a valuable and valued component of the California Geological Survey, and staff across the organization spend considerable time doing outreach to local communities, schools, state and federal partners, universities, and other interested parties.

To encourage staff to participate in Outreach and Education, whether formally or informally, and to improve their confidence and effectiveness, we have provided trainings on "*Science Communication*" and "*Scientific Storytelling*" and have additional trainings planned for 2025, including "*Social Media for Scientists*", "*Media Training and Engagement*", and "*Understanding Your Audience*". We will also be offering workshops on "*How to Give a Great Conference Talk*" and "*Poster Presentations People Will Remember*".

The CGS maintains a vibrant and growing presence on X (formerly Twitter) and Instagram, and is planning exciting social media campaigns for 2025, including video vignettes highlighting locations of interest on the soon to be released Sierra Nevada Atlas map.

The CGS is also working to create new educational and informational products for our users, including infographics, new maps, and videos. The CGS also maintains an active and engaged Outreach and Education Committee comprised of members from all seven of our programs. Outreach and Education highlights from the past year include:

- Preparation for the release of CALIFORNIA GEOLOGY magazine, coming in early 2025.

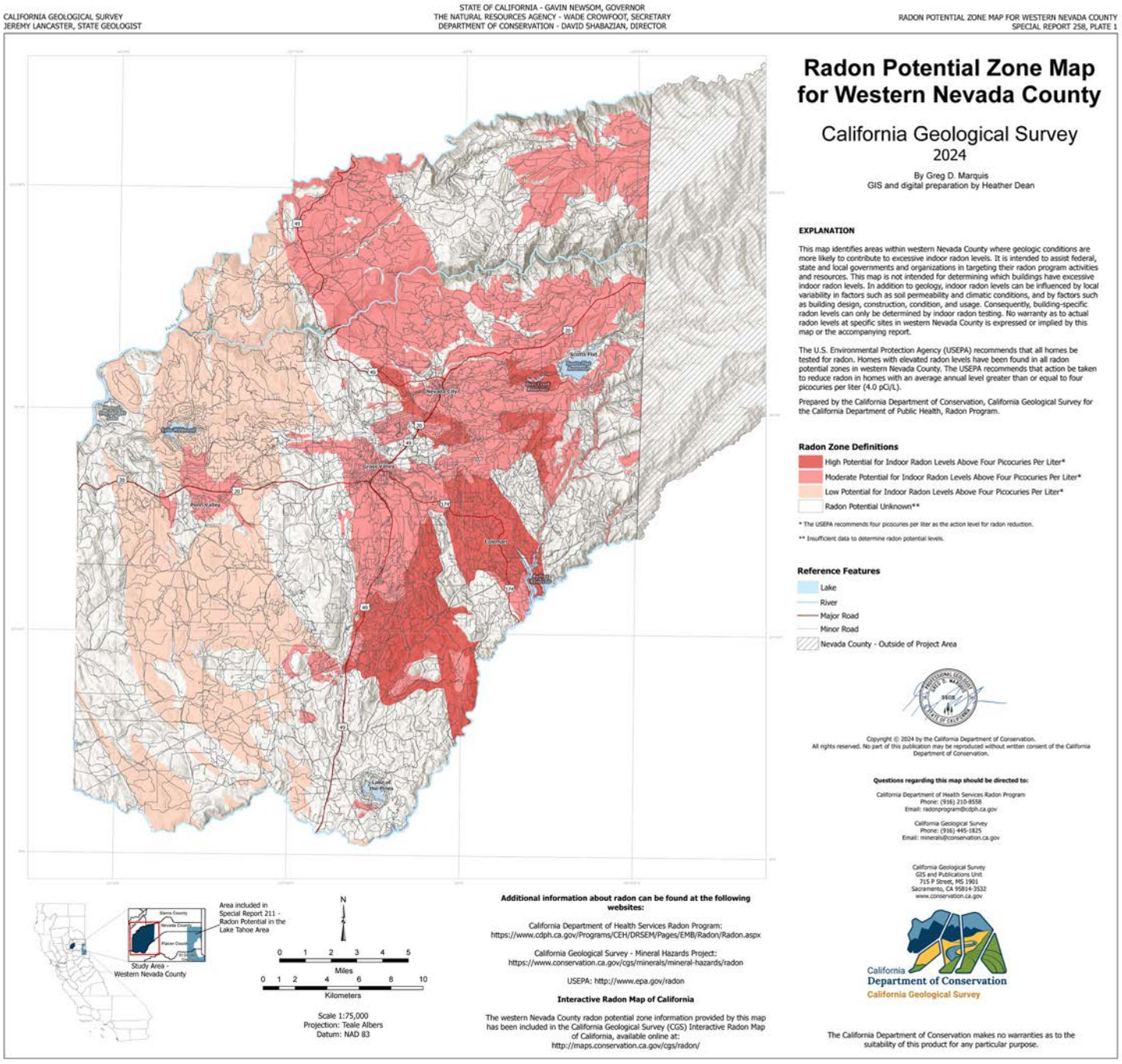

Figure 1. Radon Potential Zone Map for Western Nevada County, California.

- Staffing a booth and presenting 75-minute workshop at the California Association of Science Educators Conference (CASE)
- Staffing booths at numerous events across the state, including the Humboldt County Fair, ShakeOut Events in northern and southern California, Girl's STEM Night at the Natural History Museum of Los Angeles, Girl's STEM Day at the Aerospace Museum, the LA County Emergency Preparedness Fair, the Disaster Expo, the Disney World Preparedness event, and various events at the California Natural Resources Agency Building.
- Releasing a new informational video about our Earthquake Zones of Required Investigation Maps.
- Numerous talks to schools, including k-12 classrooms and universities.
- Leading field trips at the Geological Society of America Meeting and the South Coast Geo Society.

As the cohort of CGS geologists, engineers and GIS professionals has grown, so too has the demand for in-house mapping and publishing services. In June 2024, the CGS reorganized its GIS and publishing functions into a distinct GIS and Publications Program. This new program consolidates and coordinates efforts in mapping, spatial analysis, web presence, and publishing.

Goals of the new GIS and Publications Program (GPP) include:

- Improve the usability and availability of CGS data and publications.
- Support the other programs and create efficiencies.
- Streamline GIS and publishing processes.
- Develop and define standards and best practices related to GIS, data, and published information.
- Fill technical gaps, areas in need of new technology and expertise, and potential opportunities for growth, collaboration, and changes in direction.
- Accelerate updates to the CGS web site.
- Collaborate with and support outreach efforts to heighten CGS visibility.

Figure 2. CGS staff prepare for a helicopter flight over the 430,000-acre Park Fire burn area. Flights over the burn areas help WERT team members assess areas most susceptible to postfire flood and debris flow hazards and determine areas of highest priority for site visits on the ground. Photo: Don Lindsay.

COLORADO

COLORADO GEOLOGICAL SURVEY

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INTRODUCTION

The Colorado Geological Survey (CGS), a state agency within the Colorado School of Mines, serves Colorado by evaluating geologic hazards, assessing mineral and water resources, and conducting foundational geologic studies. Supported by State General Funds, Severance Tax Funds, external grants, and fee-based services, CGS operates across six mission areas: geologic mapping, minerals and energy resources, groundwater resources, geologic hazards and emergency response, land-use evaluation, and public outreach. CGS is staffed by 30 full-time employees and term employees, who bring expertise across these disciplines.

This year, CGS produced detailed geologic maps for six key regions under the USGS STATEMAP Program, supporting land-use planning, hazard assessments, and resource management. In the minerals and energy sector, CGS assessed critical minerals, mapped geothermal potential, and contributed to national initiatives identifying Colorado's valuable resources.

Groundwater efforts advanced the Groundwater Atlas of Colorado, aquifer mapping for El Paso County, and water quality studies, including a statewide baseline for naturally occurring radionuclides. Hazard projects included real-time seismic monitoring, debris flow early-warning systems, and lidar-based alluvial fan mapping to identify debris flow-prone areas and improve public safety in wildfire-affected regions.

CGS partnered with local governments to complete over 500 land-use evaluations, ensuring safe development. Through public outreach, CGS engaged schools, universities, and underserved communities, fostering geoscience awareness.

GEOLOGIC MAPPING MISSION AREA

Summary

During Fiscal Year 2023, the Colorado Geological Survey (CGS) successfully advanced its geologic mapping efforts as part of the USGS STATEMAP Program, focusing on producing detailed and compilation maps to support land-use planning, hazard assessment, and mineral and energy resources. CGS completed mapping six Category 1, 1:24,000-scale quadrangles, including Fort Collins, Timnath, Severance, and Devils Head in the Front Range (Project 1), and Highline Lake and Cortez in the San Juan/Western Slope (Project 3). These maps enhance understanding of local geologic units, hazards, and resource potential while aligning with CGS's long-term mapping strategy.

In addition to detailed mapping, CGS completed Phase 1 of a Category 2, 1:100,000-scale compilation map for the Northern Front Range Piedmont Project (Project 2). This compilation seamlessly integrates work from the previous fiscal year, producing a comprehensive map that covers a resource-rich region, including the Denver-Julesburg Basin. GeMS training for CGS staff (Project 4) further supported mapping quality, enabling better integration of field and GIS data.

Field and Technical Activities

Fieldwork spanned late summer 2023 through the fiscal year, employing lidar-based mapping, GPS-integrated iPads, and GIS software for data digitization. Geochronology and zircon analysis were incorporated, while lidar imagery and aerial photography informed structural mapping. CGS also navigated delays related to tribal land access, ensuring comprehensive coverage near Mesa Verde National Park.

Map Applications

The completed maps inform geologic hazard assessments, mineral resource evaluations, and land-use planning. They are instrumental for CGS's Land-Use Review Program, enabling informed decisions on residential and infrastructure projects. Regional aggregate resource maps and geotechnical evaluations also benefit from these deliverables.

Deliverables

CGS finalized and uploaded six geologic maps to the USGS National Geologic Map Database (NGMDB), with remaining maps in progress. Deliverables included draft plates, validated digital files, and GeMS-compliant databases for future integration. GeMS training materials were also completed, ensuring alignment with national standards.

Through its STATEMAP-funded initiatives, CGS continues to provide essential geologic information that supports Colorado's economic growth, environmental stewardship, and public safety.

MISSION AREA HIGHLIGHTS

The Colorado Geological Survey (CGS) has made significant contributions across multiple mission areas over the past few years, advancing minerals and energy resources, water resource management, geologic hazard assessment, and land-use planning.

In the **Minerals Mission Area**, CGS collaborated on key projects, including contributions to the Colorado Energy and Carbon Management Commission's review of geothermal resources and Department of Energy (DOE) grants focused on carbon ore and critical minerals in Colorado coal regions. Efforts extended to Region 6 CORE-CM initiatives led by the University of Utah, emphasizing carbon capture in the Piceance Basin. CGS conducted USGS EarthMRI fieldwork,

investigating critical minerals in mine effluent, performing mapping and geochemical sampling in the Wet and La Plata mountains, and reanalyzing historic uranium samples from the Paradox Basin. Additionally, CGS reviewed Colorado's mineral and energy industry activities and contributed to the University of Colorado's economic outlook reports.

In the **Water Resources Mission Area**, CGS has worked on comprehensive county geology and groundwater studies, including the development of structural and aquifer maps for El Paso County under a STATEMAP grant. The ongoing baseline radiological study examined naturally occurring radionuclides in groundwater across Colorado, focusing on areas such as the Uravan Belt and the San Luis Valley. To address challenges in participant recruitment, CGS implemented a direct solicitation strategy that significantly improved responses. Furthermore, the South Platte River geologic salinity study analyzed weathered and unweathered bedrock samples, identifying marine-sourced formations contributing to salinity.

The **Geologic Hazards and Emergency Response Mission Area** included advancements in Lidar-Based Alluvial Fan Mapping, funded by the Colorado Water Conservation Board (CWCB). This work supported wildfire readiness by identifying areas prone to debris flows. CGS also developed a Debris Flow Early Warning System in Boulder County, utilizing real-time monitoring to predict and mitigate slope instability, supported by peer-reviewed research.

In the **Land-Use Review Mission Area**, CGS conducted over 500 evaluations of proposed developments, including subdivisions and infrastructure projects, to identify geologic hazards and ensure proper mitigation measures. Operating on a fee-for-service basis, these reviews play a critical role in ensuring safe and sustainable development across Colorado.

These efforts exemplify CGS's commitment to enhancing resource management, addressing environmental challenges, and ensuring public safety statewide.

DELAWARE

DELAWARE GEOLOGICAL SURVEY

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INTRODUCTION

The Delaware Geological Survey (DGS) is a science-based state agency that is, by statute, administratively under the charge of the University of Delaware. The DGS is responsible for investigations of the geology, water resources, and natural hazards of the state, preparation of reports and maps, and advising state officials on the optimum utilization and equitable administration of the state's geological and water resources. The state geologist also has a statutory assignment to represent the Governor as the Decree Party Principal to the Delaware River Master Advisory Committee.

The DGS is unique within Delaware state government because we are both a state agency and a university research and service unit. Financial, personnel, and other administrative matters are overseen by the University. The DGS budget is funded by a direct appropriation from the State of Delaware with reporting responsibilities to both the Office of the Governor and the Delaware General Assembly. Within the university, the DGS is affiliated with the College of Earth, Ocean, and Environment (CEOE), and most DGS scientists have secondary faculty appointments in the College's Department of Earth Sciences. Currently, staffing levels are 12 scientists, two part-time contractual scientists, and 6 support staff, and one part-time contractual support staff.

GEOLOGIC MAPPING

The DGS geologic mapping program includes mapping of Delaware's surficial geology, Piedmont bedrock geology, and coastal and offshore geology at the detailed scale of 1:24,000. Geologic maps provide an understanding of the earth materials beneath our feet, benefiting Delawareans by defining the subsurface geologic framework that has applications characterizing groundwater, land-use planning, natural hazards, environmental geology, soils/agriculture, beach nourishment, and geotechnical engineering. The USGS STATEMAP Program provides federal dollar-for-dollar matching funds for most of DGS's geologic mapping efforts. Products from the mapping efforts include PDF map publications as well as digital data (shape and data point files) that can be downloaded and imported into GIS software.

Fieldwork in the Kenton Quadrangle was completed in June 2024. This quadrangle was chosen, in part, with the guidance of the Delaware Geologic Mapping Advisory Committee (DGMAC). The DGMAC is comprised of representatives from diverse backgrounds including federal, state, and county government, environmental consulting, academia, and the non-profit sector. The committee prioritized this area over two other possible project locations because it is an emerging area of concern for water-yield issues for the state. This quadrangle is also adjacent to two previously mapped quadrangles (Clayton and Dover). Fieldwork for the next mapping area, Marydel Quadrangle, is slated to begin in July 2024.

Other mapping-related projects include:

Middle Atlantic Coastal Plain Stratigraphic Reconciliation Initiative: This project is a cooperative, multi-state research effort to improve understanding and provide documentation of the equivalencies of formation names in the Middle Atlantic Coastal Plain province.

Assessing 21st Century Beach Sand Supply and Demand along the Mid-Atlantic Coast: This project aims to forecast beach sand demand until the end of the 21st century and assess the longevity of existing regional offshore sand resources.

Statewide Lidar and 3D Hydrography: DGS, in cooperation with the state's Office of State Planning, is leading an effort by the state of Delaware to acquire Q1-level lidar for the entire state through the USGS 3-DEP program. In addition, we are complimenting the new LiDAR with new 3-D hydrography data set generated with a 0.5 x 0.5-meter DEM through the USGS 3DHP program.

OTHER PROGRAM HIGHLIGHTS

Borehole Log Data Preservation Project

The Delaware Geological Survey has made significant progress in organizing and preserving decades of borehole records, enhancing our institutional archive for the state's geological and hydrological data. This effort is supported by U.S. Geological Survey's National Geological and Geophysical Data Preservation Program (NGGDPP).

In the past two years, DGS has identified, cataloged, digitized, and made public a large collection of borehole lithology log data. These logs, crucial for geological and hydrological research, have been preserved from nearly 3,400 sites drilled for Delaware highway projects and DGS geologic mapping and groundwater studies. The effort has resulted in PDF-format logs for all sites and standardized lithologic data for over 35,000 intervals in the DGS WATSYS Oracle database. These are now accessible via the Delaware Geological Survey Borehole Lithology Log Mapper, a web tool built with ArcGIS Experience Builder.

DGS has also expanded into the preservation of wireline electrical/geophysical logs, an important tool in subsurface geology and groundwater investigations. This includes digitizing old paper records and preserving digital files in a standard LAS format. Hard copy and digital geophysical logs were inventoried, with digitized logs quality-checked against originals. Poor-quality or undigitized log curves were digitized using both manual and automated tools and converted into LAS files, which were then used to create PDF log images and columnar data. So far, more than 500 boreholes have been processed. Resulting LAS files, CSV/TXT files, and PDF images will soon be added to the Delaware Geological Survey Borehole Lithology Log Mapper web application to make the project results publicly accessible.

Groundwater Monitoring Network Infrastructure Expansion: Sussex County, Delaware

DGS manages a statewide groundwater monitoring network designed to collect hydrologic, water quality, and hydraulic information that addresses near-term (10-year) critical water resource management issues. The Sussex County expansion project builds on previous expansion efforts in Kent County (2017-2021) and New Castle County (2013-2014). While population is growing throughout Delaware, Sussex County is undergoing the most significant population growth (25.2% from 2010-2021), resulting in increased water demands for drinking water supplies, in coastal areas may cause saline water intrusion into fresh water supplies, which will be exacerbated by rising sea level and salt-water flooding in areas in proximity to tidal water bodies during coastal storms. A comprehensive monitoring network is crucial to tackle pressing concerns and ensure the sustainable use of our groundwater resources. Funded by an FY2024 State of Delaware Capital appropriation, the Sussex County groundwater monitoring network expansion project will add 12 new monitoring sites that will host well nests (multiple wells at each site, each designated to monitor a specific aquifer) across Sussex County.

The statewide network has steadily expanded over the past 10 years. Currently, the network consists of more than 120 wells that monitor 17 aquifers. Most of these wells are equipped with automatic data loggers that record water levels at 15-minute intervals, while the remaining wells are measured manually four times per year. A small number of wells are equipped with automated conductivity sensors to help track any developing saltwater issues. The DGS participates in the USGS National Ground Water Monitoring Network (NGWMN) cooperative program, where we share our network data from select wells per NGWMN guidelines.

DGS Annual Report of Programs & Activities

Each year the DGS prepares its annual report, which we use to meet part of our reporting requirements to the Governor's office, and the state's General Assembly. The report provides summaries of our scientific programs and activities, updates related to staffing and partnerships, DGS publications, and service to federal, state, and local government committees and boards. Other DGS project highlights in the annual report that are not covered in this edition of the AASG journal include evaluating stormwater infiltration on groundwater, the Delaware stream and tide gage program, studies in the critical zone, assessing salt-water intrusion risk, accessing water quantity in Delaware, Delaware subsidence monitoring, natural hazards response activities, coastal flooding impacts on transportation networks, data dissemination, and education and outreach activities. The DGS 2023-2024 Annual Report can be accessed at:

www.dgs.udel.edu/sites/default/files/publications/DGS-AnnualReport_2024_hirz-no-crops_FINAL.pdf

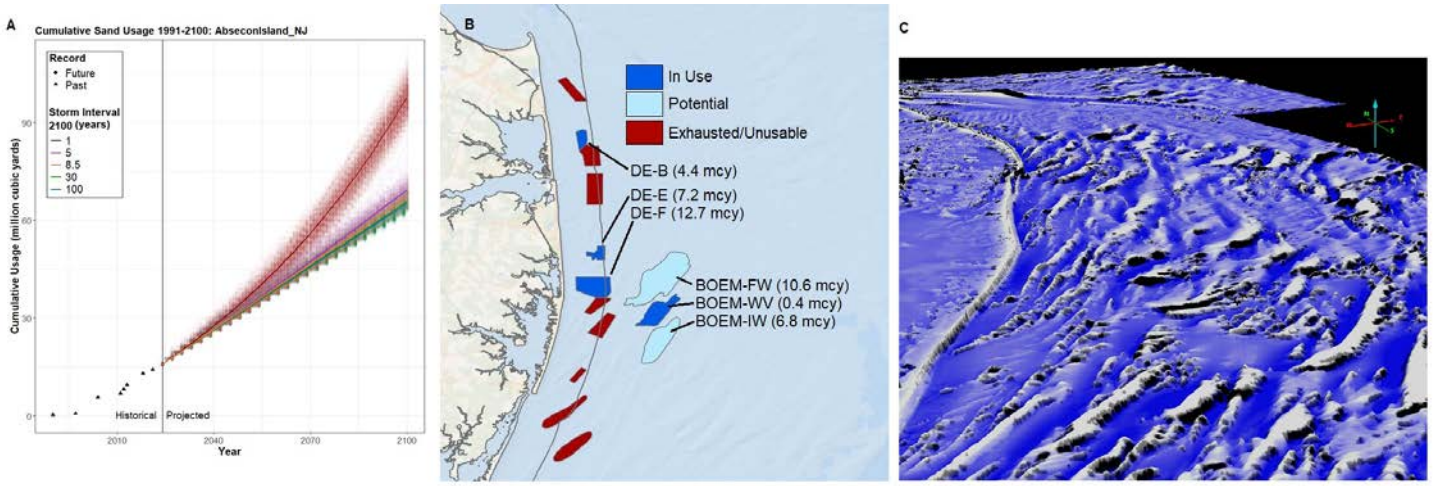

Figure 1. Overview of key steps for the beach sand and supply project including, (A) forecasting beach sand demand for each beach area along the Mid-Atlantic coastline under different climate change scenarios, (B) estimating the longevity of current offshore sand resource areas, and (C) using bathymetry-based modeling approaches for predicting where other high quality offshore sand deposits may exist.

Figure 2. DGS hydrogeologist inspecting a monitoring well using a down-well video camera.

FLORIDA

FLORIDA GEOLOGICAL SURVEY

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INTRODUCTION

The **Florida Geological Survey** (FGS) was established as an autonomous state agency in 1907 by the Florida Legislature. Today, the FGS is a division within the Regulatory Programs of the Florida Department of Environmental Protection (DEP), the state's lead agency for environmental management and stewardship, protecting our air, water, and land. The FGS collects, archives, interprets, and distributes geologic information to benefit Florida.

The FGS has 33 full time and 15 OPS (temporary) employees and manages a robust intern program. Staffing levels have remained steady during the reporting period. From July 2023 through June 2024, the FGS worked with state and federal partners to advance the understanding of Florida's geology. Surficial geologic mapping funded by STATEMAP, Earth MRI, and our internal mapping initiative advanced our goal of producing a new statewide geologic map in the next 3-5 years. FGS staff reached thousands of customers through publications, field trips, presentations, and our newsletter. We also held our annual open house during Earth Science Week where hundreds of citizens learned about the importance of geoscience to our society.

GEOLOGIC MAPPING

The Florida Geological Survey Mapping Initiative (FGSMI) was created to accelerate the completion of a new statewide surficial geologic map of Florida. In addition to the STATEMAP Program, the FGSMI includes the Florida Geologic Mapping Program (FLAGMAP), which works in areas adjacent to USGS STATEMAP-funded quadrangles to maximize mapping efforts. FLAGMAP is internally funded. In recent years, projects funded through the USGS Earth Mapping Resources Initiative (Earth MRI), discussed below, are also providing mapping support to help accelerate the achievement of FGSMI goals.

Surficial & Bedrock Mapping

The FGS FLAGMAP program continued surficial geologic mapping work in the Titusville, New Smyrna Beach, Cross City, Cedar Keys, Charlotte Harbor, Sanibel, and Okefenokee Swamp USGS 30 x 60-minute quadrangles between July 2023 and June 2024. These FLAGMAP project areas are adjacent to STATEMAP project areas.

The USGS National Cooperative Geologic Mapping Program (NCGMP) provides matching funding to the FGS STATEMAP Program to conduct surficial geologic mapping. Between July 2023 and June 2024, the FGS continued work on mapping in the Ft. Myers and Naples USGS 1:100,000 scale quadrangles in southern Florida and began mapping in the Ft. Lauderdale quadrangle.

For federal Fiscal Year 2023, the USGS awarded the FGS STATEMAP Program $417,851. The Fiscal Year 2023 award includes $369,766 to map the Fort Lauderdale 30x60-minute USGS quadrangle and finish mapping the Naples 30x60-minute USGS quadrangle, along with supplying GeMS Level 3 databases for both quadrangles. This award includes an added $48,085 for a status map of the 2D / 3D 1:100,000-scale geologic mapping GIS coverages in Florida. The Fiscal Year 2023 award is for a two-year period of performance (2023–2025).

The FGS was awarded $700,000 through the USGS Earth MRI Program to conduct surficial geologic mapping in seven partial 1:100,000-scale quadrangles (Bay Minette, Pensacola, Fort Walton Beach, Port St. Joe, Carabelle, Bainbridge, and Valdosta) in the Florida panhandle and to map quartz sand resources statewide. Quartz sand is a critical industrial mineral that Florida's economy is reliant on. The results of this project will support and inform Florida's pre- and post-tropical storm resilience and recovery activities. The award is for a three-year project period from April 2024 to March 2027.

To facilitate these mapping projects, the FGS collected 64 new cores totaling 2,869 feet during the reporting period. Of these, 60 were drilled using direct push technology and the other 4 were wireline cores. These new core samples were added to the FGS Sample Collection Facility.

OTHER PROGRAM HIGHLIGHTS

The FGS was awarded $246,792 by the USGS to complete a two-year study of critical minerals, including REE's, associated with phosphate mine waste streams in both the north and central Florida phosphate mining districts. The funding came through the USGS Earth MRI Program that focuses on critical mineral commodities associated with mining waste streams. The study began in December 2022. Project deliverables, due November 2025, include a geochemical characterization of the various phosphate mining waste streams and a set of standard operating procedures for the collection of phosphate waste stream samples.

The FGS collaborated with the Geological Survey of Alabama and the Mississippi Department of Environmental Quality's Office of Geology on the East Gulf Coastal Plain Stratigraphic Reconciliation Initiative. This interstate cooperative project, funded by the USGS National Geologic Map Database program, was aimed at addressing stratigraphic framework issues across state boundaries. The work will advance the goal of creating an integrated geologic map for the nation. Deliverables included cross sections, stratigraphic charts, and lithostratigraphic nomenclature revisions that were provided to the USGS in 2024. A publication of the results will be available through the Geological Survey of Alabama in 2025.

The USGS, FGS, Geological Survey of Alabama, and the South Carolina Geological Survey worked together to propose boundaries where future airborne geophysical surveys could be conducted with funding through the USGS Earth MRI program. In 2023, hyperspectral surveys were flown over Florida's industrial mineral mining districts and airborne magnetic and radiometric surveys covering approximately 8,000 square miles of northeast Florida began. A third survey, covering approximately 6,000 square miles in northern Florida to collect magnetic and radiometric data, began in early 2024.

The FGS was awarded $51,167.59 through the USGS National Geological and Geophysical Data Preservation Program (NGGDPP) to preserve cuttings samples from underground injection control (UIC) wells. The goals for the project were to process and accession samples from South Florida and add lithologic descriptions to the associated borehole records. Over the course of the project, the FGS processed 12,376 samples from 58 UIC wells and added lithologic descriptions for 35 boreholes to its GEO-logic Data Enterprise System (GEODES). Work began in June of 2022, and the deliverable was finalized in August of 2024.

The FGS provided outreach through our publications, website, museum tours, and newsletter. FGS staff directly interacted with over 4000 individuals over the reporting period through our annual Earth Science Week open house, internships, field trips, lectures, community science events, and virtual and face-to-face museum tours. On April 11th, 2024, the FGS Director and State Geologist dedicated Paynes Prairie Preserve State Park as the eighth State Geological Site highlighting Florida's commitment to geoheritage.

The FGS is committed to providing training opportunities for staff geologists. Florida's geology is complex and diverse depending on where in the state you are. Staff geologists are provided opportunities to travel throughout the state and see important outcrops and exposures. During the 2023-24 reporting period, FGS staff spent a week in the western Florida Panhandle learning about the surficial geology of this siliciclastic-dominated part of the state.

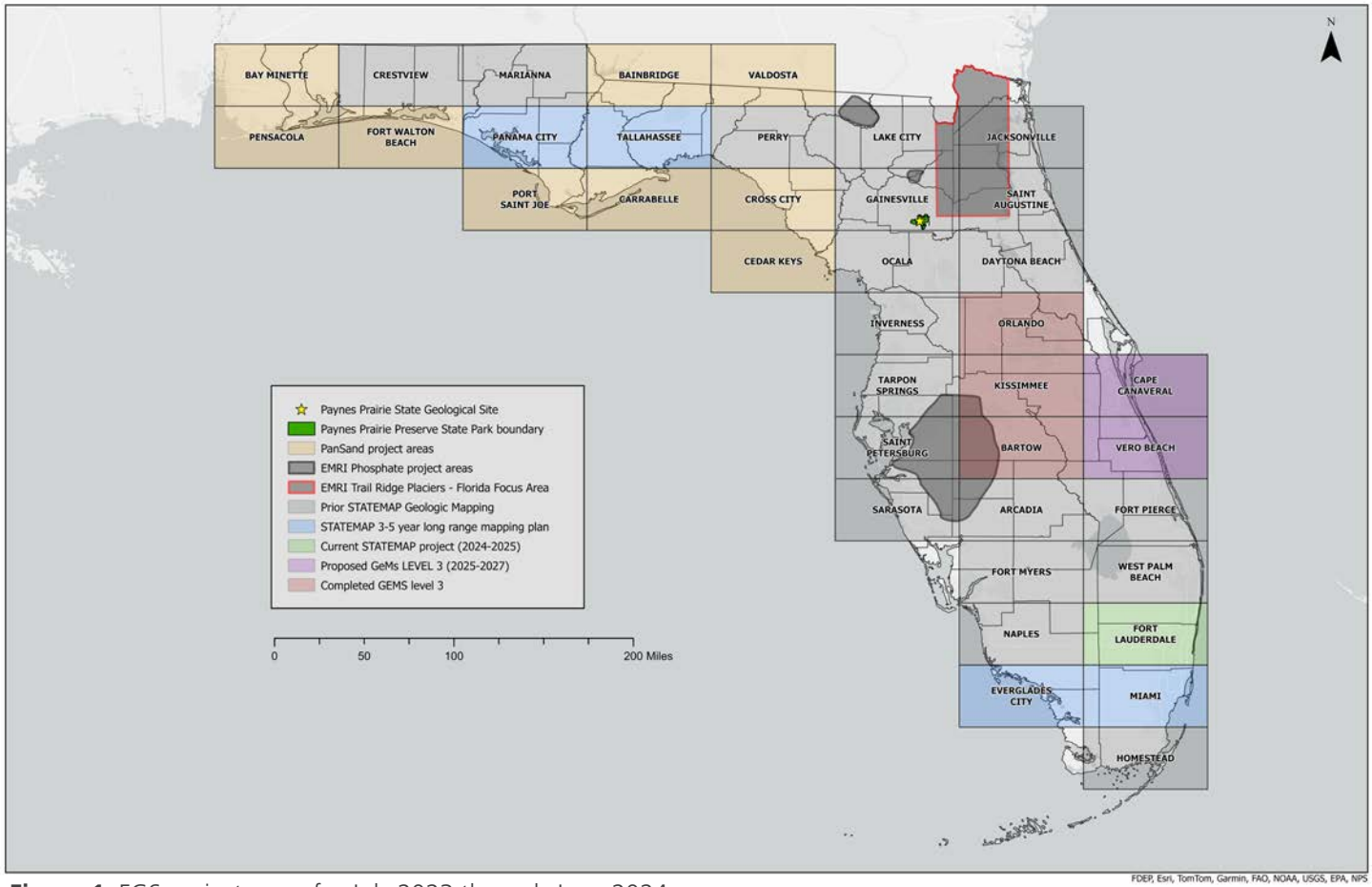

Figure 1. FGS project areas for July 2023 through June 2024.

Figure 2. FGS Director and State Geologist Harley Means designates Paynes Prairie Preserve State Park as the 8th State Geological Site.

Figure 3. Field training for staff geologists in the western Florida Panhandle (Big Coldwater Creek).

ILLINOIS

ILLINOIS STATE GEOLOGICAL SURVEY

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INTRODUCTION

The Illinois State Geological Survey (ISGS) was first formed in 1851 but has been operational continually since 1905 when it was officially established as a state agency by an Act of Illinois' General Assembly. In 2008, the University of Illinois State Scientific Surveys Act was passed by the General Assembly, and that placed the ISGS and four other scientific surveys within an institute of the University of Illinois at Urbana-Champaign. The Prairie Research Institute now houses the ISGS, Illinois Natural History Survey, Illinois State Water Survey, Illinois State Archeological Survey, and Illinois Sustainable Technology Center—together employing about 1000 scientists, support staff, and students. The ISGS has over 200 scientists, support staff, students, and affiliates.

This past year particularly has been busy for the ISGS with increased and continued funding opportunities provided by the US DOE, USGS, and others for geological characterization research that has significantly increased industrial interest in energy storage and critical mineral potential within and around the margins of the Illinois Basin. Significant State funding has also been obtained from the Illinois Department of Transportation and Department of Natural Resources for environmental site assessments, wetlands research, and abandoned mine lands work respectively. Overall efforts, while focusing on the transition to green technologies, are also considering the uncertainties of climate change and its direct impact for achieving a sustainable balance between water, energy, and mineral resource extraction and environmental protection. A key component for success has been our overall scientific understanding of Illinois' often very complex subsurface Quaternary and bedrock geology.

GEOLOGIC MAPPING

Bedrock Mapping

Five bedrock quadrangles and two county compilations were mapped during the July 2023 - June 2024 period by ISGS geologists. West of the Quad Cities, the 7.5' Montpelier, Illinois City, and Muscatine Quadrangles were completed. In extreme northwestern Illinois, in Jo Daviess County, the 7.5'-scale Mounds West and Elizabeth Quadrangles were completed. A significant magnetic high in the Muscatine and Illinois City Quadrangles on the Illinois side of the Mississippi River suggests the presence of a buried intrusive igneous complex composed of mafic or ultramafic rocks in the Yavapai Province, comparable in character to the mineralized Duluth Complex. Sphalerite mineralization was found while mapping in the Illinois City Quadrangle. It occurs in siderite nodules within the lower Pennsylvanian shales. Geological mapping in the Scales Mounds West and Elizabeth Quadrangles will assist federal and state agencies in determining the potential of critical minerals in the UMVD. Zinc and lead mines in this subdistrict, now abandoned, produced over 37,500 short tons of lead ore.

Bedrock compilations were completed for Jackson and Randolph Counties located in southwestern Illinois which supports the U.S. GeoFramework Initiative (Category 2, Guidance Criterion 4). These two counties include all or parts of 35, 7.5' quadrangles, 24 of which were previously published. Twenty of those previously published quadrangles will be delivered as GeMS level 3 databases (Category 2, Guidance Criterion 5). The other 4 published quadrangles were submitted as GeMS Level 3 databases for Fiscal Year 2020 and Fiscal Year 2021 projects. These counties follow the short-range geological mapping plan established by IGMAC.

Surficial Mapping

The STATEMAP team completed year 3 of mapping the surficial geology of Cook and DuPage Counties in Metropolitan Chicago. The work involved shallow and deep drilling to characterize the postglacial and glacial deposits, including anthropogenic materials and fills. Currently, the project's borehole database contains over 44,000 unique records that will be the basis for drafting county-scale cross sections in year 4. This past year the ISGS partnered with a private geophysical company to characterize a downtown parcel where the University of Illinois was to build their Discovery Partner Institute that led to developing additional collaborations across the region for sharing our subsurface information. The ISGS continues to partner with the NSF-DOE Geothermal Intern program for a second year with two PhD students now being mentored. The team has also developed a collaboration with the DOE-funded "Community Research on Climate and Urban Science" (CROCUS) project to study the soil and groundwater across the City of Chicago.

The ISGS is now beginning its fifth year (Phase 5) of a 5-year project to revise its 1979 surficial (Quaternary) geological map of Illinois. This project is partly funded by the USGS-STATEMAP program. During 2023-24, Phase 4 mapping was completed in north-central and northwestern Illinois. This completed mapping of the last glacial Lake Michigan Lobe and extended mapping to the Wisconsin border and to the Mississippi River valley. This new Quaternary map includes new findings from detailed quadrangle and county mapping (1:24,000 to 1:62,500 scales). In addition to mapping geological unit polygons and contacts, there was additional effort to map glacial lineations, eolian lineations, moraine crests, and loess thickness contours. The availability of LiDAR, digital USDS-NRCS soil maps, subsurface boring databases, and archived field notes greatly aided the project. Mapping follows the USGS geologic mapping schema (GeMS) to facilitate future development of a seamless national map. Contact lines were drafted digitally in GIS at 1:62,500–1:100,000 scale, with anticipated map publication at the 1:250,000 or 1:500,000 scale. New Phase 4 data address statewide stratigraphic issues and included two electrical resistivity transects in the Green River Lowland,

six shallow test holes, and 29 radiocarbon ages. To aid characterization and correlation of Quaternary sediments, 20 samples were analyzed for particle-size distribution and clay mineralogy, and 28 samples for elemental composition. New geological findings include expanded mapping of peat and last glacial lake sediment within the Green River Lowlands, greater recognition of Illinois Episode outwash deposits, and a minor revision of the glacial boundary in northwestern Illinois. The delineation of various Illinois Episode till units in northwestern and western Illinois has been aided by lidar shaded relief maps (improving the recognition of Illinois Episode moraine fronts), new cores, and a statewide compilation of particle-size data for glacial till samples with limited alteration.

3D Mapping

The ISGS has continued to progress in 3D geological mapping across the state during the last year. This 3D mapping at the county scale has continued in the collar counties of the Chicago Metropolitan Area. The 3D geological mapping of Boone County in north-central Illinois is in its third and final project year, and DuPage County will begin 3D mapping in the fall of 2024. New 3D mapping strategies are developing with HTEM technology as well. The ISGS is mapping the regional 3D geology of the Mahomet Aquifer System in east central Illinois and has acquired airborne EM data across 4 counties in the last year. New software and AI strategies are being developed to more efficiently map and model this high density HTEM data. After data acquisition in January 2024, the mapping phase of the project is expected to be completed in December 2025.

OTHER PROGRAM HIGHLIGHTS

Progress on Energy

The ISGS has been working to improve institutional databases by digitizing published map data pertinent to CCS development and using AI tools to digitize deep well regulatory records in collaboration with the US DOE Consortium Advancing Technology for Assessment of Lost Oil & Gas Wells (CATALOG). This is part of a DOE funded project "A Play Based Exploration of CCS in the Illinois Basin," whose objective is to build a database of subsurface, surface, and societal data for entities screening areas of Illinois for commercial geological CO_2 storage. The project is developing play maps to serve as communication tools for communities and CCS developers in Illinois. In 2025, the play maps will be shared via a website with embedded story maps supported by narrative text and links to download data and map layer files.

Efforts also continue on the Carbon Storage Assurance Facility Enterprise (CarbonSAFE), with two projects planning deep stratigraphic test wells near Mitchell, IN, and Springfield, IL, to be drilled in 2025 to characterize the subsurface for carbon storage associated with cement production and coal-fired energy generation, respectively. The well near Springfield will target the Cambrian Mt. Simon Sandstone, filling a data gap along a W-E dip transect of deep wells in central Illinois. The Mitchell well is more exploratory and will investigate a thick sequence of sandstones within the Ordovician Shakopee Dolomite, providing the opportunity to clarify the stratigraphic correlation with units on the western side and beyond the Illinois Basin (e.g., New Richmond Sandstone, Roubidoux Fm.).

In support of the Illinois Department of Natural Resources' Mitigating Emissions from Marginal Conventional Wells in Illinois project, part of the DOE's Methane Emissions Reduction Program, the ISGS developed a well plugging prioritization methodology. The challenges in prioritizing well-plugging efforts in Illinois are due to resource scarcity. Over 26,000 marginal conventional wells (MCWs) exist in Illinois, with >3,000 temporarily abandoned (TA). Many are likely in TA status due to economic factors like low oil prices and production rates. This large number of TA wells means that the wells volunteered for plugging could far exceed the available funding. There is a scarcity of service companies and expertise for plugging and abandonment (P&A) projects. Focusing solely on methane emissions when selecting wells to plug would be inefficient, as high-priority wells might be widely dispersed geographically. Effective project selection requires prioritization based on both efficiency and defensibility, with clear and transparent criteria.

Finally, the ISGS is continuing research to measure and evaluate the fundamental properties of hydrogen mobility in caprock samples under in situ reservoir temperatures and pressures to aid expansion of geological hydrogen storage in settings beyond engineered salt caverns (e.g., depleted oil and gas fields, saline aquifers, natural gas storage fields). This fundamental research includes measurements of breakthrough pressures, saturations, and geomechanical response of hydrogen injection into representative caprock (and selected porous rock) under in situ conditions. Results from the experimental research can then be used to condition models to increase predictability and lower risk in selecting sites for characterization.

CO_2 mineralization using industrial waste materials

Mineralizing and utilizing CO_2 through industrial solid wastes has been recognized as a promising technical route to simultaneously reduce CO_2 emissions and address solid waste management. CO_2 mineralization can be coupled with CO_2 capture from industrial flue gas within the same process because carbonation with many solid wastes is sufficiently rapid and efficient. Supported by the USDOE, the ISGS is developing a CO_2 mineralization technology using Flue Gas Desulfurization byproducts for coproducing value-added Precipitated Calcium Carbonate and ammonium sulfate fertilizer (Fig. 1). The technology is being tested on a bench-scale system for 1 lb/hr of CO_2 conversion, and preliminary results have demonstrated the desired process performance and properties of resultant products.

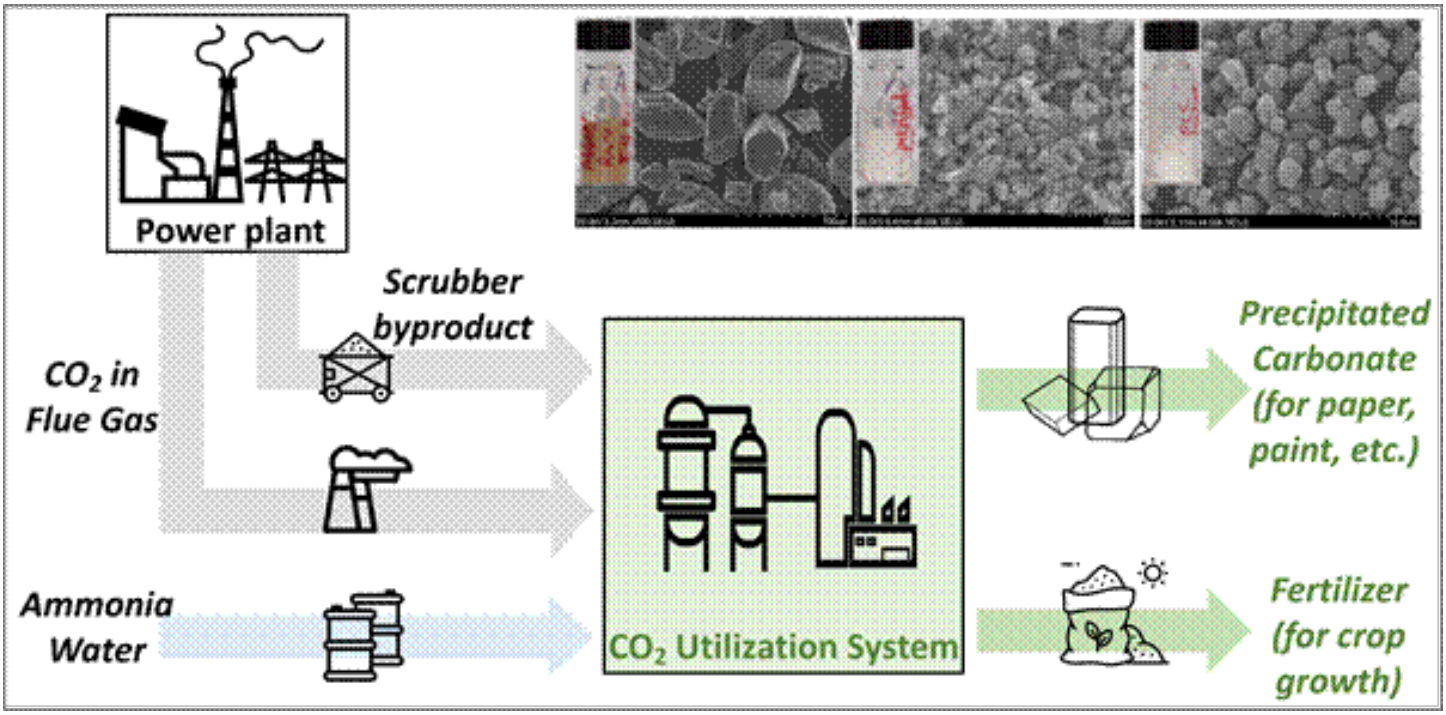

Figure 1. Schematic of CO_2 utilization through mineralization using power plant scrubber waste materials.

Development of coal-based materials for supercapacitor application

Supercapacitors (SCs) are energy storage devices that bridge the gap between rechargeable batteries and capacitors. The energy storage capacity of SCs is much lower than that of batteries, but SCs can charge and discharge at a much faster rate, even at low temperatures; therefore, batteries combined with SCs have been proposed as ideal energy storage devices for cars, trucks, trains, power backup systems, and other applications.

Supercapacitor devices are currently fabricated from special grades of coconut shell-based activated carbons which are imported to the U.S. at a relatively high cost. Development of low-cost coal-based SC materials could create new economic opportunities for the U.S. coal industry. Through USDOE support, the ISGS has developed carbon-based materials from anthracite, bituminous, subbituminous, and lignite coals for SC energy storage applications. Developed coal-based materials exhibited higher performance than the analogous commercial materials.

Lake Michigan Coastal Program

The ISGS' Coastal Geology Section continued its post-breakwater construction surveying at Illinois Beach State Park in NE Illinois, adapting to the new challenges of nearshore obstructions and acquiring sonar readings by remotely controlled vessel and beach topographic data by drone. The emplacement of several chains of breakwaters along the eroding shorelines of Illinois Beach was part of a $74M state capital development project, which included extensive beach nourishment. This work has been supported by a partnership with the Illinois Coastal Management Program. Ongoing topobathymetric monitoring will provide useful information on the impacts of emplaced structures on coastal sediment transport and morphodynamics, with a 5-year pre-monitoring dataset providing the comparison (at a seasonal resolution). This unique dataset, one of a kind within the Great Lakes, is providing the foundation for understanding event-based, seasonal, interannual, and decadal patterns of geomorphic change, as related to water-level fluctuations, impacts of winter-ice cover, human activities, and storm waves and currents.

Research activities in Chicago are expanding as exhibited by a $550,000 federally directed spending award from Sen. Durbin to expand upon an evolving map of offshore geology (surface and subsurface). These funds, which will mostly go towards subsurface geophysical data acquisition in spring-summer of 2025, will expand data coverage beyond 3 km from shore and compliment results of a regional littoral sand assessment, funded by the Illinois-Indiana Sea Grant Program, that is presently being completed. Offshore geological mapping activities by the ISGS help to inform nearshore and beach geomorphic studies using the same methods deployed at Illinois Beach State Park. Monitoring efforts in Chicago have been expanded by inclusion of two more beaches and integration of a dune area-specific monitoring component, undertaken in collaboration with the Illinois Coastal Management Program and in partnership with the Chicago Park District.

Geological monitoring activities have also been expanded to the Illinois bluff coast, around Fort Sheridan, as part of a collaborative effort with the Illinois Natural History Survey (INHS). Funding is provided the Illinois-Indiana Sea Grant

Program to study the geomorphic and ecologic impacts of emplaced nearshore reef habitat structures. As part of this project, the ISGS acquired ground-penetrating radar data, offshore geological samples, sonar readings, and beach topographic information. This project is an expansion of already ongoing work at a Great Lakes Restoration Initiative (GLRI) pilot project site at Illinois Beach, where the ISGS and INHS are monitoring three submerged rubble-mound ridges, emplaced in 2022 for shoreline protection. The effectiveness of such nature-based shoreline protection solutions will be evaluated from geomorphic change data and information from buoys and hydrodynamic sensors emplaced around the structures.

Critical Minerals

The ISGS, through its Critical & Strategic Minerals (CSM) Section and the newly established Critical Minerals Research & Development Center (CMRDC), leads groundbreaking research on the exploration, extraction, and sustainable utilization of critical minerals. These efforts focus on rare earth elements (REEs) and other essential minerals to meet the growing demand for renewable energy technologies, national security needs, and advanced industrial applications. Below is an updated summary of ISGS's portfolio of critical mineral projects for F Y2024.

- The US DOE-funded Illinois Basin Carbon Ore Rare Earth and Critical Minerals (CORE-CM) Initiative (U.S. DOE) has (1) assessed CORE-CM resources in coal, waste streams, and related deposits, (2) developed innovative technologies for resource extraction and waste reuse, and (3) established technology innovation centers for workforce training and research.
- The USGS-funded Upper Mississippi Valley Zinc-Lead District project has been (1) analyzing critical mineral contents of zinc and lead ores, and (2) conducting geological mapping and geochemical sampling.
- The USGS-funded Mine Waste Characterization in the Upper Mississippi Valley project has been (1) inventorying and characterizing mine waste sites for critical mineral recovery, (2) assessing their environmental impacts and geochemical composition, and (3) identifying critical Elements of interest that include Ge, Ga, In, and Ba.
- The USGS-funded Earth MRI: Devonian and Ordovician Phosphorites project has been (1) conducting geochemical sampling of REE-enriched phosphate deposits, and (2) evaluating resource potential for national security and green technologies.

Figure 2. I-57 bridges over Grinnell Road and the Norfolk Southern Railroad in Kankakee County.

- The USGS-funded Critical Minerals in Black Shales project has been (1) exploring metalliferous black shales for REE and other critical minerals, and (2) targeting Devonian and Pennsylvanian shale formations in the Illinois Basin.
- The USGS-funded STATEMAP Geological Mapping Program has been (1) mapping critical mineral-bearing formations across Illinois, and (2) developing 3D geological models to support exploration and hazard planning.

The significance of these projects has been to (1) strengthen U.S. supply chains by enhancing the domestic production of strategic minerals, (2) drive economic growth by fostering job creation and regional development, (3) advance technology by developing sustainable extraction and processing techniques, (4) promote environmental stewardship by mitigating the environmental impacts of mining, and (5) support national security efforts by reduce reliance on foreign critical mineral imports.

Geothermal

The geothermal research program is growing quickly as inquiries for district thermal energy systems and underground thermal energy storage increase. The program has a post-doctoral research scientist and two PhD students and more hires are expected in Fiscal Year 2025. The program just completed two projects for DOE, FedGeo and Chicago community geothermal, and both projects were awarded Phase 2 funding (totaling ~$625,000) for Fiscal Year 2025. There have also been several national and international opportunities for the program to "weigh in" on the topic of geothermal for datacenters as well as AI and machine learning providers to reduce water and energy demands. The State of Illinois is very interested in this topic, as well as the use of geothermal in greenhouses and pilots for utility-scale geothermal district heating and cooling.

Environmental Site Assessments

In 2024, the Environmental Site Assessments Section of the ISGS conducted >280 preliminary environmental site assessments (PESA) for new highway construction projects and improvements to existing roads and bridges proposed by the Illinois Department of Transportation (IDOT). These assessments provided IDOT with critical information regarding potential environmental concerns, natural features, and hazards that may be present on current IDOT right-of-ways or on properties under consideration for acquisition.

The removal and replacement of four bridges carrying I-57 over Grinnell Road and the Norfolk Southern Railroad in Kankakee County, Illinois began in March 2022 and was completed in June 2024. PESA staff conducted environmental studies for IDOT prior to the construction of this $23.6M project, which included evaluation of potential excavation sites for the presence of hazardous wastes. Potential environmental hazards were investigated at >10 properties surrounding the four bridges and areas of I-57 affected by the replacement of the structures. Recognized environmental conditions primarily were former underground storage tanks with documented releases and potential underground storage tanks. Other environmental hazards included evidence of chemical use, soil impacted with volatile organic compounds, semi-volatile organic compounds, and metals, chemical releases, and aboveground storage tanks on historic industrial properties. Two 45-page reports were sent to IDOT that documented these findings and provided preliminary information that will serve as the basis for additional, more in-depth environmental work.

INDIANA

INDIANA GEOLOGICAL AND WATER SURVEY

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INDIANA GEOLOGICAL & WATER SURVEY
INDIANA UNIVERSITY

INTRODUCTION

The Indiana Geological and Water Survey (IGWS), founded in 1837, has been a research institute of Indiana University since 1993. Its mission is to provide geo¬logical information that contributes to the wise stewardship of energy, mineral, and water resources and mitigates geologic hazards. Indiana continues to benefit from research initiatives; geologic sample and data collec¬tion and archiving; and dissemination of information through the peer-reviewed Indiana Journal of Earth Sciences, databases, and outreach programs.

Geologic mapping teams, researchers, and information services staff juggled nearly two dozen grant-funded deliverables at varying degrees of completion. The outreach team and other staff handled 92 events, reaching 10,004 people during the calendar year. Three staff members departed and seven were hired. In the spring, the records-center overflow building, housing more than 80 years' worth of assorted data, had to be quickly emptied and all items brought back to the Survey—months ahead of receiving materials to properly store them. Staff are still sorting nine months after the move.

Despite those pressures and a flatlined state budget appropriation, the IGWS celebrated several successes: training its second class of summer interns, launching a new website and online store, and landing a $1 million grant to study carbon sequestration.

GEOLOGIC MAPPING

The IGWS's long-range goal is to map the state at 1:100,000 scale and its metropolitan areas at 1:24,000 scale by the IGWS bicentennial in 2037. The IGWS was granted $347,190 from STATEMAP for fiscal year 2023 to continue this work and develop associated geodatabases. The IGWS also received funding from the Great Lakes Geologic Mapping Coalition.

Four STATEMAP-funded projects—including four databases, two maps, and one pamphlet to accompany a map—were published in the Indiana Journal of Earth Sciences toward the end of 2023. Five other projects—two for GLGMC and three for STATEMAP—had target publish dates later in 2024 or 2025. Mapping projects in progress by June 2024 included:

Bedrock Mapping

Geologic Map of the Bedford 30×60 minute Quadrangle, Indiana (1:100,000) (map, pamphlet, database): This map shows Mississippian and lower Pennsylvanian bedrock units and Pleistocene and Holocene deposits distributed over eight counties and five physiographic divisions. The pamphlet includes full unit descriptions and links to documents related to 100+ bedrock data points. (Published December 2023)

Figure 1. More than 700 visitors from the local community attended the first annual Dino Day at the IGWS Learning Lab in March 2024 to participate in activities based around fossils, extinction, and geologic time, plus a "dino egg" hunt outside. *Photo by Polly Sturgeon, IGWS.*

Geologic Map of the Indiana Portions of the 30×60 minute Jasper and Tell City Quadrangles (1:100,000) (map, pamphlet, database): This map extends over eight counties and five physiographic provinces. Agriculture and industrial mineral production dominate land use and influence water quality through intense sinkhole, cave, and spring development. Much of the surface has been modified by extensive coal mining. (Published July 2024)

Bedrock Geology of the Southern Half of the Bloomington 1:100,000 Quadrangle (map, database): This area has historically contained diverse energy and mineral wealth, including oil, gas, and dimension stone used nationwide, and prevalent karst landscapes that affect groundwater flow. Plans call for the Bloomington quadrangle to be fully mapped by 2026.

Surficial Mapping

Quaternary Geology of the Washington-Jasper Area (1:100,000) (map, database): This map shows the distribution of glacial and postglacial surface deposits and basic bedrock geology across four counties. Isolated terraces along the Patoka River display sediments of the oldest Quaternary unit in the area. (Published December 2023)

Quaternary Geology of the Bloomington Quadrangle (1:100,000) (map, pamphlet, database): This area includes portions of nine counties. Establishing the Quaternary geologic framework is important because glacial deposits host significant water resources at the southern margin of the Indianapolis metropolitan area. (Published August 2024)

Surficial Geology of the Indiana Portions of the Chicago and the Northern Half of the Kankakee 30×60 minute Quadrangles (1:100,000) (map, pamphlet, database): Mapped landforms and near-surface deposits reflect the retreat of the Lake Michigan Lobe of the Laurentide Ice Sheet, as ancestral Lake Michigan levels fell and the subsequent rebound resulted in deposition of beach, eolian, and paludal sediments, and the formation of large dunes. Formal and informal map unit names are introduced.

Quaternary Geology of the Indiana Portion of the Southern Half of the Kankakee 30×60 minute Quadrangle (1:100,000) (map, pamphlet, database): Landforms and near-surface deposits record glacial processes associated with the Lake Michigan Lobe and Huron-Erie Lobe of the Laurentide Ice Sheet and post-glacial changes. Formal and informal map unit names are introduced.

OTHER PROGRAM HIGHLIGHTS

CO_2 Sequestration

The IGWS was the co-recipient, with two other Indiana University–connected agencies, of a $1 million grant from the U.S. Department of Energy to study the feasibility of using subsurface Indiana rock formations for carbon capture and storage. The IGWS is leading this multi-year project and is focusing on the portion requiring geological data collection, analysis, and interpretation.

Hazards research

The IGWS was awarded a USGS grant to map landslides and assess risk factors south of the Wisconsin Glacial Boundary in central and southern Indiana. One paper and database, Highway Landslide Hazards in Indiana—Construction and Analysis of a Landslide Inventory, was published in August 2024; two other landslide-related data sets are in review.

Data preservation

In addition to moving and cataloging thousands of paper records, the IGWS digitally preserved hundreds of unwieldy, fragile, three-dimensional and (or) dirty objects—like lithologic strips, field maps, and field notebooks—through the purchase of a Bookeye scanner.

Geologic name changes

Two groups of researchers, one bedrock- and one surficial-focused, undertook projects to reexamine lithostratigraphic nomenclature. They decided to elevate one surficial unit to the rank of formation, introduce two new rock formation names, formalize four distinctive black shale units as members, and abandon several long-used informal names. Both papers were to be published late in 2024.

Eclipse and water

Researchers in the IGWS Center for Water collaborated with IGWS Information Services staff to undertake "citizen science" activities related to the total solar eclipse over central Indiana on April 8, 2024. A page on the IGWS website served live data, public-friendly scientific explanations of eclipses and how they relate to water studies, and opportunities for residents across the state to send in light metering data. These efforts attracted statewide media exposure.

Outreach successes

The IGWS Learning Lab hosted more than 1,300 children on school field trips during the calendar year, plus more than 1,500 walk-in visitors during 53 events in the hands-on lab. Two new lesson plans, focused on the Ice Age and extinction, were published for area teachers and homeschool families. A series published through the IGWS newsletter, the E-Geo News, walks readers through the many stages in the process of creating a geologic map. Another E-Geo News series profiled IGWS staff who've served for at least 20 years; nine now fit that description.

Internship program

With money from a designated annual endowment, the IGWS welcomed its second class of Paul Edwin Potter interns during the summer of 2024. Four undergraduate and graduate students aided IGWS staff with lab analysis, data management, field data collection, and outreach. One was eventually hired full-time, increasing recent intern-to-staff conversions to three so far.

Diverse publications

While mapping projects were being prepared, the Indiana Journal of Earth Sciences published a research paper about critical minerals in Pennsylvanian coals, shales, and paleosols; two papers highlighting noteworthy attributes of cephalopod and diploporitan fossils found in southern Indiana; an atlas of microscopic images of biochar types; and an analysis of vitrinite reflectance suppression in the Devonian-Lower Mississippian New Albany Shale.

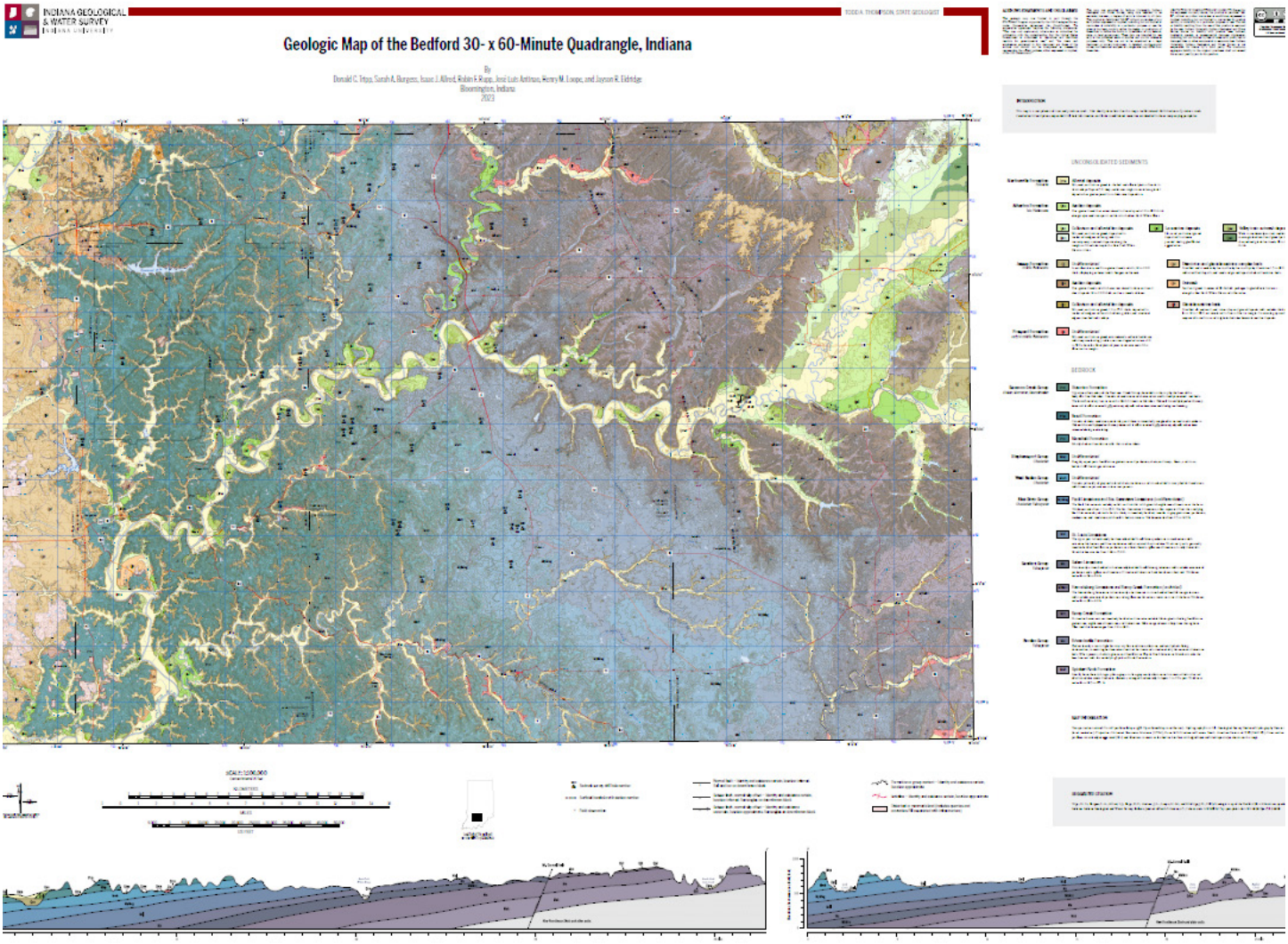

Figure 2. The Geologic Map of the Bedford 30×60 minute Quadrangle, Indiana was one of two maps published during FY23. This was the first IGWS map to include a pamphlet containing expanded research, full unit descriptions, and source data links, which has become the new standard practice when quadrangles are fully mapped. *Cartography by Casey Jones, IGWS.*

Figure 3. Two billboard-like panels hung in the Indiana Statehouse during the spring of 2024 to explain how the extensive IGWS core library connects to carbon sequestration research. *Design by Sara Clifford, IGWS.*

IOWA

THE IOWA GEOLOGICAL SURVEY

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INTRODUCTION

The Iowa Geological Survey (IGS) was established by the Iowa legislature in 1855. The IGS is a part of IIHR-Hydroscience & Engineering, a research institute within the University of Iowa's College of Engineering. The IGS currently reports through the Board of Regents State of Iowa, having been legislatively transferred to the University of Iowa in 2018 from the Iowa Department of Natural Resources (DNR).

Currently, 14 full time professional, 1 part time professional, and 1 part time support positions are supported on a mix of state appropriations, grants, and contracts.

The mission of the Survey is to collect, reposit, and interpret geologic and hydrogeologic data, to conduct foundational research, and to provide Iowans with the knowledge needed to effectively manage our natural resources for long-term sustainability and economic development.

GEOLOGIC MAPPING

Recently completed new mapping by the IGS under the USGS STATEMAP program included three subprojects in vastly different geologic areas of the state with a focus on impaired watersheds, developing areas, and water resources.

The IGS completed a third phase of surficial and bedrock geologic mapping in the Cedar River watershed in Muscatine County. This phase produced 1:24,000-scale bedrock geologic maps of the Wilton and Muscatine NW quadrangles, which subdivided the Middle Devonian Wapsipinicon and Cedar Valley groups and continued cross-state collaborations with the Illinois State Geological Survey to address lithostratigraphic nomenclatural issues across the border. Surficial geologic mapping was completed for the West Liberty and Muscatine quadrangles and focused on characterization of Illinoian-age glacial deposits, terrace mapping in the Cedar River valley, and evaluation of Wisconsin-age eolian deposits. The IGS is proposing to complete county scale bedrock and surficial geologic maps for Muscatine County during the next fiscal year.

The second project began the first phase of a multi-year bedrock mapping effort in Dubuque County with a bedrock geologic map, as well as bedrock elevation and Quaternary thickness derivative maps, produced for the Dubuque South 7.5' Quadrangle. This initiative complements ongoing and newly funded USGS Earth Mapping Resources Initiative (Earth MRI) projects focused on constraining the critical mineral potential of the Upper Ordovician succession in the region. Bedrock mapping subdivided Ordovician and Silurian bedrock units that were previously combined on the statewide bedrock map (Witzke et al., 2010).

Subproject 3 focused on watershed mapping in areas of need as determined by the Iowa State Mapping Advisory Committee (SMAC). The IGS produced a surficial geologic map of the Lime Creek and Wall Lake Inlet Hydrologic Unit Code (HUC) 12 watersheds. This mapping project not only improved our knowledge of the Quaternary succession within the study area but is also key to providing critical information related to water resources and protection in the Boyer River Aquifer that local residents depend upon.

OTHER PROGRAM HIGHLIGHTS

Geophysics

The IGS incorporates electrical and seismic geophysical methods as a primary data collection tool for a host of geologic and hydrogeologic research projects. In shallow groundwater investigations, geophysical surveying was used alongside geologic mapping, groundwater modeling, and drilling to characterize well-fields. Geophysical surveying was heavily used to inform geologic hazard efforts, including imaging sinkholes, karst terrain, underground mines, embankments/levees, and landslide slopes. Passive seismic methods are being used by the IGS to help determine the depth to bedrock in areas lacking existing information. The IGS recently began a multi-year statewide effort to image levees using electromagnetic field methods.

Data Preservation

The IGS completed three projects for the National Geological and Geophysical Data Preservation Program The first project was a collaboration between the IGS and the University of Iowa Paleontology Repository to preserve ~18,000 fossil specimens in the Robert Wolf Collection. This project established a framework for the two agencies to enhance the findability, accessibility, interoperability, and reuse of Iowa's geoscientific data. The second project modernized its well database (GeoSam) by reprograming the database and creating a new ESRI web application to display the data. The third project submitted 200 Precambrian samples from the IGS core holdings to the USGS for whole-rock geochemical analyses to evaluate the critical mineral potential of Precambrian rocks within the state.

Water Resources

The Iowa Geological Survey is responsible for assessing the quantity and availability of Iowa's groundwater supplies. Aquifers provide drinking water for over three-quarters of Iowans and for the majority water needs of agriculture, livestock, industry, energy, commercial, and domestic applications. As such, the IGS focuses on mapping and characterizing aquifers across the state by advancing our understanding of the geologic and hydrogeologic frameworks and properties of Iowa's alluvial, buried valley, and bedrock aquifers. This initiative draws on our expertise in mapping, geophysical surveys, drilling, aquifer pumping tests, logging and stratigraphic interpretation, materials testing, data pres-

ervation, numerical modeling, and other specialties. Project efforts are arrayed across state, regional, and local levels, for both governmental and private sector entities, including for example, the Iowa DNR, Iowa Homeland Security, municipalities, industry, consulting firms, etc. Our activities evaluate not only water supply but also address questions about karst (sinkhole) development, groundwater vulnerability, source water protection, mine water discharge, well water level interference, and levee/dam integrity (subsurface erosion).

MASSACHUSETTS

MASSACHUSETTS GEOLOGICAL SURVEY

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Current website: mgs.geo.umass.edu
New URL starting May 2025: umass.edu/geological-survey

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INTRODUCTION

The Massachusetts Geological Survey (MGS) is housed in the Department of Earth, Geographic, and Climate Sciences at the University of Massachusetts Amherst campus. The State Geologist reports ultimately to the Vice Chancellor for Research and Engagement. The mission of the Survey is to serve the needs of state government, industry, and the citizens of the Commonwealth of Massachusetts by providing earth science information and research relevant to natural resources, environmental quality, economic vitality, and public safety. Statutory authority for the Survey is in the Massachusetts General Laws Chapter 21A, Section 7B.

This year was a period of transition for the Survey. Dr. Stephen Mabee, State Geologist and Director for over 21 years, retired on February 2, 2024. A search was conducted, and Dr. Brian Yellen was selected to succeed Dr. Mabee, but Dr. Yellen did not begin officially until September 1, 2024.

BEDROCK ALTITUDE AND DEPTH TO BEDROCK MAPS

As mentioned last year, the Massachusetts Top of Rock Project was completed. The project was funded by the Massachusetts Department of Transportation (MassDOT) and the Massachusetts Emergency Management Agency. The goals of the project were to collect as much depth to bedrock information as practicable from easily accessible drill hole and geophysical data sources and create statewide maps of the altitude of the bedrock surface and thickness of the overburden, along with their associated uncertainties, at 100-meter resolution. The main purpose of the project was to provide a tool for MassDOT to help reduce the uncertainty associated with planning subsurface investigations for highway transportation projects. However, the information is also useful for groundwater modeling and for any project that will or is planning to disturb the earth's surface.

During this year, the bedrock altitude and depth to bedrock maps were made available to the public. The maps and supporting data are available through MassGIS (the Massachusetts spatial data clearinghouse) or by downloading an app that can be used on your phone or computer. The app was created with help from the Massachusetts Department of Environmental Protection. The app can be downloaded here.

Since publication of the bedrock altitude and depth to bedrock maps, several other important derivative products have been generated from this basic data. For example, a new NEHRP soil classification map for Massachusetts was published. Dr. David Boutt in the University of Massachusetts Amherst Department of Earth, Geographic, and Climate Sciences and his team produced a new Hydrogeologic Atlas of Massachusetts that includes statewide data layers of hydraulic conductivity, specific yield, water table ratio, and transmissivity. Ongoing work by Dr. Boutt includes an examination of the impact of sea level rise and climate change on groundwater levels and the likelihood of groundwater flooding affecting homes and infrastructure.

QUATERNARY GEOLOGIC MAP OF MASSACHUSETTS

We are continuing to work with the U.S. Geological Survey to complete the new statewide Quaternary Geologic Map of Massachusetts. The Massachusetts Geological Survey's role in the Quaternary Map will be to provide 20-meter structure contours of the top of the bedrock surface for the major alluvial fill valleys and sand and gravel deposits throughout Massachusetts. The structure contours are generated from the bedrock altitude map but still require some manual editing. This work continues.

PYRRHOTITE EVALUATION PROGRAM

The Massachusetts Geological Survey continued to work with the Massachusetts Department of Transportation (MassDOT) to develop a licensing program for all quarry and sand and gravel operations providing aggregate for use or sale in concrete. The goal is to limit the use of aggregate containing pyrrhotite in concrete for any commercial, residential or Department of Transportation project. The work has involved developing an online data management and licensing portal, geologic source report template, operations plan template, testing procedures, and communication plan. This work continued through the year and is being carried on by Dr. Mabee's successor, Dr. Brian Yellen, still working in close collaboration with MassDOT.

IDENTIFYING STRATIGRAPHIC PROBLEMS IN NEW ENGLAND

The New England States Geologic Mapping Coalition (NESGMC), a consortium that includes the geological surveys of the six New England states, completed its work on Identifying Stratigraphic Problems in New England. This was a project funded by the National Cooperative Geologic Mapping Program. The purpose of the project was to identify, research and summarize cross-border stratigraphic inconsistencies. The project included three objectives: 1) select lithotectonic domains affecting Coalition states that present significant stratigraphic issues; 2) research and assemble the body of literature relevant to the stratigraphic issues in each domain; and 3) summarize the most significant stratigraphic problems in each domain and prepare a preliminary list of possible

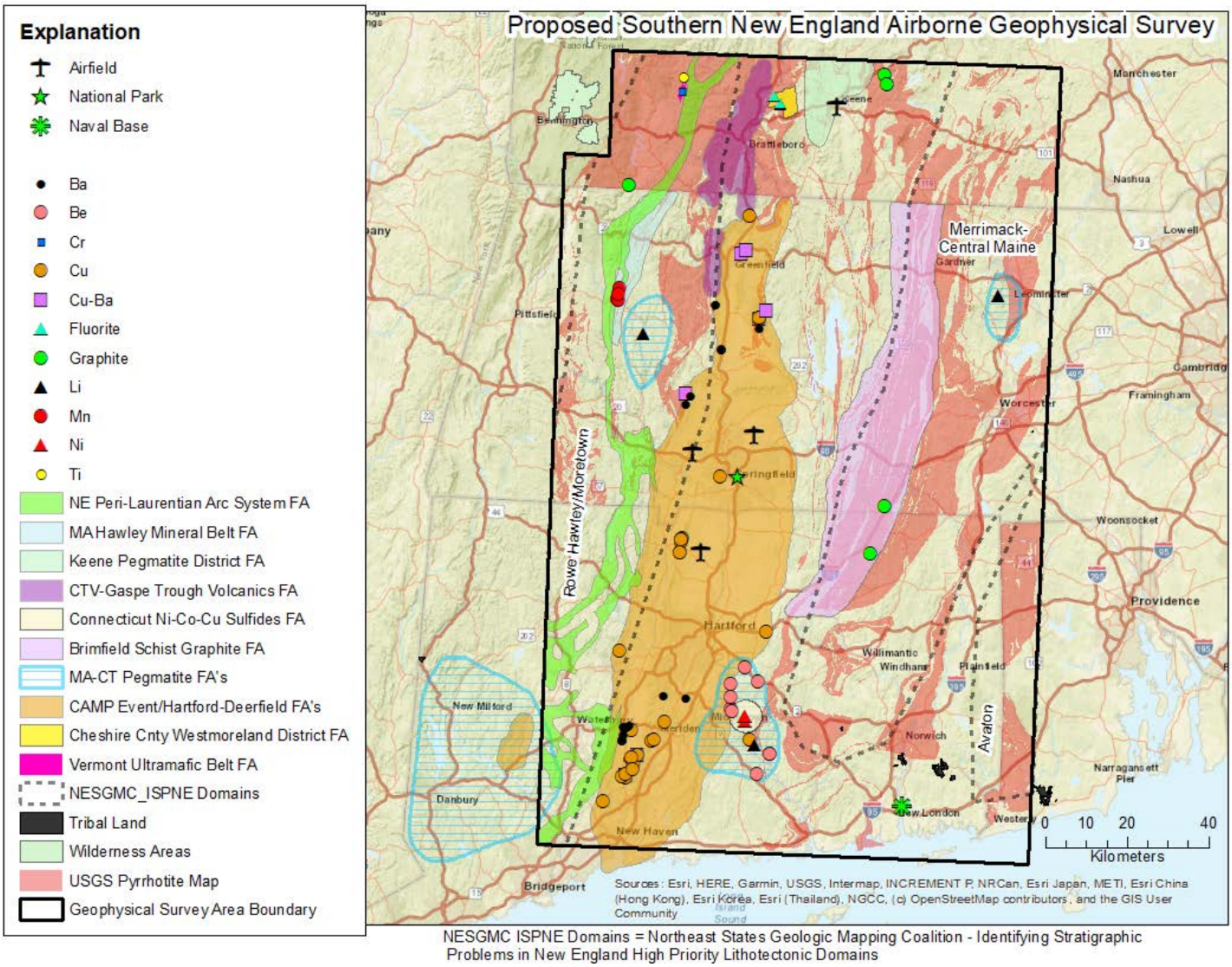
projects or methods to resolve some of the issues. The final report provides a roadmap for future geologic mapping and includes links to over 1600 geo-located bibliographic entries.

EARTH MRI – SOUTHERN NEW ENGLAND AIRBORNE GEOPHYSICAL SURVEY

This year the Earth MRI Southern New England Airborne Geophysical Survey project was selected for funding (Figure 1). The survey will include airborne radiometric and magnetic surveys of western Rhode Island, central Massachusetts, southern New Hampshire, southeastern Vermont and eastern Connecticut. The survey will cover portions of five states, 12 focus areas, 5 mineral systems and 27 critical mineral and associated commodities. The survey will be conducted in spring 2025.

CLIMATE RESPONSE NETWORK

The Massachusetts Geological Survey (MGS) continues to contribute to the Climate Response Network, a network of over 70 wells used to monitor ground water levels across the state. MGS monitors 4 wells in the western part of the state on a monthly basis and reports results to the U.S. Geological Survey. This work is done in collaboration with the Massachusetts Department of Recreation and Conservation and the Department of Environmental Protection. Some of these wells have been in service since the 1950s. The data set is used by the State's Drought Management Task Force and provides a valuable time series of historic droughts against which current dry periods can be compared.



NESGMC ISPNE Domains = Northeast States Geologic Mapping Coalition - Identifying Stratigraphic Problems in New England High Priority Lithotectonic Domains

Figure 1. Map showing the extent of the Earth MRI airborne geophysical survey for southern New England.

MICHIGAN

MICHIGAN GEOLOGICAL SURVEY

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INTRODUCTION

The Michigan Geological Survey (MGS) has grown significantly following the appropriation of $3 million in annual operations funding. This funding has strengthened geologic mapping efforts, including partnerships with the U.S. Geological Survey for critical minerals identification and mapping and the statewide aggregate resource mapping project.

MGS is also leading projects in groundwater resource identification and mapping, working with state and federal agencies to improve groundwater monitoring and management across Michigan. These efforts aim to support sustainable water use and long-term resource planning.

Education and outreach efforts have expanded, with the CoreKids program reaching thousands of students and community members through hands-on geoscience activities.

The funding has also improved data preservation and public access, with plans for a new core repository to store Michigan's growing geological collections. Additionally, MGS has strengthened its staffing capacity, now employing more than 20 staff members and many student workers specializing in hydrogeology, mapping, and data management.

As MGS continues to expand its impact, Sara Pearson, CPG, has joined as the new director, succeeding emeritus director John Yellich, CPG, and leading the survey into its next phase of growth and innovation.

GEOLOGIC MAPPING

The Michigan Geological Survey (MGS) has been actively engaged in several geologic mapping initiatives across the state, focusing on surficial, bedrock, and resource mapping. These efforts are crucial for understanding Michigan's geologic framework, resource distribution, and environmental conditions. Supported by state and federal funding, these projects aim to provide stakeholders, researchers, and policymakers with detailed and accessible geologic data.

Surficial and Bedrock Geologic Mapping

MGS continues to expand its surficial and bedrock geologic mapping through collaborations with the U.S. Geological Survey (USGS) National Cooperative Geologic Mapping Program (NCGMP) and Great Lakes Geologic Mapping Coalition (GLGMC). In Muskegon, Montcalm, and Kent counties, mapping efforts are focused on understanding glacial deposits, groundwater resources, and potential mineral resources. These maps, produced at various scales, support land-use planning, hazard assessment, and resource management.

MGS recently completed the compilation of datasets for the Cass County surficial geology map, which was published at the end of 2024. This work integrated multiple sources of geologic data to produce a comprehensive mapping product for stakeholders. Additionally, MGS has undertaken bedrock mapping as part of the Earth MRI program in partnership with Michigan Technological University of four quadrangles in the Upper Peninsula, specifically in Baraga and Dickinson counties. These efforts aim to refine geological interpretations and support resource exploration in the region.

Critical Minerals and Resource Mapping

Additionally, through the USGS Earth MRI program MGS is conducting critical mineral assessments, particularly through the Watersmeet Rare Earth Elements (REE) project in the Western Upper Peninsula. This project, funded by the Earth Mapping Resources Initiative (Earth MRI), includes detailed geologic mapping, geophysical surveys, and sample collection to evaluate REE and other mineral resource potential. The survey team recently shipped rock samples to USGS laboratories for geochemical analysis, aiding in the identification of viable deposits.

Additionally, MGS is leading aggregate resource mapping efforts in partnership with the Michigan Department of Natural Resources (DNR). This project involves desktop reviews, field validations, and subsurface data analysis to assess the distribution and availability of sand, gravel, and bedrock aggregates. Nearly half of the documented pits have been reviewed already, with mapping completed for eight priority counties. The data is publicly accessible via an interactive ArcGIS dashboard, providing valuable insights for infrastructure development, zoning, and industry planning.

Hydrogeologic and Groundwater Mapping

Understanding Michigan's groundwater resources is a key focus of MGS mapping efforts. The Wellogic Triage Project, which is now 91% complete, involves validating and correcting the locations of over 1.12 million water wells. This work enhances the state's ability to manage groundwater resources, monitor contamination risks, and support sustainable water use.

MGS is also collaborating with Ottawa and Allegan counties to improve glacial aquifer mapping and groundwater monitoring. In Allegan County, the team is installing and equipping monitoring wells with telemetry-capable dataloggers, ensuring long-term data collection. These efforts will contribute to the National Ground-Water Monitoring Network (NGWMN) and Michigan's statewide groundwater monitoring framework.

Conclusion

Through these diverse mapping initiatives, MGS is expanding Michigan's geologic knowledge, improving data accessibility, and supporting sustainable resource management.

DATA MANAGEMENT, PRESERVATION, AND ACCESSIBILITY

The Michigan Geological Survey (MGS) is actively advancing several significant projects focused on data preservation and the use of 3D imagery to enhance geological research and outreach.

New Core Repository

A key initiative is the construction of a new core repository to accommodate the MGS's expanding collection of geological data. The current leased facility is no longer sufficient to meet the growing needs of the survey, prompting the development of a new, state-of-the-art facility. The new core repository will be located at the Business, Technology, and Research Park on the Western Michigan University (WMU) campus, adjacent to the College of Engineering and Applied Science. With 20,000 square feet of space, this facility will be capable of storing more than 60% additional core material compared to the current facility. This expansion will help preserve valuable geological samples and support ongoing research and education. Funding for the new facility has been provided by the Michigan Department of Environment, Great Lakes, and Energy (EGLE), the Michigan Department of Education, and WMU, underscoring the collaborative support for the project.

Data Preservation

The MGS is also focusing on the digital preservation of geological data, ensuring that physical samples and records are safeguarded for future generations. One of the core components of this effort involves converting geological data into digital formats, including the 3D scanning of samples and cores. This digitization is supported by funding from the U.S. Geological Survey's (USGS) National Geological and Geophysical Data Preservation Program (NGGDPP). Additionally, the MGS is partnering with Michigan Technological University (MTU) on a joint venture aimed at inventorying and digitizing geological documentation. This collaboration is a crucial step in preserving valuable historical geological data that may otherwise be lost over time.

3D Imagery

3D imaging is playing a central role in the MGS's efforts to enhance research, education, and outreach. By creating digital models of geological samples and cores, the MGS is transforming physical data into interactive and accessible formats. These 3D models can be used for a variety of purposes, including research, educational programs, and public outreach. The MGS has already uploaded over 600 3D models to Sketchfab, a platform that allows users to interact with and explore geological samples in a virtual environment. Additionally, the MGS is using 3D imagery to produce physical outreach materials, such as 3D-printed models that bring geological data to life in a tangible form. These innovations not only make geological data more accessible but also enhance the learning experience for students and the public alike.

Collaborative Initiatives

Beyond the core repository and data preservation projects, the MGS is involved in several collaborative initiatives related to 3D imagery and data management. One such initiative is the Upper Midwest CORE-CM project, a partnership with the Illinois State Geological Survey (ISGS). This project focuses on compiling existing data and publications related to critical minerals, collecting new samples, conducting volumetric assessments, and providing outreach and educational resources. Additionally, the MGS is working with the U.S. Energy Association (USEA) on a project to develop outreach materials, including 3D-printed objects and short educational videos, further expanding the survey's ability to communicate geological insights to a broader audience.

Through these ongoing projects, the MGS is leading the way in advancing geological data preservation, fostering collaboration, and leveraging cutting-edge technologies to benefit the scientific community and the public.

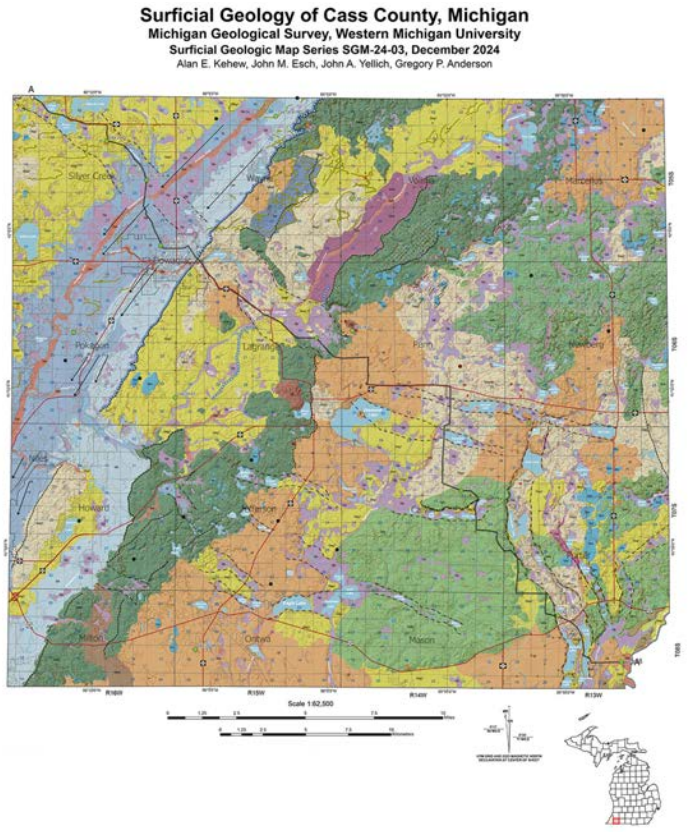

Figure 1. Newly published Cass County Surficial Geology map.

Figure 2. Screen image of 3D scanned brachiopod fossil is an example of the hundreds of MGS specimen samples available online at https://sketchfab.com/MGRRE.

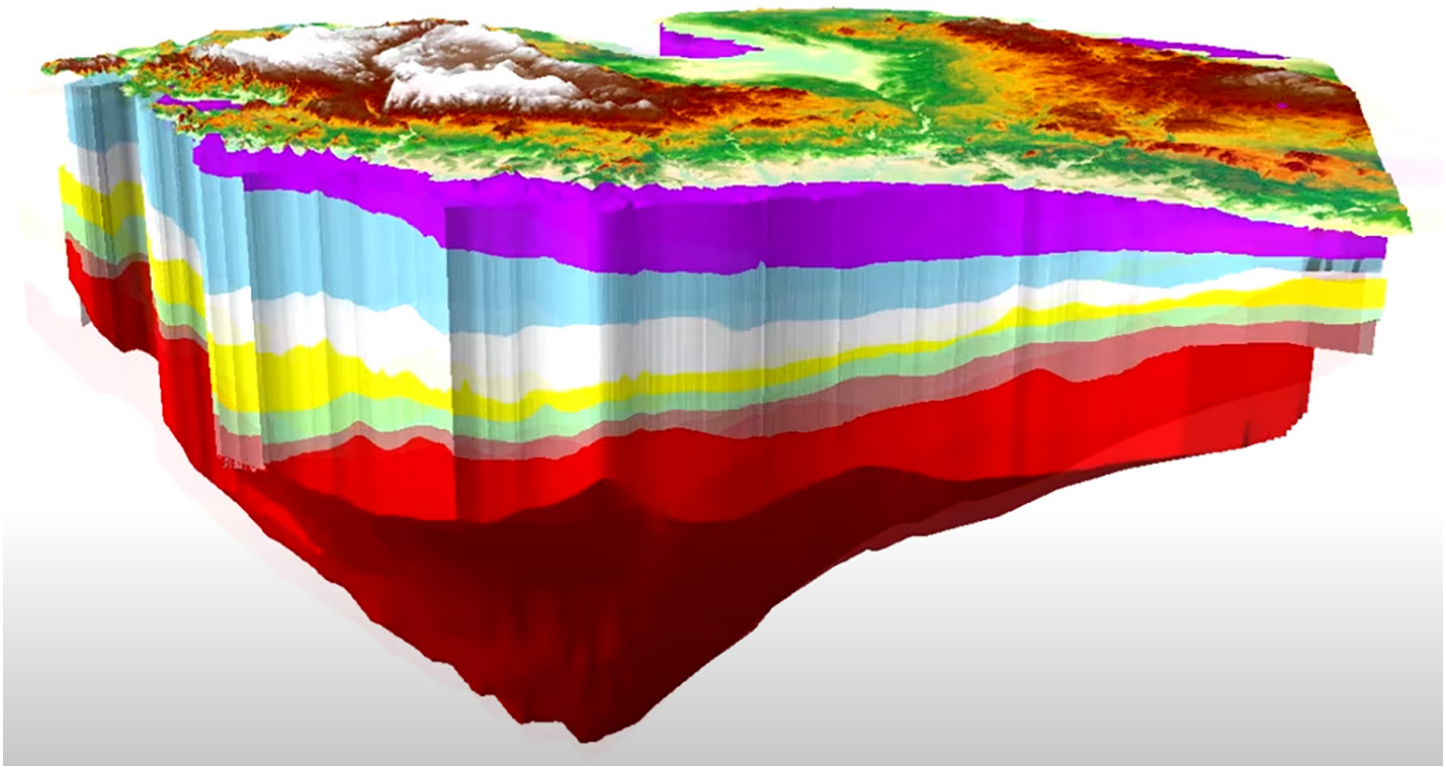

Figure 3. Three dimensional visualization of the Michigan Basin that is being used to develop 3D printed models of the basin that will be used in education and outreach activities.

MINNESOTA

MINNESOTA GEOLOGICAL SURVEY

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INTRODUCTION

The Minnesota Geological Survey (MGS) is a unit of the School of Earth and Environmental Sciences in the College of Science and Engineering at the University of Minnesota.

MGS carries out geological research and provides service and education in geological matters to the people of Minnesota. Principal activities include geologic mapping in (1) structurally complex Precambrian terranes, (2) essentially un-deformed sedimentary strata of Paleozoic and Mesozoic age, and (3) varied glacial deposits of Quaternary age. The mapping is integrated with vigorous research programs. MGS publications and databases serve the needs of scientists, decision-makers, and resource managers concerned with groundwater, environmental issues, land-use planning, waste disposal, mineral discovery, and mineral-resource development. The Survey works with state, tribal, county, and regional offices to set up geologic databases and provide technical guidance for water resource planning, land management and mineral exploration policy, energy system development, and other planning and resource management activities.

The MGS is funded by a special appropriation from the State Legislature and receives significant contract funding for special projects and research from various governmental agencies. We currently have 30 professional geologists, hydrogeologists, geophysicists, and support personnel, and operate on an annual budget of approximately $3 million.

GEOLOGIC MAPPING

County Geologic Atlas Program

Most MGS mapping is conducted as part of the County Geologic Atlas (CGA) program, which provides maps and databases essential for improved management of all geologic resources, with a focus on information relevant to ground and surface water. This is foundational data that supports management of drinking water, domestic and industrial supply, irrigation, and aquatic habitat. CGAs are specifically identified as essential data for sustainable water management. The distribution of geologic materials defines aquifer boundaries and the connection of aquifers to the land surface and to surface water resources to enable a comprehensive water management effort.

Mapping at a resolution of 1:24,000 and a publication scale of 1:100,000 is focused on the CGA projects that are underway. Mapping is being compiled as seamless 1:100,000 surficial and bedrock databases, and as statewide, consistent 1:500,000 maps and incrementally updated databases.

Atlases are complete for 53 of the 87 counties and we currently have active projects in 26 counties (Fig. 1). The goal of the program is to complete CGA coverage statewide.

USGS Mapping Programs

MGS leverages state funding for the CGA program with federal funding through a variety of USGS programs including: STATEMAP, Earth Mapping Resources Initiative (Earth MRI), and the Great Lakes Geologic Mapping Coalition (GLGMC). We are currently cost-sharing mapping of the surficial and the bedrock geology of Koochiching County as part of our STATEMAP funding and recently completed four counties (bedrock) as part of our Earth MRI award. Rotary sonic drilling operations for three counties were funded in part by the GLGMC.

It is mutually beneficial for us to integrate the Federal funding into our existing mapping programs. Not only are we able to achieve the MGS mission and goals, but we are able to identify areas that may have potential to contain critical mineral resources and support the US GeoFramework Initiative as well.

Watershed mapping

The Department of Health has identified Groundwater Restoration and Protection Strategies (GRAPS) to support water planning efforts. The goal is to provide a compilation of surface and subsurface geologic data within selected HUC 8 watershed boundaries in a format suitable for both modelers and the public.

Seamless geologic products are based on a compilation of previously published MGS County Geologic Atlas maps along with new mapping where necessary. These products are displayed as web-based 3D models (Fig. 2) so they can be visualized and used outside of a GIS environment by water planners, state agencies involved in the GRAPS process, and the public. A GRAPS project beginning in the fall of 2024 will integrate groundwater chemistry and residence-time estimates into the 3D watershed scale model.

This type of project is a natural step that follows CGA mapping. We can revisit counties that may not contain the same digital products as more recent CGAs. Furthermore, adjacent counties within a watershed may not have seamless CGA mapping across their border. We can update a targeted watershed with new data and mapping as necessary, rectify border discrepancies, and produce a seamless three-dimensional map.

OTHER PROGRAM HIGHLIGHTS

MGS updated their aging borehole geophysics program with the purchase of Mount Sopris Instruments equipment (Fig. 3). A new two-stage winch and data logger with 1,000 m (3,281 ft) of cable will allow MGS to log deeper than it has in the past. New downhole probes were also purchased including a gamma/resistivity probe and a wide-range caliper which are part of our general logging program. MGS also acquired a fluid temperature and conductivity probe to

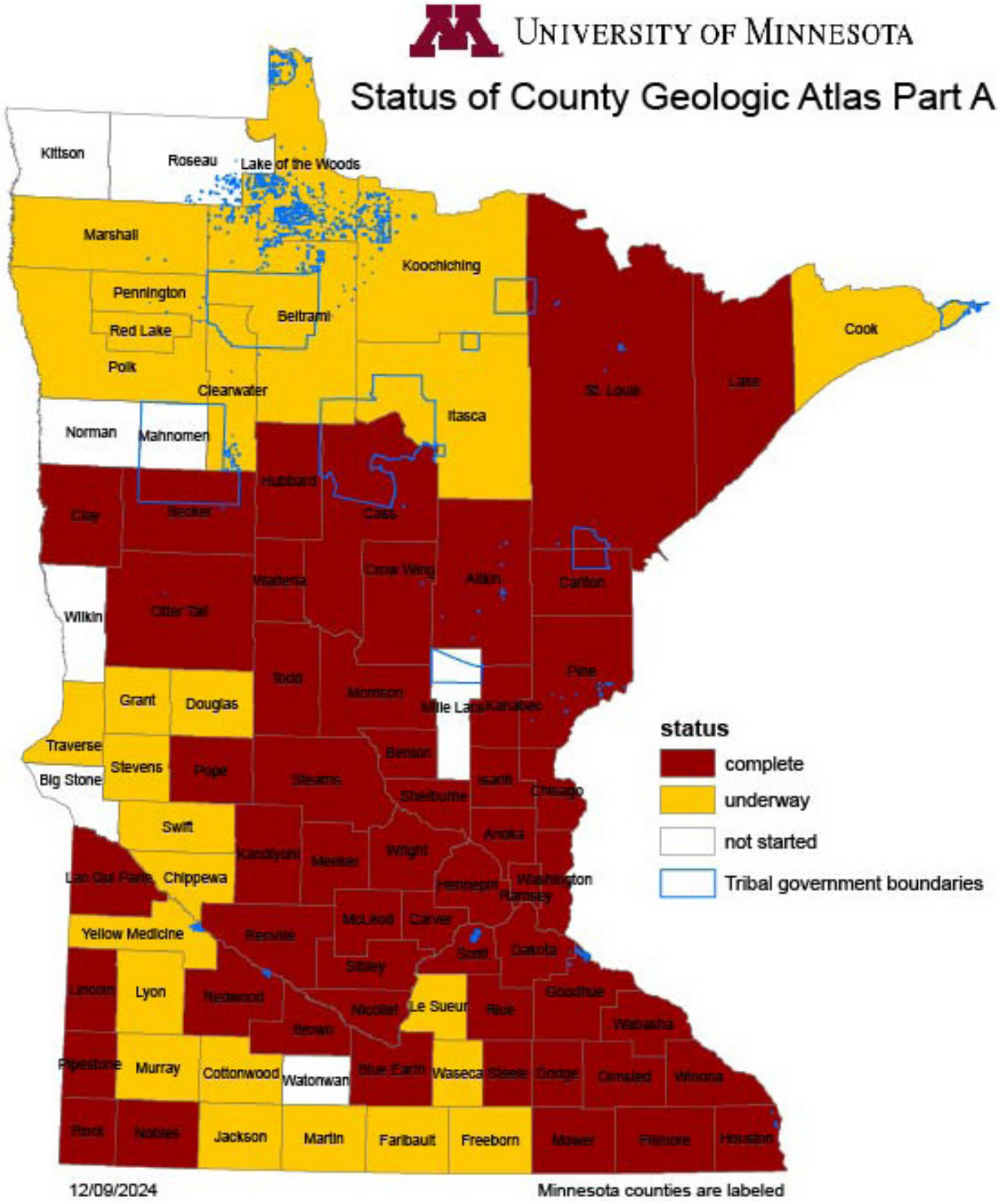

Figure 1. Status of County Geologic Atlas mapping.

measure fluid flow and dissolved mineral concentrations, a heat pulse flowmeter to measure low groundwater flow, and a fluid sampler for additional groundwater related studies. MGS also purchased televiewers and a sonic probe. The sonic tool measures seismic velocity of the surrounding rock which can be related to density and porosity. The optical televiewer takes a high-resolution image of the borehole, and the acoustic televiewer uses an ultrasonic beam to record borehole diameter, fractures, geologic bedding, rock strength, and other geologic and structural information; both tools generate a continuous 360 degree-oriented products. This new equipment has already been tested and used in groundwater related studies, a 700+ foot borehole, bedrock wells, observation wells, and CGA related borehole logging across most regions of Minnesota.

Although not within the July 2023- June 2024 timeframe of this report, MGS is delighted to announce the appointment of Robert Tipping as our new director. Bob returns to the MGS from the Minnesota Department of Health – Source Water Protection group. He began his appointment this past October – more to follow in next year's newsletter!

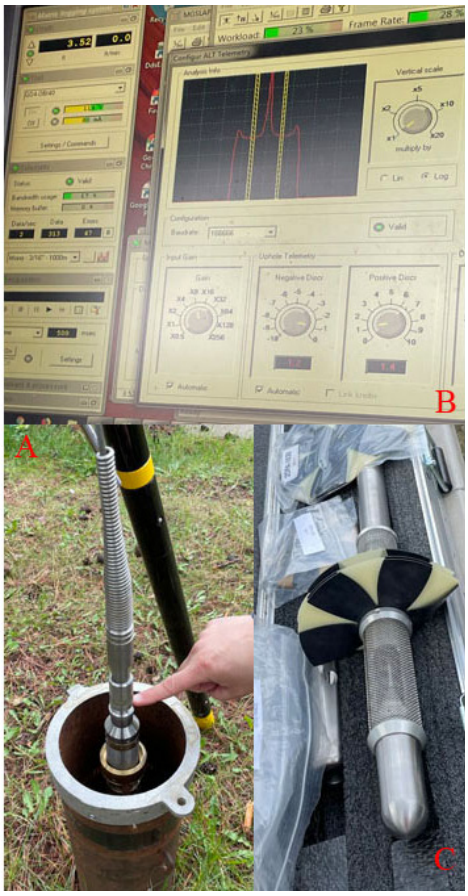

Figure 3. New Borehole geophysical equipment: (a) setting starting depth for logging; (b) software interface within the logging van; (c) heat pulse flowmeter.

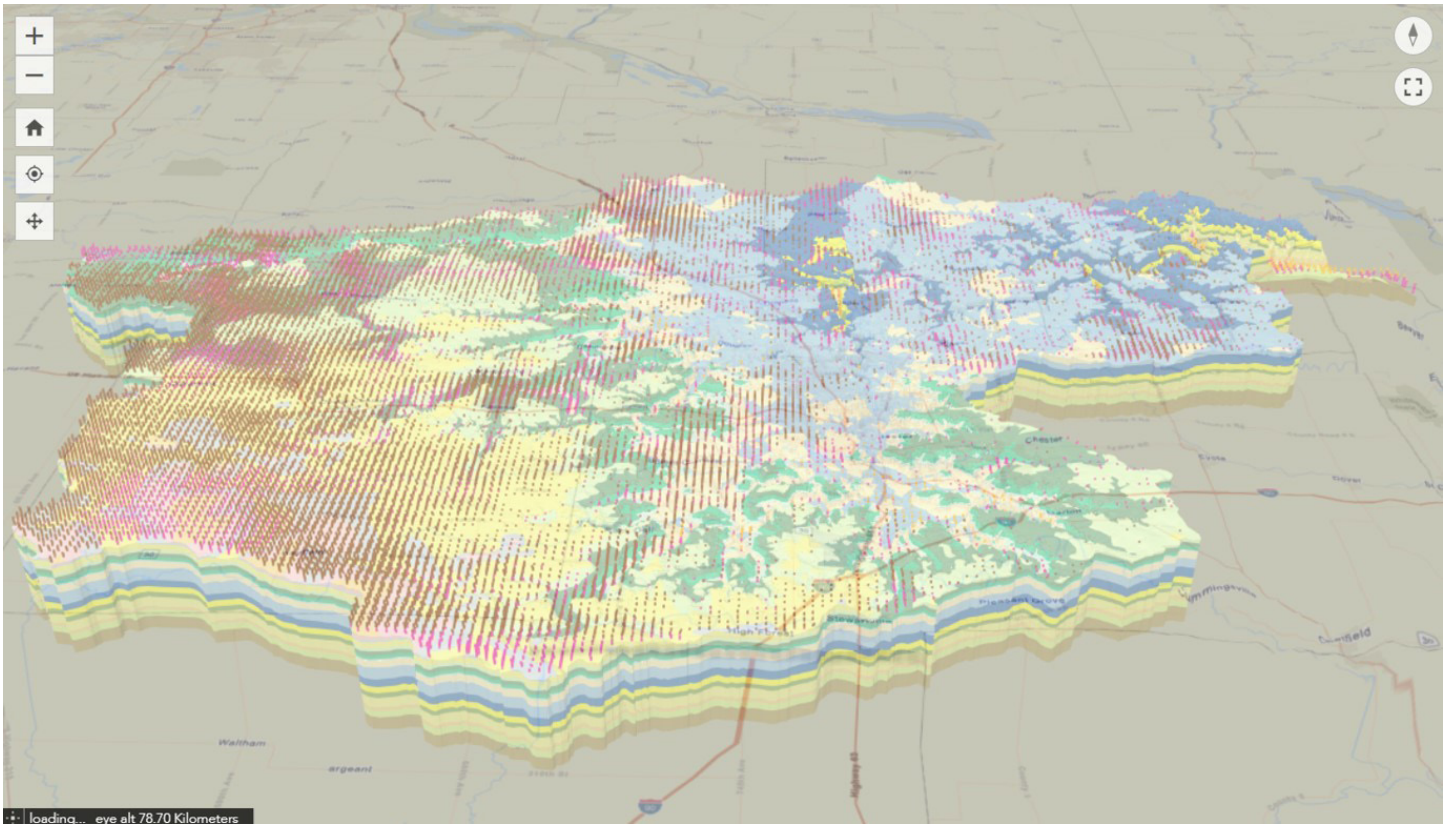

Figure 2. Three-dimensional representation of surficial and bedrock data for the Zumbro River watershed.

MISSISSIPPI

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY, OFFICE OF GEOLOGY

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INTRODUCTION

During Fiscal Year 2024, the Mississippi Office of Geology continued research into the surface and subsurface geology, paleontology, and mineral resources of Mississippi; regulatory responsibilities for surface mining and reclamation also continued. The Office of Geology is a component of the Mississippi Department of Environmental Quality, and our staff interacts extensively with personnel of the water management and pollution control offices. The State Geologist is a member of the Environmental Quality Permit Board and served as Board Chairman in Fiscal Year 2024.

FISCAL YEAR 2024 ACCOMPLISHMENT HIGHLIGHTS

- Contributing author of a six-hundred-page book, Handbook of Mississippi's Prehistoric Indians and Artifacts, Borgo Press.
- A total of seven 7.5-minute geologic quadrangle maps were published in Fiscal Year 2024, three for the STATEMAP 2023 grant and four funded by the National Park Service.
- The Surface Geology Division worked with the Mississippi State University's Extension Service to publish a syllabus and outdoor environmental activities for a club in the state's 4-H program called the 4-H Geo/Arch Club. The syllabus has also been used in Alabama.
- Excavation of a fossil mosasaur skeleton and delivery to the Mississippi Museum of Natural Science.
- The Mississippi Department of Environmental Quality (MDEQ) was awarded the Southern Public Relations Federation's Lantern Award for public relations achievements across Alabama, Louisiana, Mississippi, and the Florida Panhandle. The award named James Starnes (Office of Geology), Jan Schaefer (Public Relations), and Alice Perry (MDEQ Legislative Liaison) for their contributions in getting Mississippi Opal designated as the State Gemstone with unanimous passage in the 2023 legislative session.

GEOLOGIC MAPPING

Geologic maps of Mississippi created by the Office of Geology's Surface Geology Division staff are fundamental to characterizing the environment and have applications in water resources, pollution prevention, mineral resources, and protecting property from geologic hazards such as landslides, swelling clays, and floods. A total of three geologic maps funded in part by the STATEMAP grant were published in Fiscal Year 2024: 7.5-minute Geologic map of Queens Hill Lake in Hinds and Warren Counties; 7.5-minute Geologic map of Eldorado in Warren, Yazoo, and Issaquena Counties; 7.5-minute Geologic map of Oak Ridge in Warren and Hinds Counties. Geologic mapping for the National Park Service is being funded by a 2-year renewable contract totaling $100,000 for the completion of detailed geologic quadrangle maps along the Natchez Trace Parkway. A total of 2 geologic maps were published in Fiscal Year 2023 funded by the National Park Service: 7.5-minute Geologic map of Edwards in Hinds County and 7.5-minute Geologic map of Learned in Hinds County. An additional two National Park Service maps in Northeast Mississippi produced unfunded in cooperation with Mississippi State University: the 7.5-minute Geologic map of Houston East in Chickasaw County, the 7.5-minute Geologic map of Troy in Chickasaw and Pontotoc Counties. The geologic mapping program for Fiscal Year 2024 was funded in part by a federal STATEMAP (2023) grant of $167,591 and a federal contract with the National Park Service.

Figure 1. Cut Mississippi Opals from the Catahoula Formation and the 2024 Lantern Award for Public Relations achievements in the successful effort to make Mississippi Opal the State Gemstone.

The staff answered questions generated through the "Ask a Geologist" portal on the Office of Geology website and created weekly public educational posts on the MDEQ Twitter, Instagram, and Facebook for #Fossil Friday (Surface Geology Division) some of which were reprinted as natural science interest news stories in both local and national news outlets. Surface Geology staff also worked with other state and federal agencies, our universities, neighboring state surveys, researchers, and professional consultants on issues, projects, and research related to the diverse aspects of our state's geology in addition to conducting numerous public education and outreach programs.

Flood Mapping

The Office of Geology's Geospatial Resources Division is focused on remote sensing and geographic information systems activities and manages the Mississippi Flood Map Modernization Initiative and Mississippi Risk Mapping, Assessment and Planning (Risk MAP). The Risk MAP program develops and updates digital flood insurance rate maps for the 82 counties under funding from FEMA. In 2024, the Division currently has 12 active HUC_8 Watershed Flood studies affecting flood maps in portions of 43 counties, three LAMP projects (Levee Analysis and Mapping Plan) involving portions of 9 counties.

Mississippi Digital Earth Model

The Geospatial Resources Division is responsible for the development of the Mississippi Digital Earth Model (MDEM). MDEM develops digital geographic information that will serve as the state base map and consists of eight layers of digital information. MDEQ manages and monitors the MDEM data development contracts and the quality assurance of the mapping products that result from this work. Products will be used by state and local governments, engineering firms, and construction companies involved in planning, development, construction, or regulatory work throughout the state. The division has and will continue to manage development, collection, and review of local resolution hydrography data, lidar elevation data and development/production of 6-inch annual orthoimagery projects covering a third of the state each year (funding allowing) and updating the Statewide Land Ownership Parcel Layer.

In Fiscal Years 2025 and 2026, the division will continue management of FEMA-funded flood mapping projects as well as work on the FEMA Risk MAP program, which adds mitigation and risk assessment data development to the ongoing flood map maintenance activities. During the 2023–2024 winter leaf-off season, MDEQ contractors collected six-inch, four-band, color Orthoimagery over the northern third of the state. The data is expected to be delivered in early December 2024. This project totals approximately 16,500 square miles and covers 30 counties. A third project to be completed in late 2024 is the collection and updating of the statewide database of all 82-county parcel/land ownership data sets to the 2023 tax year information. All Orthoimagery, lidar, and county parcel/land ownership data acquired by the Division is considered a part of MDEM and will be made available for distribution from the Mississippi Automated Resource Information System (MARIS) to all state, county, and federal governmental agencies, as well as engineering firms, public businesses, and individuals.

Figure 2. The #1 WRB Ranch test hole and picked geophysical log for the Geological Map of the Queens Hill Lake 7.5-Minute Quadrangle Map in Hinds County, Mississippi.

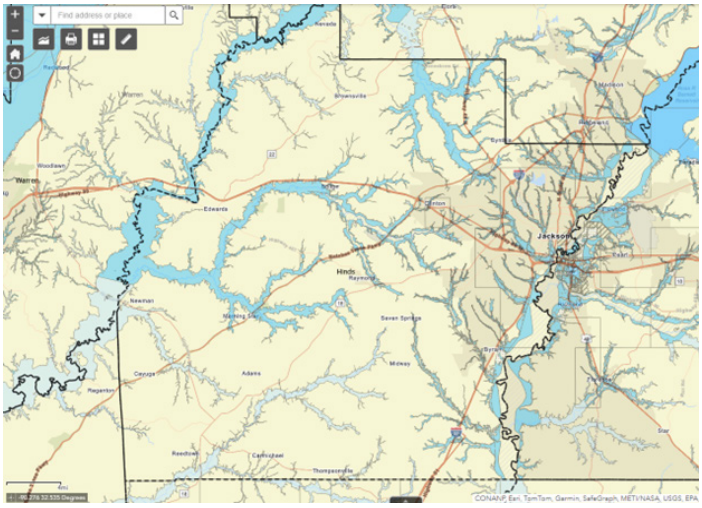

Figure 3. Zoomed-out view of Hinds County (central Mississippi) area FEMA National Flood Hazard Layer.

SURFACE MINING AND RECLAMATION OF SURFACE-MINED LANDS

Reclamation Objective: Ensure lands impacted by mining activities are restored to reclamation standards that are protective of human health and the environment.

MDEQ's Office of Geology regulates all non-coal surface mines in the state as provided for in the Mississippi Surface Mining and Reclamation Act of 1977. This includes issuing surface mining permits and notices of exempt operations, inspecting permitted areas and complaints, overseeing the reclamation performed by operators, and enforcing the law as per the promulgated Rules and Regulations and Commission orders. Additionally, coal and lignite mines are regulated under the Mississippi Surface Coal Mining and Reclamation Law of 1979, with oversight of the program by the federal Office of Surface Mining Reclamation and Enforcement (OSMRE).

In Fiscal Year 2024, the Mining and Reclamation Division performed 511 inspections (of which 30 were bond release inspections), recommended to the Permit Board the issuance of 25 initial and 5 amended permits, and received 31 Notices of Exempt Operations (operations less than four acres in size). A total of 2,226 exempt operations are on file, covering approximately 8,904 acres. A total of 1,627 bonded acres were completely reclaimed as a result of the division's efforts to oversee reclamation. The state currently has 582 permits covering approximately 34,562 acres. The Office of Geology's Mining and Reclamation Division continues to update the mining database that provides valuable mining information in a GIS format so mining sites can be located and viewed by anyone using the online Mining Viewer.

RECLAMATION

Reclamation Objective: Ensure lands impacted by mining activities are restored to reclamation standards that are protective of human health and the environment.

The Mining and Reclamation Division provides the required Mine Safety and Health Administration (MSHA) training for mining operations in the state. MSHA regulations require that all mine workers undergo New Miner Training as well as an eight-hour Refresher Training. In Fiscal Year 2024, the staff provided 60 New Mining / Annual Refresher Certifications. The Mining and Reclamation Division continues to focus on the complexities of coal mine regulation. Mississippi has an industry-estimated five billion tons of surface mineable lignite, a low-grade coal ranked just below sub-bituminous coal. The Mississippi Lignite Mining Company is mining lignite at the Red Hills Mine in Choctaw County to supply fuel for an adjacent 440-megawatt (MW) mine-mouth power plant. The mine produces over 3.5 million tons of lignite per year and has a permitted 6,090 acres. This permit (MS-002) was initially issued in 1998 and was renewed in February 2017 for its fourth five-year return. The Planned life of the mine is 30 years. In January of 2020, a new surface coal mining permit (MS-004) was issued to the Red Hills Mine for an additional 4,190 acres. The Liberty Fuels, LLC mine permit (MS-003) in southwestern Kemper County was issued in December 2011 for 2,299 acres. This permit was renewed in 2016. The Liberty Mine was to produce an average of 2.2 million tons of lignite per year for the initial five-year term, and 4.5 million tons per year for the planned 40-year life of mine. In 2017, Mississippi Power Company discontinued the coal gasification process and elected to operate the power plant exclusively on natural gas. In 2018, MDEQ approved a modification to the surface coal mining permit, fostering the reclamation of the site. Reclamation activities at the site were ongoing in Fiscal Year 2024 and will continue in Fiscal Year 2025. Staff site inspections of all three surface coal mining permits are conducted at least monthly. One or more joint inspections of each mine are conducted annually with the Office of Surface Mining, Reclamation and Enforcement. It is anticipated that at least three applications for permit revisions and at least two bond release applications will be submitted during Fiscal Year 2025.

Work under Mississippi's Abandoned Mine Land Program to identify and locate abandoned historic coal mines has identified four sites—two in Choctaw County and one each in Winston and Lauderdale Counties. All these sites are believed to have been active sometime in the period from the mid to late 1800s to the late 1920s. Necessary reclamation work at the sites was completed in June 2018. In June 2020, another mine entrance was located in Winston County. This area was reclaimed in Fiscal Year 2022. In Fiscal Year 2024 the division shifted the focus to the reclamation of non-coal sites and a non-coal inventory was established. In Fiscal Year 2025, the program anticipates completed reclamation of AML sites on 16th Section lands in Covington and Simpson Counties.

ENVIRONMENTAL GEOLOGY

Since the 1950s, the Office of Geology has been collecting subsurface geological information by sending scientific instruments down test holes and water wells to record data on rocks and groundwater. Environmental Geology Division staff logged 50 test holes and water wells during Fiscal Year 2024 and collected 25,610 feet of data on test holes that otherwise would not have been wireline logged. These geophysical logs were run for 15 different entities from industry, academia, and the Mississippi Office of Geology. Division personnel maintained the core and sample library by cataloging and archiving samples from oil and gas tests drilled in the state. The Environmental Geology drilling program drilled four boreholes in support of Surface Mapping's STATEMAP grant. The total depth drilled was 805 feet.

PUBLICATIONS

MDEQ's Office of Geology staff published twenty-seven geologic papers in Fiscal Year 2024. These include: eleven abstracts in the *Mississippi Academy of Sciences Journal* for 2024, three abstracts in the *Mississippi Archaeological Association Bulletin*, nine articles in the *Mississippi Geological Society Bulletin*, one abstract in the *North American Paleontology Conference Journal*, eleven articles in the *Mississippi Gem and Mineral Society Newsletter Rocky Echoes*, one program syllabus for Mississippi State University Extension Service's 4-H, two papers in the journal *Review of Palaeobotany and Palynology*, one book—*Handbook of Mississippi's Prehistoric Indians and Artifacts*, Borgo Press (595 pages illustrating artifacts and identifying lithic sources), and seven geologic quadrangle map published as Open File Reports 332, 333, and 340–344.

NEBRASKA

CONSERVATION AND SURVEY DIVISION

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INTRODUCTION

The Conservation and Survey Division (CSD) recognized its 131st year in 2024. Its work includes research, scholarly service, extension, outreach, and formal and informal education. CSD publishes the annual *Nebraska Statewide Groundwater-Level Monitoring Report* as part of a program that began in 1930. CSD personnel play important roles in numerous boards, panels, and committees, facilitate the long-term Eastern Nebraska Water Resources Assessment (ENWRA), maintain Nebraska GeoCloud (an internet data repository for groundwater, geology, and geophysics), and coordinate the highly successful Nebraska Water Leaders Academy for professionals. The CSD retains cores, cuttings, and other samples occupying nearly 29,000 square feet of floor space.

CSD is unique in its large proportion of university faculty, its direct integration with university academic programs, and its 51 years of inclusion within the Institute of Agriculture and Natural Resources at the University of Nebraska-Lincoln. CSD personnel include ten faculty members (five tenured) as well as outstanding professional staff. CSD personnel possess skills in cyberinfrastructure, environmental social science, geochronology (OSL dating), geological and groundwater modeling, geomorphology, geophysics, human dimensions of natural resources, hydrogeology, image analysis, low-temperature geochemistry, machine learning, mapping, mineral resources, paleontology petrography, petroleum, remote sensing, sedimentology, stratigraphy, surface-water monitoring, and well drilling and instillation.

GEOLOGIC MAPPING

CSD continues to participate in the STATEMAP Cooperative Geologic Mapping Program, emphasizing the production of detailed surficial geologic maps at the scale of 1:24,000. The Belgrade NE and Central City quadrangles were mapped and published in 2024 and mapping of the Brule, Clatonia, and Pickrell quadrangles is currently under way. CSD is also converting six previously mapped quadrangles to comply with the USGS Geologic Map Schema (GeMS) and training a new hire on geologic mapping techniques and the GeMS framework. Paul Hanson, who coordinates CSD's STATEMAP program, was a coauthor on a U.S. Geological Survey data release consisting of a geologic map of the Niobrara National Scenic River corridor.

OTHER PROGRAM HIGHLIGHTS

CSD personnel directly interacted with nearly 6,300 individuals during the year and addressed more than 500 requests for information and (or) analysis. They were involved in at least 24 media contacts, and they made 70 presentations to a variety of audiences at the local to international levels. CSD faculty published 22 peer-reviewed journal articles, and both faculty and staff produced 35 other published works of all kinds. The CSD drilling crew drilled 5,550 ft of geologic test holes, monitoring wells, and other borings. The total external funding in which CSD personnel were involved exceeded six million dollars. Two major field trips for professionals were led or co-led by CSD staff members.

CSD's Troy Gilmore and collaborators continued to expand the development and application of Gaugecam Remote Image Manager-Educational (GRIME) software, which relies on machine learning and artificial intelligence. Aaron Young contributed a chapter on groundwater to *Understanding and Assessing Climate Change: Preparing for Nebraska's Future*, 2024, a report commissioned by the state's legislature. CSD soil scientist Judy Turk received an NSF CAREER Award to conduct research on erosion and land use effects on soil structure and carbon stocks, as well as educational programs on field-based education and K–12 outreach. She also co-led the UNL Soil Judging Team to a 2nd place finish in the National Collegiate Soil Judging Contest, the highest ranking ever achieved by a University of Nebraska team in at that event. Katie Cameron coordinated a major overhaul of the Eastern Nebraska Water Resources Assessment (ENWRA) website (https://enwra.org), which includes two decades years of results such as airborne electromagnetic (AEM) surveys, groundwater monitoring, recharge, and age-dating results. The Nebraska Water Leader's Academy, coordinated by CSD's Mark Burbach, graduated 20 individuals in 2024, increasing the total number of program alumni to 206. For this achievement and many others in his career, Mark was awarded the Extended Service Award by the School of Natural Resources. Paul Hanson was awarded a Visiting Professor position at University Paul Sabatier and University of Toulouse in Toulouse, France.

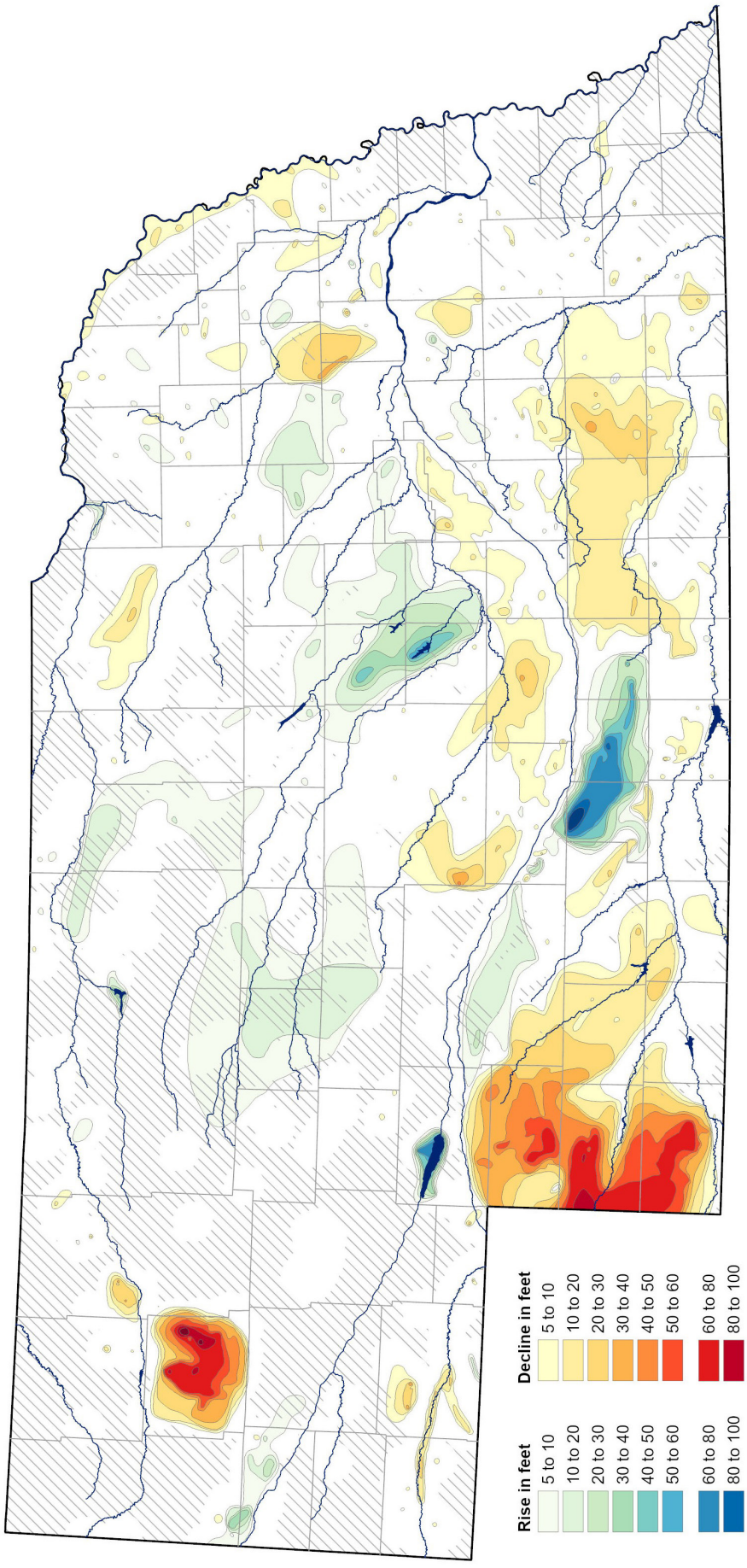

Figure 1. February 2024 map of changes in Nebraska's groundwater levels from pre-irrigation development (circa 1950) to spring 2023, produced by CSD's Aaron Young for the annual groundwater-level report.

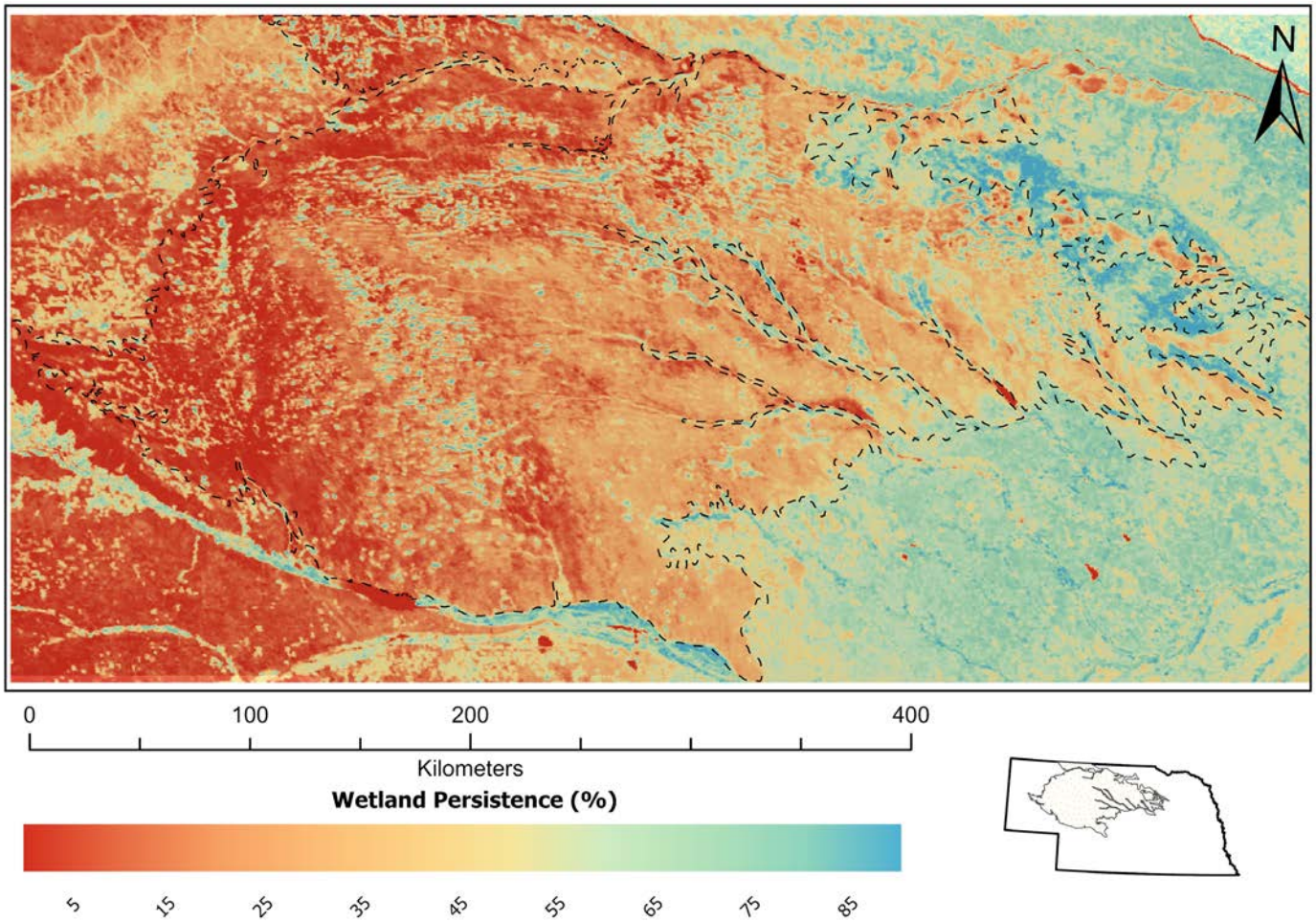

Figure 2. Persistence of wetlands in the Nebraska Sand Hills, 2000–2024 using MODIS Terra and Aqua image archives, produced by CSD's Nawaraj Shrestha.

Figure 3. CSD's Troy Gilmore (in red at right) installs a camera system to monitor surface water at the Kearney Outdoor Learning Area in Kearney, Nebraska while University of Nebraska at Kearney (UNK) student Chris Terry assists. CSD also monitors groundwater levels nearby (photo by Mary Harner, UNK).

NEVADA

NEVADA BUREAU OF MINES AND GEOLOGY

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INTRODUCTION

The Nevada Bureau of Mines and Geology (NBMG) is a research and public service unit of the University of Nevada, Reno (UNR), and serves as the state geological survey for Nevada. NBMG is a statewide agency that resides in the Mackay School of Earth Sciences and Engineering within the College of Science at UNR. As defined by state statutes, NBMG is the state's official locus of data, analysis, and exchange on Nevada's geology, natural resources, and geologic hazards. NBMG scientists conduct research and publish reports that facilitate economic development, public safety, and enhancement of the quality of life across the entire state. NBMG products include geological maps and reports on mineral and geothermal resources, as well as earthquake, flood, landslide, and other geological hazards. NBMG disseminates this information to local, state, and federal agencies, major industries, engineers, educators, and the general public. As such, NBMG has cooperative research and information programs with numerous local, state, and federal agencies. In addition, NBMG hosts three major centers of excellence: 1) the Ralph J. Roberts Center for Research in Economic Geology (CREG), 2) the Great Basin Center for Geothermal Energy (GBCGE), and 3) the Nevada Geodetic Laboratory (NGL).

GEOLOGIC MAPPING

Geologic mapping by NBMG addresses the needs of an extraordinary state. For example, Nevada commonly leads the nation in non-fuel mineral production (as is the case for 2024), is the top producer of gold in the country, and is rich in geothermal and critical mineral (e.g., lithium) resources. Nevada is also the third most seismically active, fastest growing (tectonically speaking), and most urban state (in terms of proportion of citizens living in large cities). NBMG currently has three priority regions for geological mapping: 1) Clark County in southern Nevada, which is home to Las Vegas and nearly three-quarters of Nevada's citizens; 2) the Reno-Carson City urban corridor in western Nevada and adjacent areas rich in geothermal and mineral resources; and 3) north-central to northeastern Nevada due to its wealth of mineral resources and classic setting for extensional tectonics. Northeastern Nevada contains the Carlin Trend, one of the richest regions on Earth for gold production, as well as several other areas well-endowed with mineral resources. All regions contain geological hazards (e.g., earthquakes, floods, debris flows, and landslides) that must be reckoned with for infrastructure planning and development. To date, we estimate that ~20-25% of the state (Fig. 1) has been mapped in sufficient detail (typically 1:24,000 scale) to adequately understand the geological framework, natural hazards, and mineral, energy, and groundwater resources. Accordingly, significant work remains to produce high-quality, detailed geological maps for the state and the USGS STATEMAP program enables the publication of several new quadrangles/areas per year. Although the arid climate greatly facilitates geological mapping in Nevada, the complexity of the geology, with multiple overprinting tectonic episodes since the late Paleozoic, impedes rapid progress on geological mapping. Recent increases in funding for the STATEMAP program have accelerated the pace of detailed geological mapping by NBMG in the state, including publication of high-quality maps by authors external to NBMG (e.g., USGS geologists and university professors). The USGS EarthMRI program has also provided funding for geological mapping in areas with significant potential for hosting critical minerals (e.g., lithium and the rare earth elements).

The large amount of public land (~85%) in the state means that Nevada has, until recently, lagged behind many states in the acquisition of high-resolution lidar and geophysical data that could expedite geological mapping, facilitate exploration of mineral and geothermal resources, and permit evaluation of geological hazards. However, this has changed significantly in the past few years, as evidenced by recent USGS Earth MRI and Department of Energy related precompetitive data acquisitions.

OTHER PROGRAM HIGHLIGHTS

Geothermal Research and Resource Assessments

Nevada's minerals industry remains of great importance to the state, not just in financial terms ($10 billion in nonfuel mineral production in 2024, 1st out of the 50 U.S. states and up from just over $9 billion in 2023; Fig. 2) but also with significant positive employment and economic development impacts, among others. In addition to geological mapping and the generation of other precompetitive data that can directly benefit the minerals industry, NBMG is home to the Ralph J. Roberts Center for Research in Economic Geology (CREG). The Center will celebrate its 30th year at UNR in 2026 and is named for Ralph J. Roberts, a USGS geologist who outlined the model for how the extensive Carlin-type gold deposits in northern Nevada formed, paving the way for exploration success over the last few decades. The continued high levels of exploration in Nevada are indicated by the amount of exploration drilling that happens in the state each year (Fig. 3). This level of activity requires both research support and workforce development, both of which are supplied by CREG. The Center is one of the largest training and research centers in mineral exploration in the nation, with an annual research budget of more than $1 million (and growing) from federal, state and industry sources. In addition to a Director, the Center currently employs one research faculty member, three postdoctoral researchers, and ten graduate students, all of whom work on a variety of economic geology-focused projects. Current research at CREG includes:

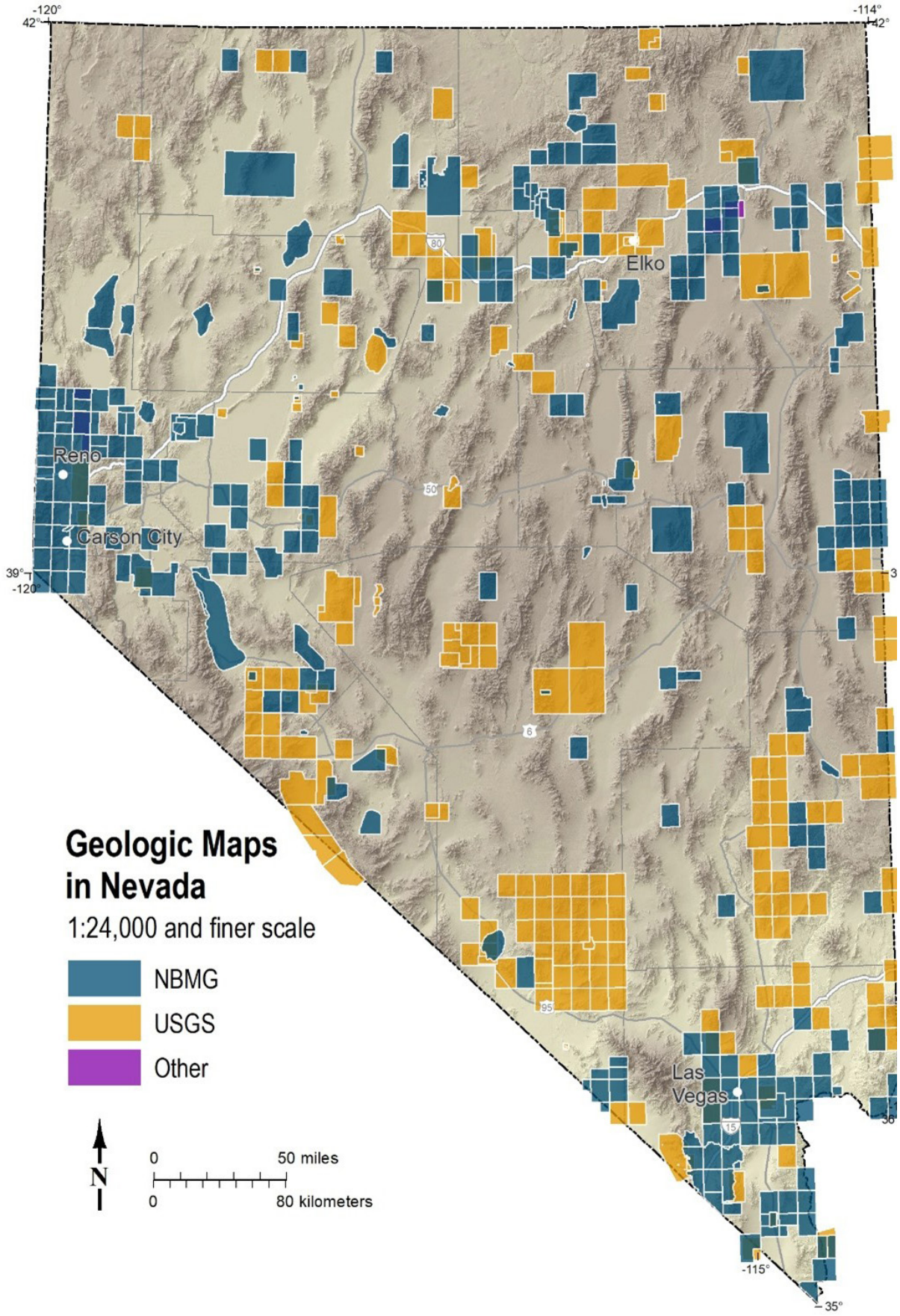

Figure 1. Status of detailed geological mapping in Nevada. Map shows distribution of completed maps at 1:24,000 and finer scale by NBMG and the USGS.

- Understanding the geology of clay/sediment-hosted lithium systems in Nevada and the genesis of these important future sources of lithium
- Understanding the structural and lithological controls on epithermal precious metal mineralization within Nevada
- Unravelling complex and overprinting Carlin-type, skarn, and carbonate replacement mineral systems in various locations within Nevada
- Furthering our knowledge of Carlin-type gold systems, including the importance of intrusive hosts for gold mineralization and breccia systems
- Understanding the critical, base, and precious metal and mineral potential of mine waste within the state
- Mineral economics and data-focused research on state, national, and global lithium and gold resources and supply, demand, and future challenges for these sectors
- Determining the co- and by-product critical metal potential of existing base and precious metal supply chains

After a successful nearly 30 years of existence, CREG will continue to grow and engage with industry and government and undertake and develop research to support the state of Nevada and the U.S. minerals industry, including developments in mineral exploration and resource characterization and improving the security of critical mineral and metal supply chains.

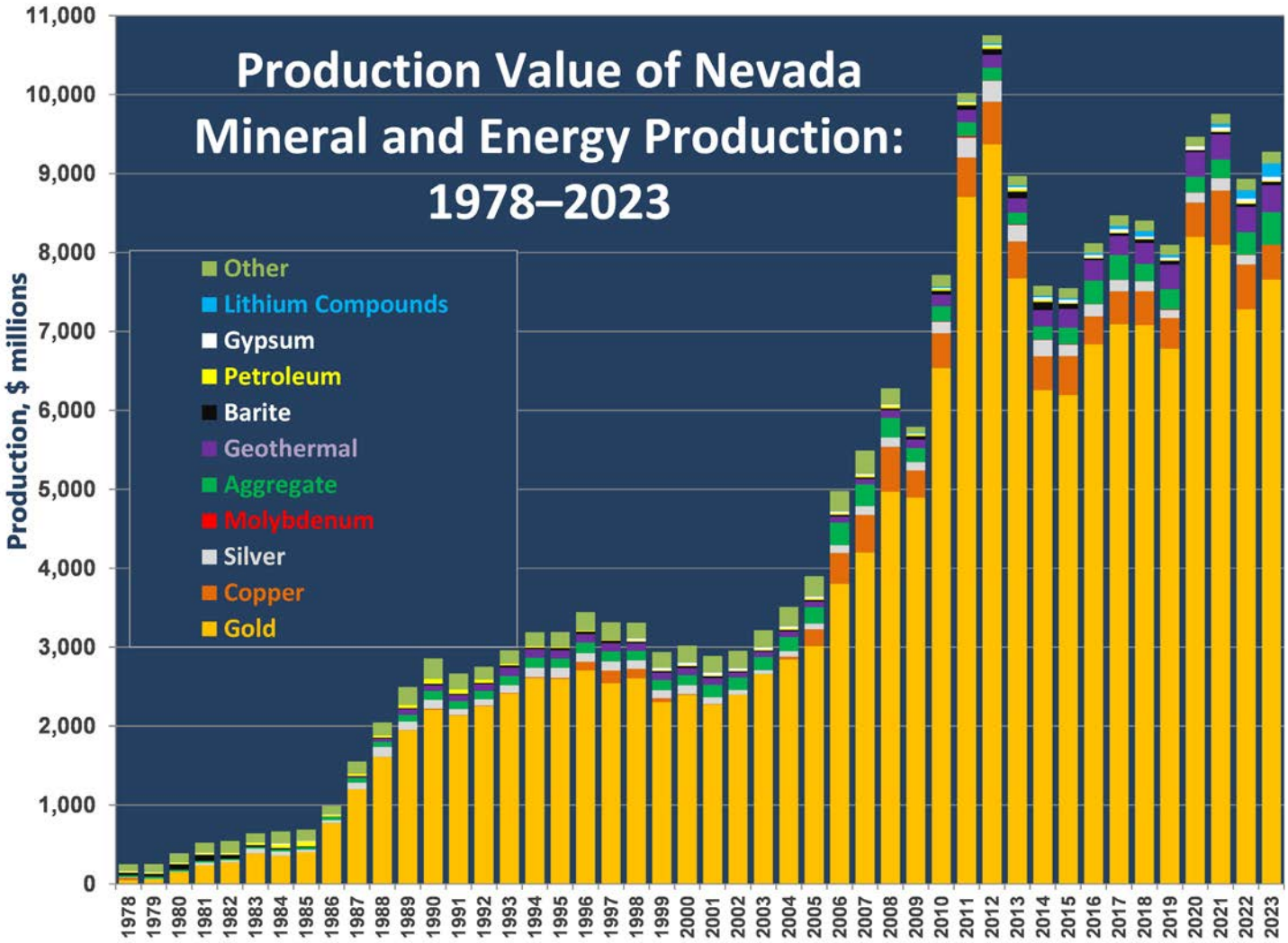

Figure 2. The relative values of Nevada gold, copper, silver, molybdenum, aggregate, geothermal energy, barite, petroleum, gypsum, and other mineral production from 1978 to 2023; Nevada was third out of the 50 U.S. states in the value of nonfuel mineral production in 2023 but moved to 1st in 2024 with the production of nearly $10 billion of nonfuel minerals. Molybdenum production is only separated from other minerals from 2011 through to 2023, and Lithium compounds production is only separated out from other minerals for 2021 through to 2023.

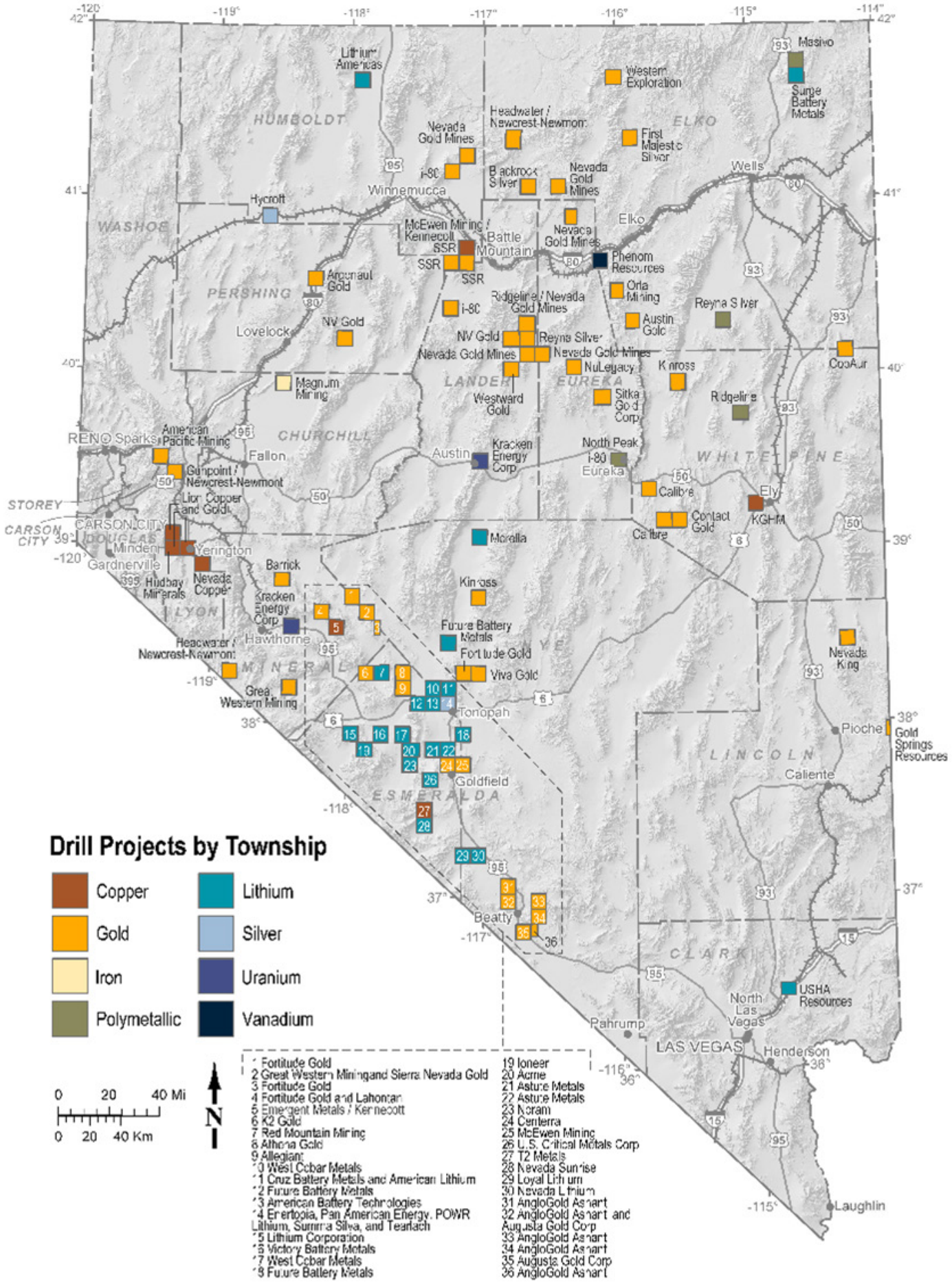

Figure 3. Map showing the distribution of 2023 metal exploration-focused drilling programs in Nevada located by township and split by commodity type. This map clearly indicates the intensity of mineral exploration activity within the Silver State.

NEW HAMPSHIRE

NEW HAMPSHIRE GEOLOGICAL SURVEY

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INTRODUCTION

The New Hampshire Geological Survey (NHGS) was established in 2001 to "collect data and perform research on the land, mineral, and water resources of the state, and disseminate the findings of such research to the public through maps, reports, and other publications." This redefined the Office of the State Geologist, established in 1839. NHGS has five authorized full-time positions. One permanent part-time position serves as Outreach Coordinator, a second part-time position focuses on maintenance of the state Water Well Inventory, and four summer intern positions round out the staffing in NHGS. Geologic mapping remains a key function of NHGS, as with all state surveys, and mapping efforts continue a transition to more populated areas of the state in direct applied support of water resources availability and groundwater quality concerns of interest to the state. To reinforce water resource assistance the unit has responsibility for the statewide Groundwater Level Monitoring Network, and continues to update its well systems and information communication infrastructure as it serves a critical part of statewide drought management. Support for statewide flood mitigation efforts, particularly as they relate to failed stream crossing infrastructure and broader stream and river management concerns, remains an important role for NHGS.

GEOLOGIC MAPPING

NHGS continues to perform bedrock and surficial geologic mapping as part of the U.S. Geological Survey (USGS) STATEMAP program. Many of NHGS' historical suite of contract geologic mappers are entering second retirement. As a result, NHGS, with the advice of the Geological Resources Advisory Committee (GRAC), which serves as the SMAC for New Hampshire, and with the support of the New Hampshire Department of Environmental Services' Commissioner's Office, is shifting its programmatic focus to populated areas of the state that remain to be mapped, to address water resources availability and groundwater quality concerns.

Bedrock mapping continues in the White Mountains region, with one active mapper remaining there. The emphasis of this work centers on the timing and sequences of the mountains' formation. A second area of bedrock mapping is in far northern New Hampshire on the border with Quebec to better understand the geologic history of that region. Though these efforts will be maintained while these two contract mappers remain with us, NHGS is also pivoting the primary focus of bedrock mapping to the more populated interior of southern New Hampshire. This summer 1:24,000-scale mapping in the Manchester South quadrangle, which covers a large portion of New Hampshire's largest city, was completed. While mapping an area that has experienced groundwater contamination and availability concerns is productive on its own, operating in New Hampshire's largest city also allowed NHGS and its mappers to dive right into mapping urban bedrock geology in New England. Closely examining the geology in Manchester also opened up new questions regarding the formation of the Massabesic Gneiss, a key geologic unit in the local region. Southern New Hampshire will continue to be a focus for 1:24,000-scale bedrock geologic mapping in the coming years.

This year, NHGS and its contract mappers completed portions of three 1:24,000-scale quadrangles for surficial geology within the state. Given New Hampshire's considerable attention to date on surficial geologic mapping and its needs for aquifer mapping and groundwater availability identification, GRAC has charged NHGS with maintaining program focus to complete the 1:24,000-scale surficial geologic mapping of the state. The unconsolidated sediments existing in many of the mapped areas largely reflect deposition related to the most recent period of continental glaciation and post-glacial deposition within fans and along streams and rivers. The advance and retreat of the glacial ice resulted in the deposition of an assortment of surficial deposits and the formation of a variety of landforms. For all geologic mapping, NHGS utilizes its collaborative field review process with a daylong field conference for each quadrangle, incorporating members of New Hampshire's geologic community, in order to bring in fresh perspectives to interpret the timing and nature of these glacial and post-glacial deposits. NHGS continues to refine standardization of its geologic maps in order to enhance the quality of our geologic map products.

Overall, NHGS' geologic mapping efforts are designed to produce quality paper and digital products that directly serve the needs of New Hampshire today.

OTHER PROGRAM HIGHLIGHTS

For many years NHGS has been integral to statewide flood hazards efforts, with specific emphasis on issues surrounding undersized stream crossings (culverts) and their failures during floods. A multi-agency team has coordinated the collection of data on the state's stream crossings and the nearby streams they reside within to identify those at greatest risk for failure. NHGS has hosted many summer interns through the years to go into the field to collect data, which, combined with other agency and partner interns, has led to 79% of the state's crossings being assessed and in the state database. NHGS has a key role in the maintenance of this dataset and in conducting annual training of data collectors. This year, NHGS received an EPA Wetland Program Development Grant to work with Southwest Regional Planning Commission, the municipalities of Marlborough and Winchester, and the Technology Transfer Center at the University of New Hampshire to begin working with local municipalities to establish frameworks for them to assume ownership and effectively utilize the collected data. Simultaneously, the grant will also fund NHGS and its collaborative partners to develop a Flood Planning Tool to identify stream crossings that provide flood reduction and wetland protection benefits

as part of the state's overall next step in its stream crossing efforts, which is prioritizing stream crossings for upsized restoration. This grant also funded two summer interns this year to complete stream crossing assessments in the HUC-12 watersheds that intersect Marlborough and Winchester so that a full dataset is achieved to support both municipalities and the development of the Flood Planning Tool.

Prior to the retirement of the National Hydrography Dataset NHGS served as New Hampshire's steward for that dataset in the state. The survey has maintained connections to this community, particularly in New England, and participates in monthly calls to discuss issues related to hydrography. To date, NHGS has not participated in USGS' 3D Hydrography Program's efforts to derive hydrography from lidar, however, the unit has been exploring funding options to enable participation in the coming years. NHGS is continuing a partnership with the White Mountain National Forest to verify and map the locations of streams in the field based on field indicators to refine the understanding of stream reaches that constitute the permanent streamflow network on the landscape. NHGS housed two summer interns this year to work toward these goals.

Figure 1. Examining a bedrock exposure in the heart of New Hampshire's largest city, Manchester. *Photo courtesy of Rebecca LeCain, NHGS.*

Figure 2. NHGS' 2024 summer interns, left to right: Gabrielle DeAngelis, Erin Davis, Olivia Peterson, and Delia Brochu.

Figure 3. Collaborative field review team examining a bedrock outcrop in Bethlehem, New Hampshire.

NEW JERSEY

NEW JERSEY GEOLOGICAL AND WATER SURVEY

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INTRODUCTION

The New Jersey Geological Survey (now the Geological and Water Survey- NJGWS) was founded in 1835 and has had a state geologist continuously serving since 1864. Its roles and responsibilities have evolved over time to address the state's geologic needs and currently has a wide range of responsibilities. These include: management of water supply allocation and well permitting; water supply planning and modeling; groundwater resource assessments; mapping onshore & offshore geology; evaluating natural hazards; advising on energy issues (geothermal, natural gas, and wind) with their related geologic issues; site evaluations; and providing earth science information to government agencies and the public to address economic, environmental, public health and safety issues. The Survey also provides technical expertise and direction for New Jersey on numerous strategic programs including the State Hazard Mitigation Team, Board of Licensed Site Professionals, Board of Licensed Well Drillers and Pump Installers, Pinelands Commission, Highlands Commission, Delaware River Basin Commission, and the Delaware River Decree Parties.

GEOLOGIC MAPPING

The Geologic Mapping and Coastal Geology Section completed three STATEMAP deliverables and met the Geologic Map Schema (GeMS) federal requirements.

Bedrock Mapping

The NJGWS published bedrock maps of two quadrangles: the Rocky Hill Quadrangle and the New Jersey Portions of the Easton Quadrangle.

Combined Surficial and Bedrock Mapping

One combined surficial and bedrock quadrangle map was published: the Mays Landing Quadrangle.

DATA PRESERVATION

NJGWS used the 2023 Data Preservation Grant to create a design document for a digital data management system, web portal and administrative portal to house and disseminate numerous types of NJGWS geoscientific information.

PUBLICATIONS AND WEB

An open file report on Amber in New Jersey was published and an Information Circular on The Generalized Stratigraphic Table for New Jersey was slightly revised. A new publication series was introduced "Story Maps" with two being released, The Waterfalls of New Jersey and the Deepest Bodies of Water in New Jersey. Other items of note were the creation of two webpages on our website. One was the 4/5/2024 New Jersey Earthquake Summary Web Page and the second was the New Jersey Drought Information Web Page.

The NJGWS website had more than 96 inquiries for information with sinkholes and rock identifications being the most common. There were 24 requests to purchase various sale publications. The most popular site visits were Digital Data, Geologic Maps, Earthquakes and Educational/Classroom Materials. Map views were 4,540 with 3,452 downloads. DGS views were 1,655 with 1,039 downloads. There was a total of 21,735 downloads from the website.

WATER SUPPLY MODELING AND PLANNING

NJGWS provided technical support to water resource planning and permitting groups within and external to State government. Major work efforts included the publishing of the 2024 Statewide Water Supply Plan, which included assessments of climate change impacts to water supplies, water use data trends and forecasts, emerging contaminant and new MCL impacts to drinking water supplies, and water supply impacts specific to overburdened communities. Surface water modeling support was provided to quantify risks to drinking water reservoirs from large harmful algal blooms (HABs) during the summer of 2022. Drought monitoring and technical support was provided for a Statewide Drought Watch and upgraded to drought warning and continues to be in place. NJGWS also provides support to the Delaware River Basin Commission.

GROUNDWATER QUALITY

NJGWS sampled fifty monitoring wells as part of the New Jersey Ambient Groundwater Quality Monitoring Network. The network is designed to assess geogenic and anthropogenic impacts to the unconfined aquifers of New Jersey. Emerging contaminates 6PPD, glyphosate, and per-and polyfluoroalkyl substances (PFAS) were included in the parameter list along with the network's traditional field, nutrients, major ions, trace elements, VOCs, and pesticide schedules. Lithium was also introduced to the parameter list. PFAS sampling from all one hundred fifty monitoring wells has been completed and it will be sampled in future sampling events to assess trends. Due to low occurrence of 1,4 dioxane in the AGWQMN between 2021-2023 it was dropped from the parameter list. The last state-wide occurrence data has been released by the NJGWS as DGS05-2 (NJDEP| NJ Geological Survey | DSG05-2), as well as on the NJ Department of Environmental Protection's NJ-GeoWeb (NJDEP| Geographic Information Systems | NJ-GeoWeb) and NJDEP's Open Data (NJDEP Open Data).

Sampling was conducted in twenty-three monitoring wells installed along the Delaware Bay to assess saltwater intrusion/inundation in the Kirkwood-Cohansey aquifer. The following parameters are being analyzed for in this multi-year project: age dating (Carbon-14, sulfur hexafluoride, tritiogenic helium (3-helium)), major anions and cations, trace elements, oxygen-hydrogen stable isotopes, major dissolved gases, radon-222, radium and nutrients along with field parameters. Originally, five continuous monitoring probes were deployed to record specific conductivity, temperature, and water levels once every hour. The number of continuous monitoring probes has since increased. NJGWS is working with partners to release continuous monitoring data on multiple platforms, and plans on collecting cores within the study area.

NJGWS performed groundwater sampling in response to potable water issues as needed in support of NJDEP response to protect potable water sources and public health. It continues to design digital dashboards which will be made available to the public to disseminate groundwater quality raw data and trends, and is working to design and implement a long-term supported data management/database for all non-potable, non-regulatory groundwater data.

OFFSHORE SAND RESOURCES

NJGWS is preparing the final report for the Cooperative Agreement with the US Bureau of Marine and Energy Management (BOEM) to evaluate and prioritize sand and gravel resources to support coastal resilience projects needs with consideration of the lifetime and scale of the project along portions of the New Jersey Coast. The study has developed a methodology, with a capacity to be applied on a regional scale, to evaluate and prioritize resources and assess the availability and quality of offshore sand deposits for future coastal resilience projects and to accommodate BOEM renewable energy transmission corridors.

NJGWS has secured a contract to collect thirty (30) offshore vibracores in support of beach replenishment projects in the state. Collection of the cores will begin in 2025.

MINED UNDERGROUND STORAGE CAVERNS

Under an Act passed under the Laws of 1951 concerning the permitting the underground storage of natural or artificial gas or of petroleum products and their derivatives allowed for six underground storage caverns to be constructed in the 1950s and 1960s. New regulations (N.J.A.C. 7:1F, Underground Storage Caverns) were promulgated May 1, 2023. These new regulations replaced the original ones from 1952 which had sunset. An application for two new mined hard rock caverns at the site of one of the original caverns has been submitted and a draft approval for the two caverns was approved pending a public hearing.

HYDROGEOLOGIC INVESTIGATIONS

The Hydrogeology Research and Analysis Section performed seventeen hydrologic evaluations of new and existing water supply sources as part of its day-to-day responsibilities, to determine the impacts that these diversions may have on existing water supply users, known contamination sites and the diversion sources themselves. This included eight projects involving new or increased diversions, one aquifer test proposal, and eight requests for aquifer test waivers. Team members also continued work on updating the well head protection area database with respect to both new wells that have come online since the last update and the removal of wells that have been abandoned and sealed. GPS locating of new and existing wells was put on hold due to staff retirements but will resume in 2025.

In addition, team members were involved in a significant number of projects beyond the work that they perform on a daily basis, including: continued research and analysis of the impacts of sea level rise to aquifers and wells in New Jersey due to climate change, preparation of an Open File Report (OFR) documenting the fluctuation of water levels in Plainfield and South Plainfield that began when a water company took its wellfield offline for an extended period of time since the early 1900s to install treatment for PFAS, and implementation of a research project investigating the presence or absence of microplastics in GWUDI wells throughout the State.

NEW MEXICO

NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES

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INTRODUCTION

Established by legislation in 1927, the New Mexico Bureau of Geology & Mineral Resources (NMBGMR) is a Research and Service Division of New Mexico Tech. It serves as the state geological survey and is a non-regulatory state agency for the State of New Mexico. Through our offices, museum, store, laboratories, publications, and website, our staff serves the diverse population of New Mexico. From elementary students to research and industry scientists, there is something at the Bureau of Geology for everyone who has an interest in the exceptional geology and natural resources of New Mexico. Our multifaceted organization comprises several interwoven programs, including geologic mapping, energy, mineral, and water resources; basic geologic research; archiving and disseminating mining, petroleum, and rock core data; assessing geologic hazards; and public education and outreach. During the past year, we had a staff of approximately 75 full- and part-time employees, supported by a mix of state appropriations and funds obtained from grants and contracts.

GEOLOGIC MAPPING

The geologic mapping program at the NMBGMR supports developing a modern and digital geoframework of the state to address our top socioeconomic challenges of the 21st century. Three topics of concern have been identified for focused, long-term geologic mapping by an advisory committee, a diverse group of professionals from federal, state, local, and tribal agencies, to the private sector. These topics include water resources, energy and mineral resources, and geologic hazards. Focus areas for mapping include the Rio Grande watershed, the Pecos River watershed, and the San Juan basin—regions home to most of the state's population, natural resources, and critical infrastructure. Primarily funded by the STATEMAP component of the National Cooperative Geologic Mapping Program, our goal is to provide 2D and 3D geologic and resource maps at various scales to a broad audience in an interactive web-based application.

2D Mapping

Geologic mapping at scales between 1:24,000 and 1:62,500 remains the cornerstone of our mapping program. These maps and their geodatabases provide the necessary details to make informed decisions about the state's resources and hazards. Of the 121,598 square miles of New Mexico, approximately 33% of the state has been mapped at these scales during the 32-year history of STATEMAP. Early mapping was focused on major metropolitan corridors. New efforts primarily focus on sparsely populated areas of equal importance but have not been the focus of dedicated, detailed mapping. Between July 2023 and June 2024, eight 7.5-minute quadrangles (1:24,000 scale) and three 15-minute quadrangles (1:62,500) were completed as part of our Fiscal Year 2022 STATEMAP award. Likewise, geologic mapping began on six 7.5-minute quadrangles as part of our Fiscal Year 2023 STATEMAP award.

U.S. GeoFramework Initiative (USGI) Activities

Our mapping program prioritizes projects that align with the USGI, the USGS Program that seeks to produce a seamless 2D and 3D map of the country. Much of our detailed mapping (i.e., 1:24,000 scale) is now focused on laying the groundwork for 1:100,000 scale compilations of large state regions to support this effort. A compilation of the Socorro 30x60-minute quadrangle (Fig. 1) was completed during the period of interest, and work to compile the Carlsbad 30x60-minute quadrangle began. With support from the NMBGMR hydrogeology program, 3D models of critical basins and watersheds have become a central component of our STATEMAP work. A 3D subsurface model of the Delaware basin—where hydrocarbon extraction supports the state's economy and contributes to the nation's energy supplies—was completed and includes 22 modeled formation tops down to the crystalline basement. 3D modeling efforts are now focused on the central High Plains, where intense groundwater extraction requires an improved geoframework to manage aquifers. Other USGI activities include converting legacy maps to modern geodatabases (i.e., GeMS level 3 databases) and data compilations related to geochronology and stratigraphy.

OTHER PROGRAM HIGHLIGHTS

Hydrogeology

At all levels of state leadership, the NMBGMR is regarded as an essential partner for better understanding the state's groundwater resources. Two recent reports from the state executive office, The NM Water Policy and Infrastructure Task Force, and the Governor's 50-year Water Action Plan challenge the NMBGMR to characterize all the state's aquifers and establish a new 100-well monitoring network over the next 15 years. In 2024, we received $1.1M in new base funding to expand our three water programs: Aquifer Mapping, NM Water Data Initiative, and NM Water Education. The hydrogeology research team produced eight open-file reports (Fig. 2) and attended over 22 national or state conferences or workshops, providing 27 presentations to share research findings or basic hydrogeologic information.

Geothermal

The geothermal research program at the NMBGMR has been active since 2010. During the 2024 legislative session, the NMBGMR was awarded $1.5M over three years to focus on building the capacity to understand New Mexico's

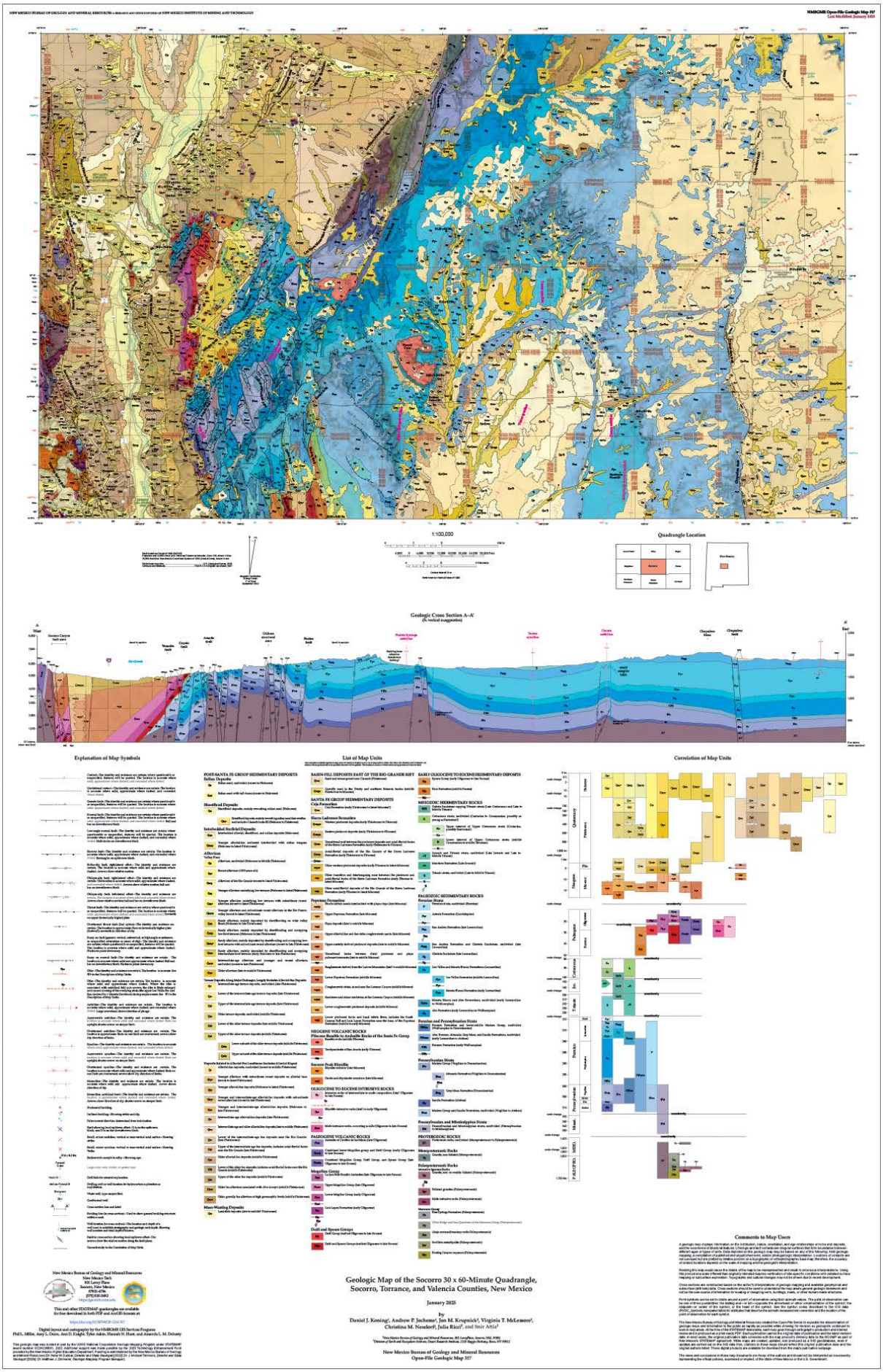

Figure 1. An example map from the NM STATEMAP Program: Geologic Map of the Socorro 30 x 60-Minute Quadrangle, Socorro, Torrance, and Valencia Counties, New Mexico

geothermal resources better, providing high-quality scientific information to our stakeholders, seeking out grant opportunities to expand research prospects, and promoting communication on the challenges and opportunities of geothermal energy in New Mexico. A workshop in April 2024 was convened to examine opportunities and challenges to geothermal development in New Mexico with geothermal researchers and representatives from the private sector, state government, academia, and national laboratory personnel.

Energy

The Energy and Carbon Capture program conducts and facilitates research in traditional and emerging low-carbon subsurface resource characterization and maintains the NMBGMR Subsurface Library. The NMBGMR continued as an on-campus partner in the Carbon Utilization and Storage Partnership (CUSP) of 13 western states' goal is to reduce atmospheric carbon dioxide. As part of the CarbonSAFE initiative and other DOE programs, the NMBGMR and partner agencies continued work to characterize the San Juan Basin to evaluate the capacity of carbon dioxide reservoirs and the integrity of the seals for prospective sequestration units. The project is funded by awards of $17.5 million and $1.18 million from the Department of Energy (DOE).

Minerals

The Bureau's Minerals Group enjoys continued funding success through the USGS Earth MRI and DOE CORE-CM programs. Several field-based projects were active in 2024, including the examination of critical mineral deposits in the Blackhawk District and Laramide porphyry systems in southwestern New Mexico, the examination of critical minerals in mine waste, and also in coals of the San Juan and Raton Basins. These field studies are complemented by the Bureau's Ore Deposits and Critical Minerals experimental laboratory, which receives funding from the DOE and NSF for thermodynamic studies to understand critical mineral formation.

Laboratories

In 2024, our laboratories supported research work for 245 users, including 110 students from New Mexico Tech and beyond, investigating a wide range of research topics. Total income to bureau lab service centers was ~$335,000, used to pay salaries, maintain and expand equipment, and facilitate research on societally relevant projects. We are excited to receive funding for a new single-crystal X-ray Diffractometer and a new microprobe (Fig. 3) to expand and improve our analytical capabilities.

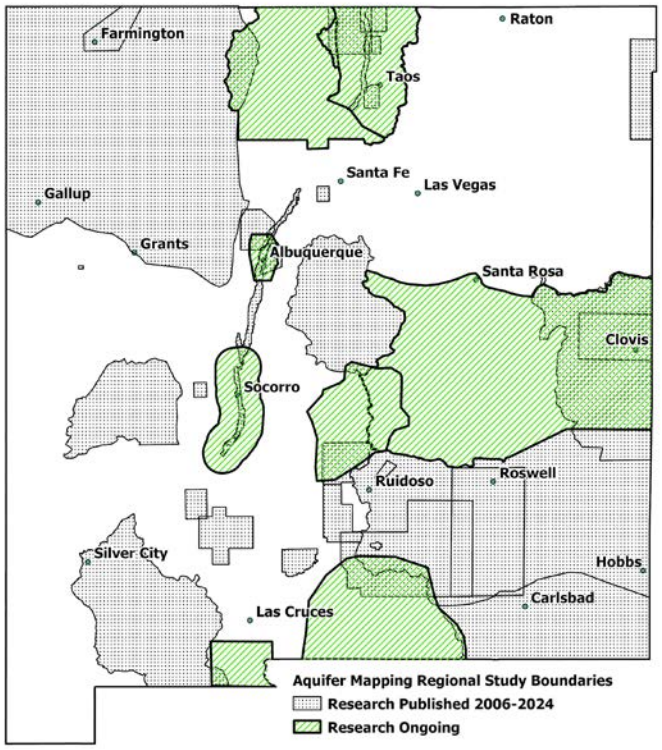

Figure 2. Map showing past and active Aquifer Mapping Program research areas in 2024.

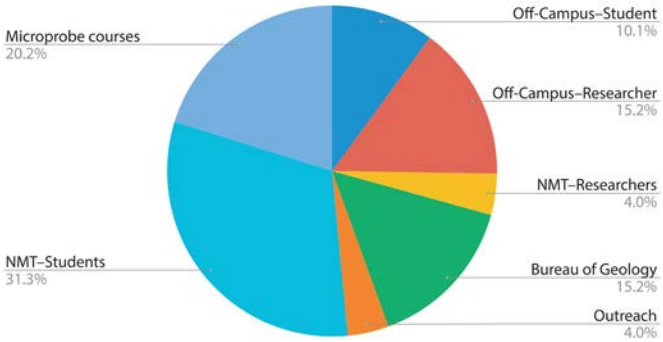

Figure 3. The variety of users for the electron microprobe laboratory shown in this pie chart is typical of Bureau of Geology laboratories, with wide use for classes, student research, and projects on and off campus.

NORTH DAKOTA

NORTH DAKOTA GEOLOGICAL SURVEY

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INTRODUCTION

The North Dakota Geological Survey (NDGS) was established in 1895 under the guidance of the State Board of Higher Education. The State Geologist also served as Chairman of the Department of Geology at the University of North Dakota in Grand Forks until 1985. In 1981, the ND Industrial Commission Oil and Gas Division was split from the Geological Survey and in 1989 the Geological Survey was placed under the ND State Industrial Commission and moved to Bismarck. In July 2005, the Geological Survey became a division and both it and the Oil and Gas Division were placed within the newly formed Department of Mineral Resources (DMR). The State Geologist is director of the Survey and an assistant director within the DMR. The State Geologist reports to the Industrial Commission on a quarterly basis. The NDGS shares an office and warehouse with the ND Oil and Gas Division in Bismarck. We also maintain the Johnsrud Paleontology Laboratory in the ND Heritage Center & State Museum in Bismarck. The NDGS operates the Wilson M. Laird Core and Sample Library on the campus of the University of North Dakota in Grand Forks

Surface Mapping

The NDGS completed five, 24k maps during the 12-month time period. Four of these quadrangles are in the Fargo area where the primary geologic unit at the surface is the Sherack Formation—alternating silt and clay deposited in glacial Lake Agassiz. The Sherack and the underlying Brenna Formation were also mapped in Walsh, Pembina, Grand Forks, and Cass counties. The other mapped quadrangle is located in the Bismarck area.

Landslide Mapping

After recently mapping 65,000 landslides across the entire state of North Dakota (Figure 1) at a scale of 1:24,000 (Phases I and II landslide mapping), attention was turned to comparing the two lidar coverages across North Dakota. By comparing the two coverages, typically flown 8–10 years apart, we were able to identify the elevation changes that resulted from slope failure and filter out the man-made changes, etc. (Phase III landslide mapping). During this twelve-month period, 5,331 active landslides were identified within 417 quadrangles.

Subsurface Mapping

We completed the Garrison 100K map sheet mapping the potassium oxide percentages of a half-dozen potash members of the Prairie Formation (Devonian) in north-central North Dakota. This is the eighth 100K sheet that we have completed for this formation in northwestern and north-central North Dakota. In addition to the Prairie Formation, the deepest and thickest salt in the Williston Basin, we have also been investigating the shallowest salts in the basin for their potential to store hydrocarbons. Contour and isopach maps were recently completed for the Opeche A and B salts (Permian) after interpreting more than 5,000 electric logs. We have now mapped the five shallowest salts in the Williston Basin—in descending order: Dunham (Jurassic), Pine, Opeche A and B, Charles A (Mississippian).

OTHER PROGRAM HIGHLIGHTS

Critical Minerals

During the 2023 state legislative session, the Geological Survey received funding to complete a 50-hole critical minerals drilling project in western North Dakota targeting coals within and immediately beneath paleosols of the Bear Den Member of the Golden Valley Formation (Paleocene-Eocene) and the Rhame bed at the top of the Slope Formation (Paleocene). Two Survey geologists spent 400 hours correlating the coals from thousands of electric logs in an effort to choose North Dakota Trust Lands surface and mineral tracts that held the most promise for intercepting coals within these target zones. Additionally, hundreds of hours were spent obtaining a permit from ND Trust Lands, securing contracts with drilling and logging companies, field checking the proposed drill sites, contacting Trust Lands lessees and the surface owners of Trust Lands mineral tracts, clearing the sites through ND One Call, and procuring drilling supplies. Seventy-five potential drill sites were chosen: 25 Trust Lands surface and mineral tracts and 50 tracts with Trust Lands minerals and private surface.

Drilling was scheduled to commence on September 3, 2024.

Woolly Mammoth Bones Under a Garage in Northwestern North Dakota

In August of 1988, Ed Murphy was doing fieldwork in Bowman County when he was asked to investigate a site in northwestern North Dakota where woolly mammoth bones were reportedly encountered while digging the foundation for a garage. By the time he received the information, the slab was poured and the garage/addition had been completed. Murphy met with the high school science teacher at the job site and got the names of the three construction workers who had encountered the bones (Figure 2). There were no bones or scraps of bone visible on the surface, so the site remained a mystery for 35 years. Trying to tie up loose ends before retirement, Murphy tracked down the original construction workers in December 2023 and verified their stories. He then contacted the current homeowner and obtained permission for the Geological Survey and the State Historical Society to investigate the site. In May 2024, the Historical Society conducted ground-penetrating radar and resistivity surveys, both inside and around the perimeter of the garage. Preliminary interpretation of the ground-penetrating radar confirmed the location where the science

teacher said the bones had been encountered in 1988. Roughly 100 students (K–8) from the nearby town toured the site and participated in the dig by removing a shovelful of the foundation backfill (Figure 3). That backfill turned out to contain several pieces of bone and tusk. Survey paleontologists then carefully deepened the pit with hand trowels and bushes, discovering three undisturbed mammoth bones beneath the backfill. The bones were covered with plaster to protect them until the paleontologists could return in the fall after completing four other public fossil digs around the state.

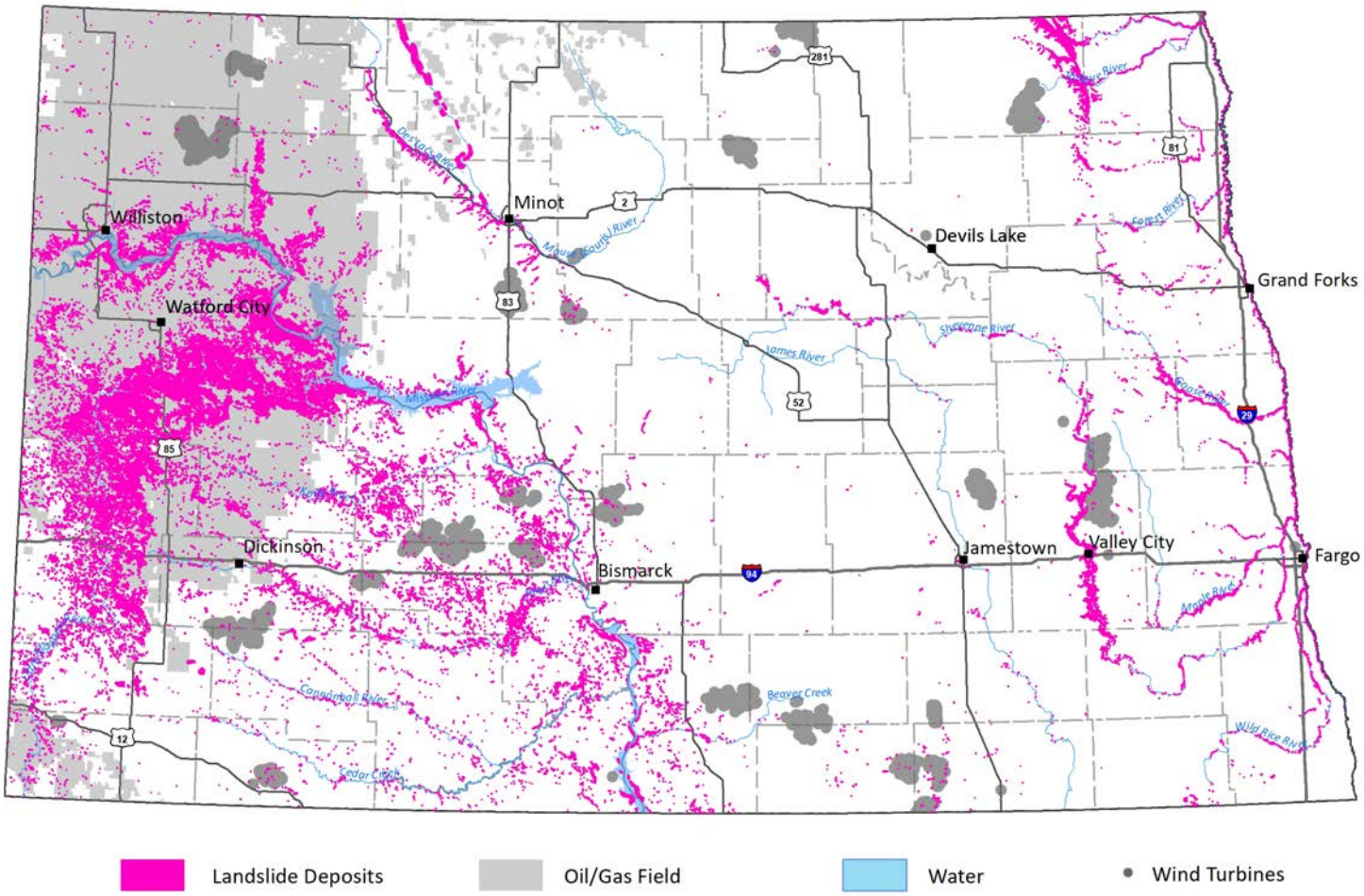

Figure 1. Landslides in North Dakota, a compilation of fourteen hundred 24K quadrangles.

Figure 2. The local high school science teacher stands at the spot where woolly mammoth bones were encountered while digging the foundation. *Photograph taken by Ed Murphy on August 25, 1988.*

Figure 3. Grade school students line up to take turns digging a shovel full of backfill material along the north side of a garage in May 2024 while Ed Murphy guards against the next in line getting hit with the butt end of the shovel. *Photograph taken by Survey Paleontologist Clint Boyd.*

OHIO

OHIO DIVISION OF GEOLOGICAL SURVEY

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INTRODUCTION

The Ohio Department of Natural Resources (ODNR), Division of Geological Survey was founded in 1837 and has been continuously authorized since 1869. Our mission is to provide the geologic information and services needed for responsible management of Ohio's natural resources. We research and report on the geology of the state and serve as Ohio's archive of geologic information. Our main office is at the ODNR campus in north Columbus. The Horace R. Collins Laboratory in Delaware County houses our core and sample archive and the offices of the Lake Erie and OhioSeis programs. The Survey has a full-time staff of 37, arranged into seven groups: Geologic Mapping and Industrial Minerals, Groundwater Resources, Energy Resources, Geologic Hazards, Publications and Outreach, Library and Records Center, and Administration and Fiscal. The Survey's funding derives from severance taxes on fuel and nonfuel commodities, federal and state grants, department-allocated funds, and income from the sales of publications and data.

GEOLOGIC MAPPING

The mapping group at the Ohio Geological Survey (OGS) published two new geologic maps, one statewide digital map compilation, and one annual report between July 2023 and June 2024. A new county-scale (1:62,500) Quaternary geology map of Pickaway County (Fig. 1) was published with partial funding from a USGS NCGMP Great Lakes Geologic Mapping Coalition (GLGMC) grant. This was the third Quaternary geology map produced by the OGS since 2020 and the second to be published under the QG-2 series. This follows a new long-term plan to produce detailed Quaternary geology maps published at the county scale. All new QG-2 map products follow the GeMS framework, and digital data is stored in a single statewide database to facilitate future state-scale mapping products. This mapping led to a better understanding of two Wisconsinan glacial advances. These advances were separated by an interstadial period sometimes represented in the stratigraphic record by a paleosol which dates to about 22 ka. Geomorphic evidence, through cross-cutting relationships of glacial landforms, supports these multiple advances.

OGS also published the final statewide compilation of all surficial "stack" maps at a 1:24,000 scale through funding provided by the GLGMC. This mapping began in 1997 and culminated with the release of a digital database that is easily accessible on the Ohio Geology Interactive Map and can also be downloaded directly from our website. Throughout the compilation process about 30,000 unit contacts were revised, equating to nearly half of the entire dataset. This revision process was documented and released as an Open-File Report (OFR 2023-1).

OGS published maps depicting the bedrock topography and unconsolidated sediment (drift) thickness of Champaign County, with partial funding provided by the USGS NCGMP STATEMAP program. Over 1,600 newly acquired passive seismic (HVSR) data points were acquired to constrain the location and morphology of the buried Teays Valley. This pre-glacial drainage system is buried under a maximum of about 850 feet of unconsolidated Quaternary-age sediments. These Quaternary-age sediments contain highly productive aquifers that are poorly understood at depth. Typically, residential and municipal water wells are developed within 200 feet of the surface, leaving more than 500 feet of potential aquifers undeveloped. Results from this mapping indicate that the buried Teays Valley is narrower and more sinuous than previously mapped.

OGS also continues to assess geologic hazards through our karst inventory mapping program. Karst and potential karst features of Warren and Clinton counties (exurban Cincinnati area) were identified via remote sensing and digital mapping techniques before being field verified. During the 2023 field season (approximately December 2023–March 2024), a total of 546 new karst features were added to the statewide inventory. Of these, 412 were field visited. The OGS maintains a karst features database with over 30,000 mapped features linked directly to a publicly available interactive map. Yearly updates to this database are now detailed in an annual report that describes the mapping results and updates the status of the karst inventory mapping program.

OTHER PROGRAM HIGHLIGHTS

Energy Resources Group

During the reporting period, the Energy Resources Group:

- Continued its role in the 20-state Midwest Regional Carbon Initiative (MRCI) partnership to study carbon capture, utilization, and storage.
- Continued work under a USGS Earth MRI grant to perform geochemical (critical minerals) reconnaissance on Pennsylvanian-age marine black shales.
- Published twelve open-file (see example in Fig. 2) maps of isopachs and structure contours on the Silurian-age Salina Group (interbedded anhydrite, dolomite, halite, and shales).
- With the Ohio Geological Society, held a core workshop on Ordovician-age carbonates.

Horace R. Collins Laboratory and Core Repository

The H. R. Collins Laboratory was awarded a National Geologic and Geophysical Data Preservation Program grant to acquire a multispectral core scanner and new core storage racks. These will be used to scan, photograph, re-box, and

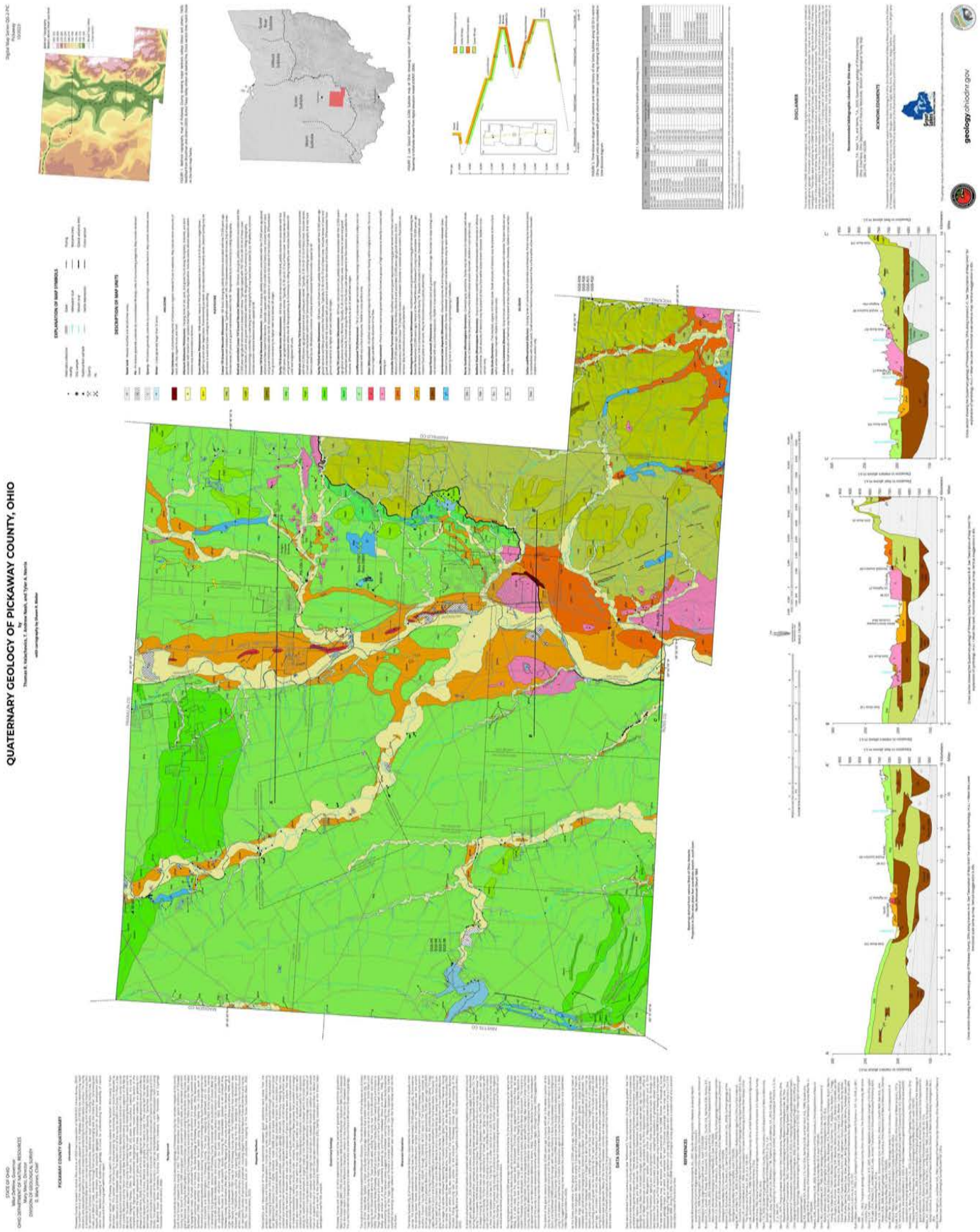

Figure 1. Thumbnail view of the Quaternary Geology map of Pickaway County, Ohio.

preserve about 13,000 linear feet of Pennsylvanian-age core which were acquired in the late 1960s and early 1970s. The cores are in distressed condition because of pyrite disease, and overcrowded, crumbling boxes make these core essentially inaccessible for research purposes. The resulting scans and high-resolution imagery will be made available online.

Groundwater Resources Group

The Groundwater Resources Group documented over 30,000 new water well records. The Group also released a new web-based application to help users monitor groundwater resources throughout Ohio. The software, called AQUARIUS, lets users view and download the Survey's extensive collection of groundwater data from our Groundwater Observation Well Network. The new interface includes a statewide interactive map showing the locations of the wells, data charts and tables for each well (including real-time monitoring for 17 sites), and information about the history of the network.

The Ohio Seismic Network

The Ohio Seismic Network (OhioSeis) program completed installation of four new seismic stations, at locations chosen to fill gaps in our earthquake detection network, along with three station upgrades. New stations were placed in northeast Ohio, which has seen a recent uptick in earthquake detections, and in southwestern Ohio to help locate earthquakes occurring deep underground near the border with Kentucky.

Publications and Outreach Group

A particular highlight was the publication of the Life in Ancient Ohio poster series, a set of seven 24- by 36-inch posters of custom art commissioned exclusively for the OGS, that depicts life in Ohio over seven geologic periods, as informed by actual fossil finds at actual locations in the state of Ohio (Fig. 3). The Group also continued to expand outreach efforts, enabling the OGS to reach more people at public events in Fiscal Year 2024 as compared to Fiscal Year 2023. It grew its social media network by more than 2,000 followers and provided 37,000 handouts and maps to the public. The Survey reached an estimated 17,345 people at 89 events and revised four educational publications on the topics of dimension stone, sand and gravel, placer gold, and concretions.

Pauline Smyth Geological Library and Records Center

The library and records center added another 1,300 items to the online geologic library catalog. Additional items are added daily, and the catalog is accessible to the public.

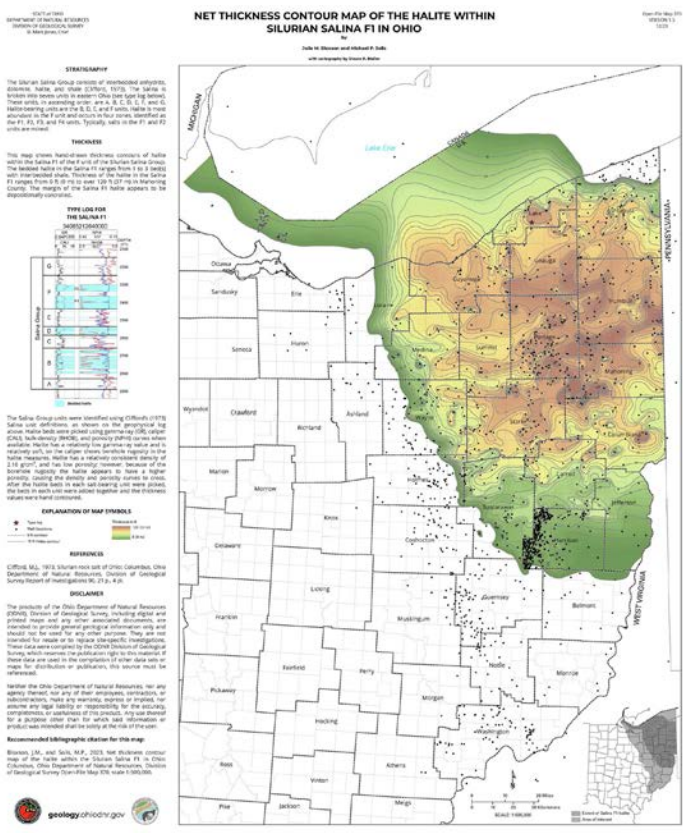

Figure 2. Example of a halite isopach map of the Silurian in Ohio.

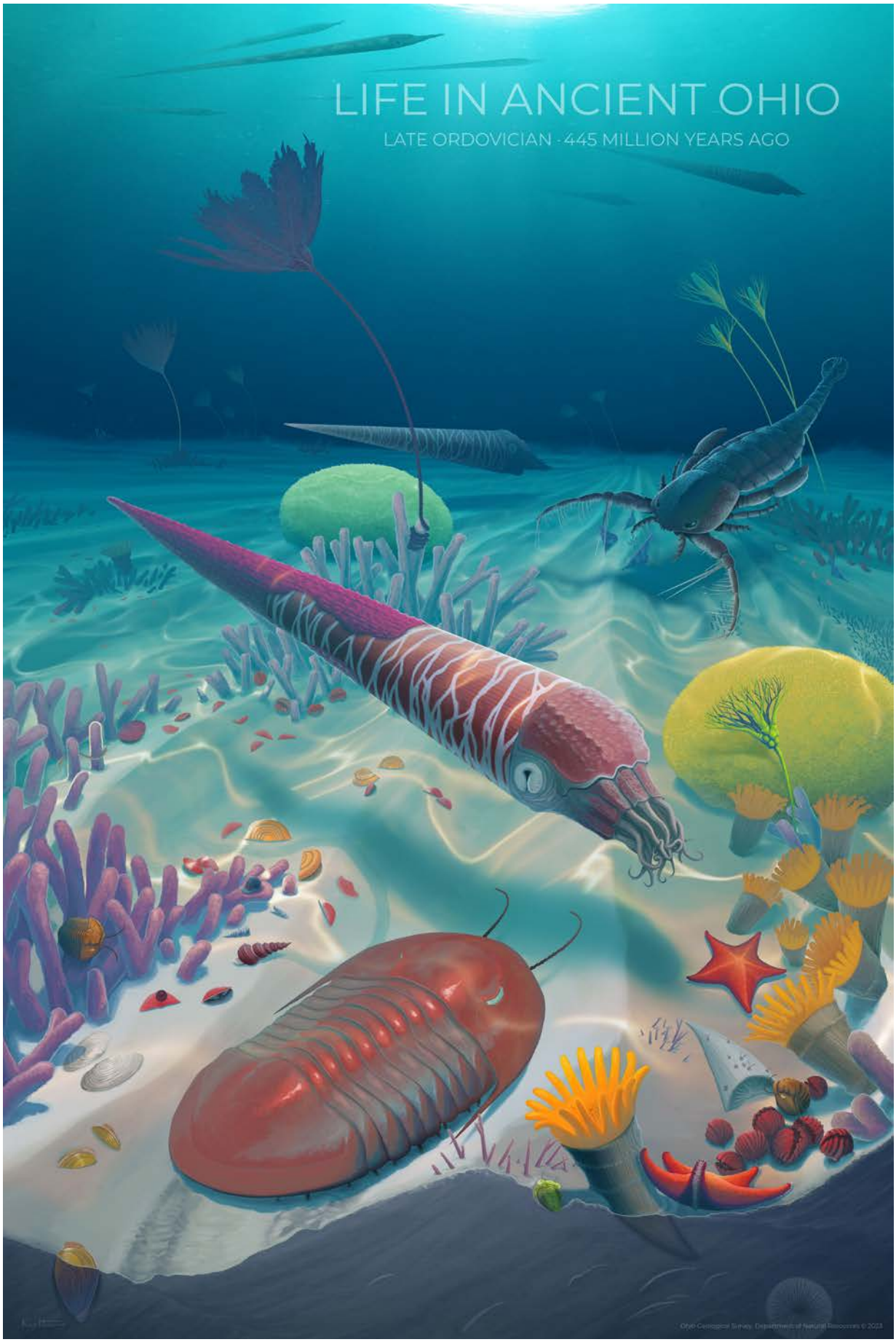

Figure 3. Example of the new *Life in Ancient Ohio* poster series featuring a reconstruction of the Late Ordovician.

OKLAHOMA

OKLAHOMA GEOLOGICAL SURVEY

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INTRODUCTION

The Oklahoma Geological Survey is a state agency for research and public service located on the Norman Campus of The University of Oklahoma within the Mewbourne College of Earth and Energy. The Survey is chartered in the Oklahoma Constitution, and is charged with investigating the state's land, water, mineral, and energy resources, and disseminating the results of those investigations to promote the wise use of Oklahoma's natural resources consistent with sound environmental practices. OGS currently has thirty-six staff members, about half of whom are PhDs, and several graduate and undergraduate students. OGS coordinates with both state and federal agencies, the university community, as well as industries, on research and service for Oklahoma. In 2024, OGS hired six new project-supported research associates and full-time staff, and several promotions within the survey filled important management roles, including our core-repository curator.

GEOLOGIC MAPPING

Over the last fiscal year, the STATEMAP program of OGS was involved in extensive bedrock and surficial mapping of the Muskogee 1-degree sheet in eastern Oklahoma. Mapping procedures encompassed reconnaissance mapping of 32 individual 7.5-minute quadrangles over a period of four months. Field quadrangles were then finalized, digitized, and imported into ArcGIS mapping software. Individual quadrangle geology was then refined and merged into a final 1-degree geologic map, complete with detailed field description and correlation of geologic units. Besides continued 1-degree sheet mapping that will deliver 1:100,000-scale map coverage of Oklahoma, plans for the STATEMAP program include a detailed mapping program along the Oklahoma-Kansas border to answer stratigraphic problems within the Marmaton Group (Desmoinesian) as outlined by the Pennsylvanian Reconciliation committee between the state surveys of Oklahoma, Kansas, and Missouri.

The OGS also continues to work with the USGS Data Preservation and Earth-MRI programs. With Earth-MRI, OGS has been mapping parts of the Wichitas, an old mountain range in the southwestern part of the state. The OGS also began several projects in the east-northeastern parts of the state, including the Phosphatic shale belt and the large tailings ("chat") piles in Picher, Oklahoma.

OTHER PROGRAM HIGHLIGHTS

The OGS continues to expand in the science and service for carbon capture and sequestration efforts in the state, as well as onramps for the hydrogen and electric vehicle economies. These efforts include research into carbon management, carbon-free H_2 production and storage, methane mitigation, and the state's critical minerals. The net-zero approach is entirely consistent with OGS's ongoing support for the oil and gas production economy, who we serve through workshops, publications, regional compilations, site-specific studies, and data stewardship.

The OGS seismic network and instrumentation are currently deployed across the state. In 2024, the Governor of Oklahoma approved funding for a refurbishing of the network via the office of the Oklahoma Secretary of Energy and Environment. Additionally, the OGS seismic-network

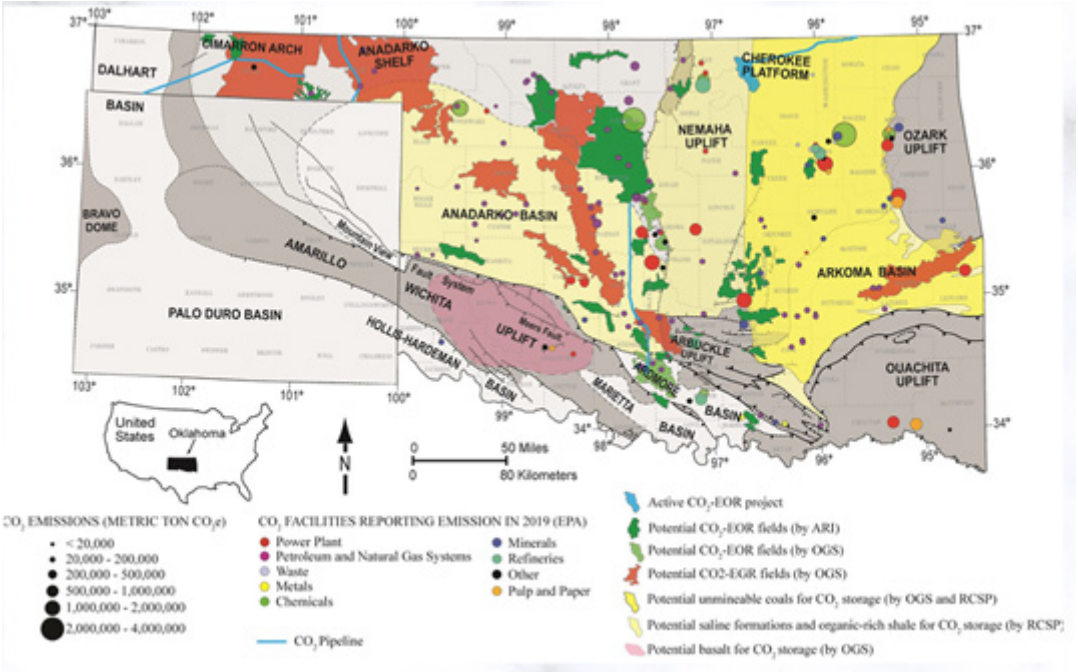

Figure 1. Carbon management map for Oklahoma, from the 2021 OGS Fact Sheet. (https://www.ou.edu/ogs/research/carbonmanagement)

staff worked closely with the USGS to respond to the February 3, 2024 Prague earthquake. Such hazard response and mitigation efforts translated into ongoing advisement of the state's regulatory. The seismic-network program continued development of machine-learning approaches to augmenting earthquake identification and contributes to open-source software to achieve those goals.

In our research of the Oklahoma environment, with support from National Aeronautics and Space Administration (NASA) program (2022–2025) OGS studied properties of shallow landslides in eastern Oklahoma and prepared a map of landslide susceptibility.

OGS's education and outreach program (E&O) continues to be a flagship program. The team provides a monthly open-house, free to the public. Additionally, OGS's E&O team has developed several K–12 teaching modules, with on-site visits to familiarize teachers with these tools.

OGS houses a large core and data repository, the Oklahoma Petroleum Information Center (OPIC). In 2024 OPIC received a donation of several cutting-edge analytical instruments from Baker-Hughes. The donation includes two CT (X-ray tomography) scanners and a core multi-analyzer. These facilities will come on line in 2025.

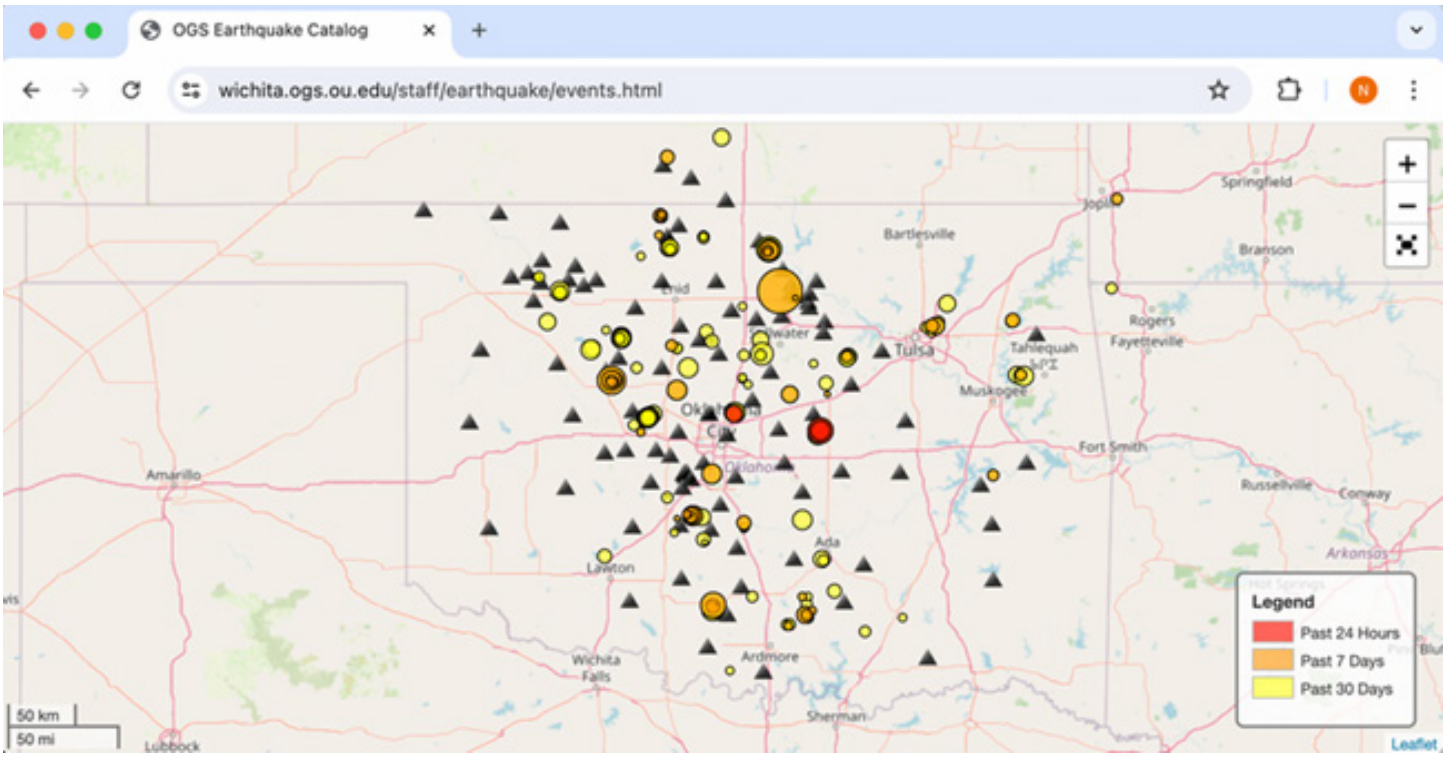

Figure 2. OGS earthquake catalog. See: https://wichita.ogs.ou.edu/staff/earthquake/events.html

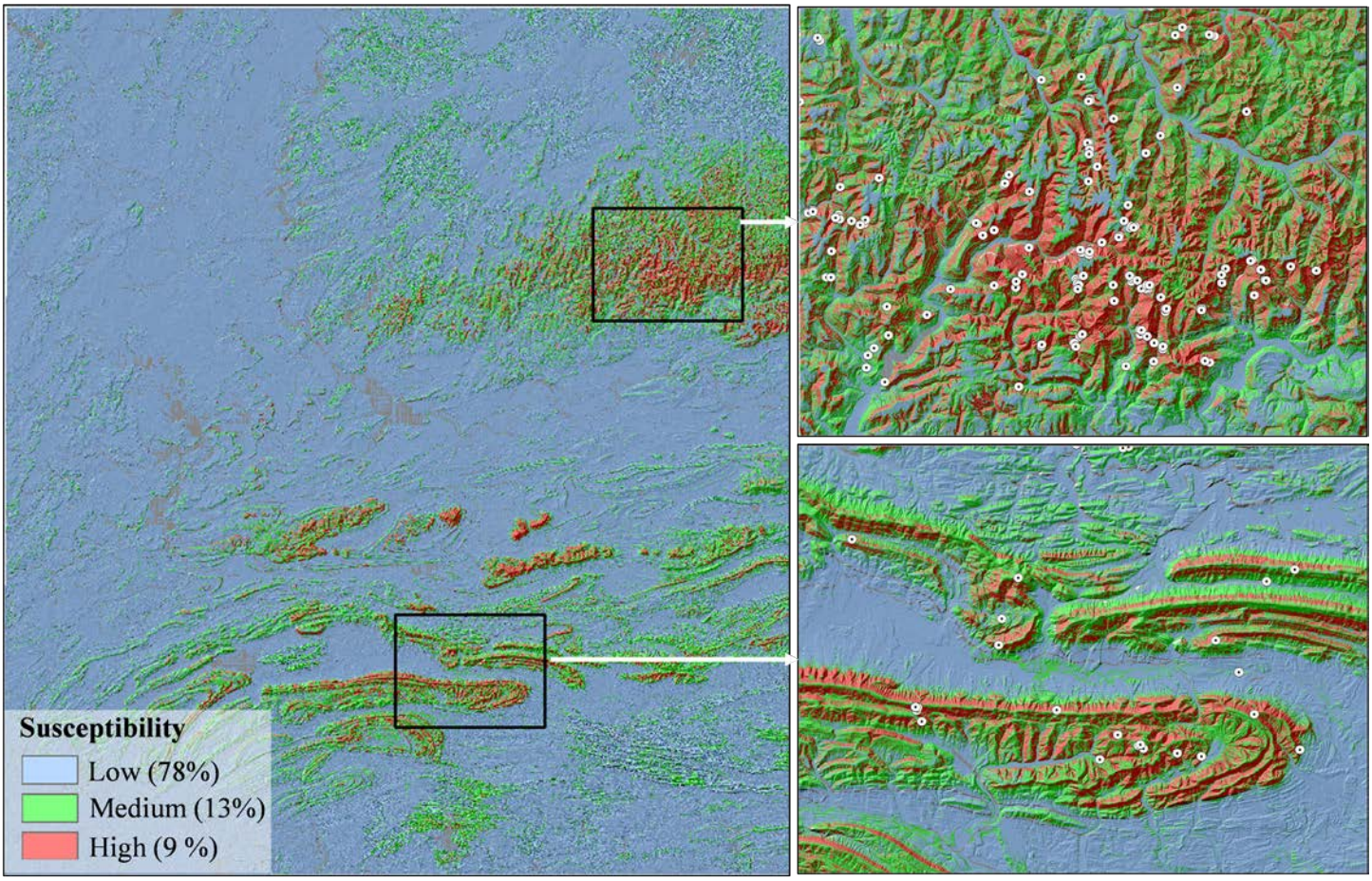

Figure 3. A landslide susceptibility map of eastern Oklahoma and western Arkansas. The percentage within the bracket indicates the coverage area of each susceptibility class. See: https://doi.org/10.1016/j.catena.2024.108344

OREGON

OREGON DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

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INTRODUCTION

The Oregon Department of Geology and Mineral Industries (DOGAMI), established by the Oregon legislature in 1937, is the state's primary source of geoscientific information. DOGAMI's mission to provide earth science information and regulation to make Oregon safe and prosperous is accomplished through the Geological Survey and Services (GS&S) and Mineral Land Regulation and Reclamation (MLRR) programs (Fig. 1). The GS&S program gathers geoscientific data and maps mineral resources and hazards through three major focus areas: Lidar & Remote Sensing, Geologic Mapping & Mineral Resource Evaluation, and Natural Hazards Mapping. The MLRR program regulates the exploration, extraction, production, and reclamation of mineral and energy resources for conservation and secondary beneficial uses of mined lands. As an independent executive agency of the State of Oregon, DOGAMI advises state policy related to geologic materials, natural resources, and hazards, as well as policy related to mining, oil, gas, and geothermal exploration, production, conservation, and reclamation. DOGAMI's current funding supports 43 positions across our 2 programs. The agency's staff are primarily geologists and geospatial analysts, many with professional licensure in Oregon. A five-person Governing Board chosen by the Governor and confirmed by the Senate steers agency operations.

GEOLOGIC MAPPING

Bedrock Mapping

DOGAMI conducts geologic mapping, creates, and maintains digital geologic databases, and collects high-resolution aerial lidar to characterize the state's unique geology and to enhance our understanding of the state's geologic resources and hazards. DOGAMI is currently leading several geologic mapping efforts funded through the U.S. Geological Survey STATEMAP and Earth MRI programs.

STATEMAP projects between July 2023 and June 2024 were in the Walla Walla and Harney Basins in eastern Oregon. An additional cross-state project with the Idaho Geological Survey (IGS) mapped geology along the Snake River at Weiser and Payette. These areas were targeted to understand the stratigraphic and structural controls on groundwater, mineral and energy resource potential, and geologic hazards. The Geologic Map of the Milton-Freewater and Bowlus Hill 7.5' quadrangles, published from the Walla Walla Basin work, is a prime example of the utility of a comprehensive GeMS level 3 database in constructing both detailed surficial and bedrock geologic maps (Fig. 2; https://www.oregon.gov/dogami/pubs/Pages/gms/p-GMS-130.aspx).

DOGAMI's Earth MRI geologic mapping efforts are located in the McDermitt caldera of southeastern Oregon (3-year project started September 2023) and in the Quartzburg mining district, northeastern Oregon (3-year project started July 2024). Past development at McDermitt has focused on mercury, the only commodity mined with commercial significance. However, deposits or concentrations of several other elements, including lithium, gallium, zirconium, gold, and uranium are also known. McDermitt hosts the only known lithium deposit in Oregon, and recent mineral resource evaluations of the caldera indicate that it may contain the largest known lithium resource on Earth. Historic mining in the Quartzburg district largely focused on the extraction of gold and silver, but other critical-mineral commodity occurrences for cobalt, copper, zinc, nickel, antimony, arsenic, manganese, and bismuth are recognized in the district. Chief among these critical-mineral commodities may be cobalt. The Standard Mine, located within the heart of the Quartzburg mining district, operated as the only major cobalt producer in the United States during the early 20th century, targeting massive lode deposits of copper-cobalt.

Surficial Mapping

Landslides are common in Oregon, representing a serious natural hazard that can disturb lives, property, infrastructure, and the environment. The first step to reduce landslide-related damage and losses is to find where previous landslide activity has occurred, followed by targeted risk reduction actions. In January of 2023, DOGAMI entered into an inter-agency agreement with the Oregon Parks and Recreation Department (OPRD) to evaluate current and future landslide susceptibility and risk within Ecola State Park in coastal NW Oregon. Landslide information is needed by OPRD to make decisions to reduce landslide risk, emphasizing public safety and maintaining and preserving roadways. As a result of this study, DOGAMI created landslide inventory maps based on serial lidar and historic orthophoto analysis and a new landslide susceptibility and risk map that estimates where future landslide activity may occur (Fig. 3). DOGAMI concluded that the study area has an overall High landslide hazard based on the over 270 landslides that cover approximately 21% of the region. This study has been published as DOGAMI Open-File Report O-25-02 on the agency's website (https://www.oregon.gov/dogami/pubs/pages/ofr/p-o-25-02.aspx).

OTHER PROGRAM HIGHLIGHTS

Statewide Geoscience Databases

Major updates to three of DOGAMI's statewide geologic databases were completed in 2024 (www.oregon.gov/dogami/gis/Pages/index.aspx). These include:

- The Statewide Landslide Information Database for Oregon (SLIDO 4.5), a compilation of >50,000 landslides identified on published maps in Oregon;

- The Mineral Information Layer for Oregon (MILO-4, in press), a geospatial database that stores and manages information regarding Oregon's 24,664 mineral occurrences, prospects, and mines; and
- The Oregon Geologic Data Compilation (OGDC-8, in press), a geodatabase containing the most up-to-date geologic mapping data and stratigraphic correlations for the state.

Tsunami Evacuation Routes

In 2023–2024, DOGAMI assisted two of Oregon's coastal communities in identifying, prioritizing, and justifying life-saving mitigation projects through an analysis of tsunami evacuation routes. Seaside and Cannon Beach, two popular tourist destinations on the northern Oregon coast, face significant evacuation challenges for a local tsunami generated by an earthquake on the Cascadia Subduction Zone due to long distances to high ground, aging bridges, and large numbers of people. DOGAMI assessed survivability by modeling evacuation for multiple scenarios, including the present-day road and bridge network, vertical evacuation structures (VES), and seismic bridge retrofits. A VES is a structure designed to survive the earthquake and tsunami and provide refuge for people that otherwise could not reach safety. Detailed population distributions for residents and visitors within the tsunami zone underpin the evacuation modeling, providing a better understanding of which neighborhoods have the highest vulnerability and which mitigation projects will have the largest impact on life safety.

Results demonstrate a significant portion of Seaside cannot reach natural high ground given the present-day road and bridge network. Evacuation routes are as long as ~1.5 miles and require pedestrian travel speeds of up to 6.8 mph to successfully evacuate before wave arrival. We estimate 25% of permanent and temporary residents (~4,200 people out of ~17,000 total) within the tsunami zone could survive. A hypothetical scenario simulating a seismic retrofit of every bridge in Seaside yields a 1% increase in survivability, a stark demonstration of the ineffectiveness of this mitigation solution. Alternatively, a *single* VES placed in downtown Seaside would allow for as many as 50% of the total population in the tsunami zone (~8,500 people) to survive the event.

DOGAMI's tsunami evacuation modeling is designed to aid in community planning, raise awareness of tsunami hazards and preparedness, and to support emergency management and land use planners to make informed life-safety decisions.

Outreach

DOGAMI in collaboration with the University of Oregon, Oregon Health Authority, and city of Bend submitted a proposal to the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) Cities and Volcanoes Commission to host the thirteenth Cities on Volcanoes conference in Bend, Oregon, July 2026. It was announced at Cities on Volcanoes 12 in Antigua, Guatemala in February, 2024 that Bend was approved as the host site for Cities on Volcanoes 13. This international conference is conducted every two years to advance the cause of connecting scientists, authorities, sociologists, psychologists, emergency managers, economists, city planners, and others to evaluate/advance volcanic crises preparedness and management.

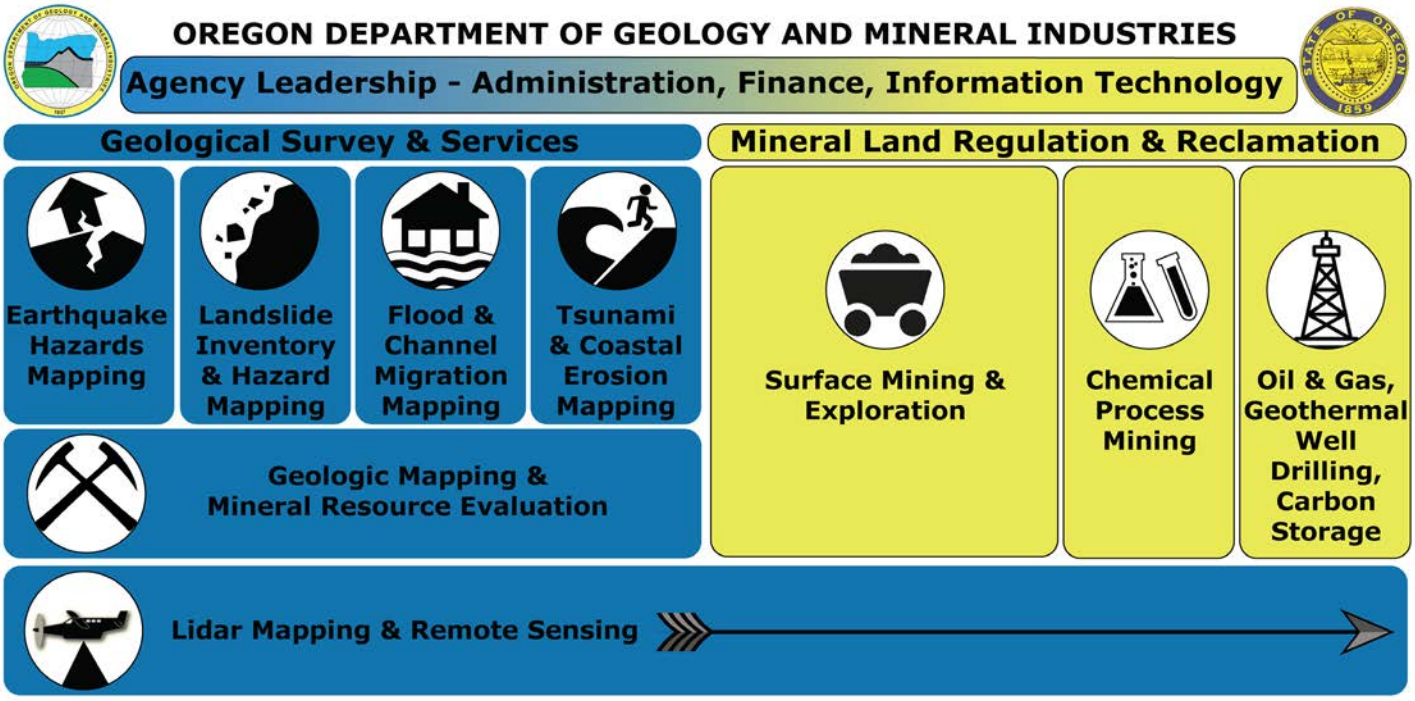
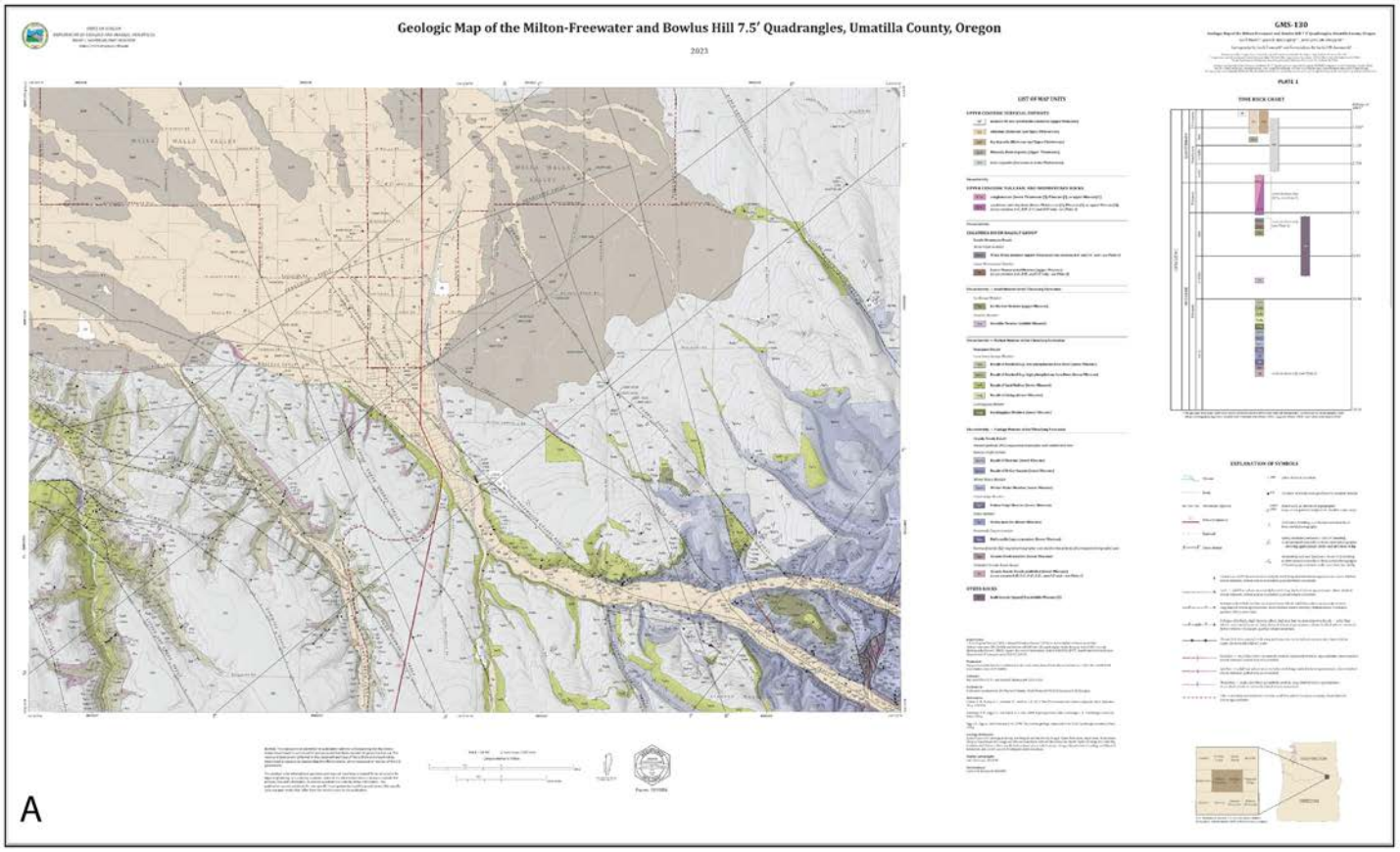


Figure 1. Organizational structure of the Oregon Department of Geology and Mineral Industries.



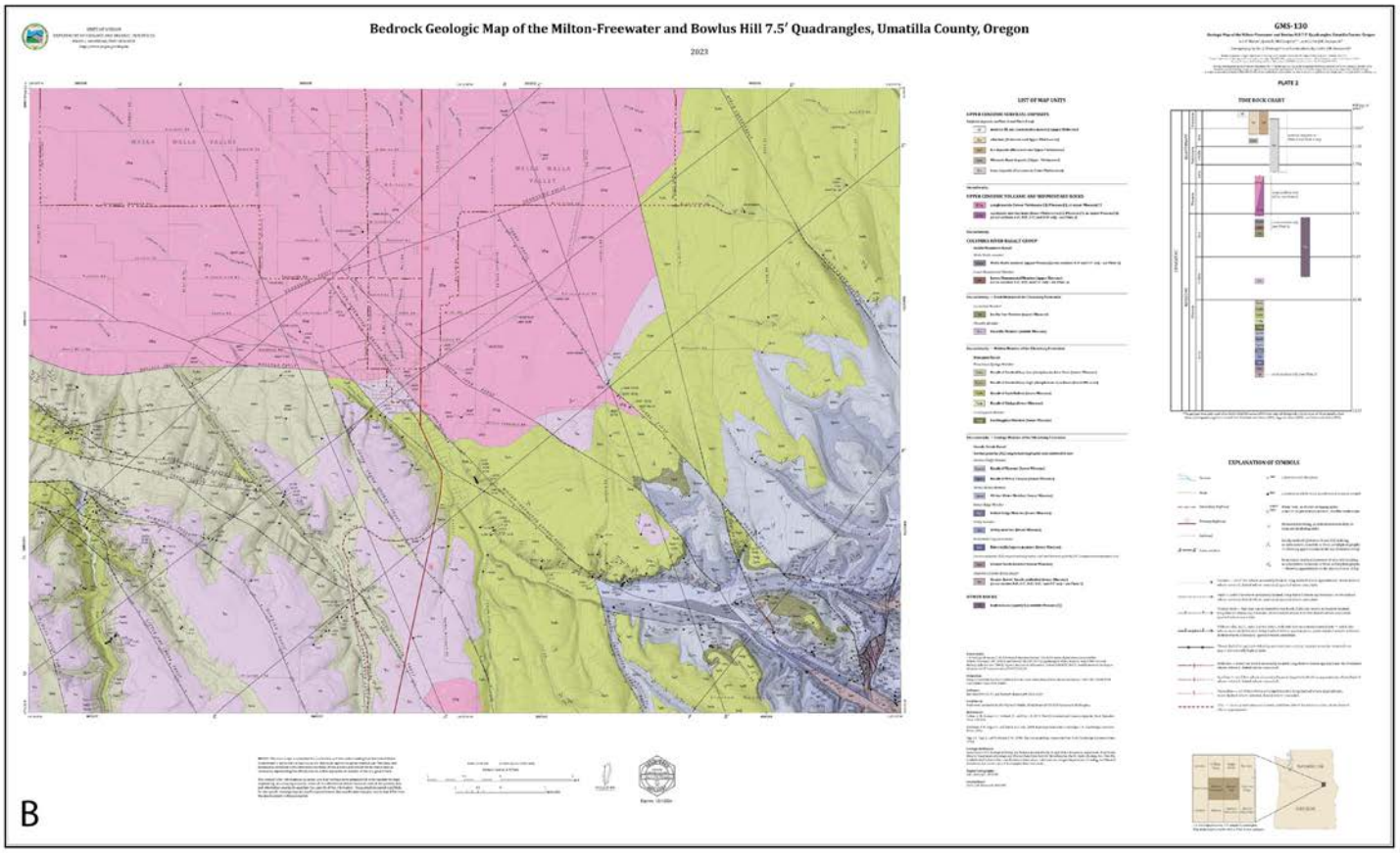


Figure 2. DOGAMI Geologic Map 130, published in December 2023 uses a detailed GeMs-3 geodatabase to create both a detailed geologic map of surficial and bedrock units (A) and a derivative bedrock only map (B).

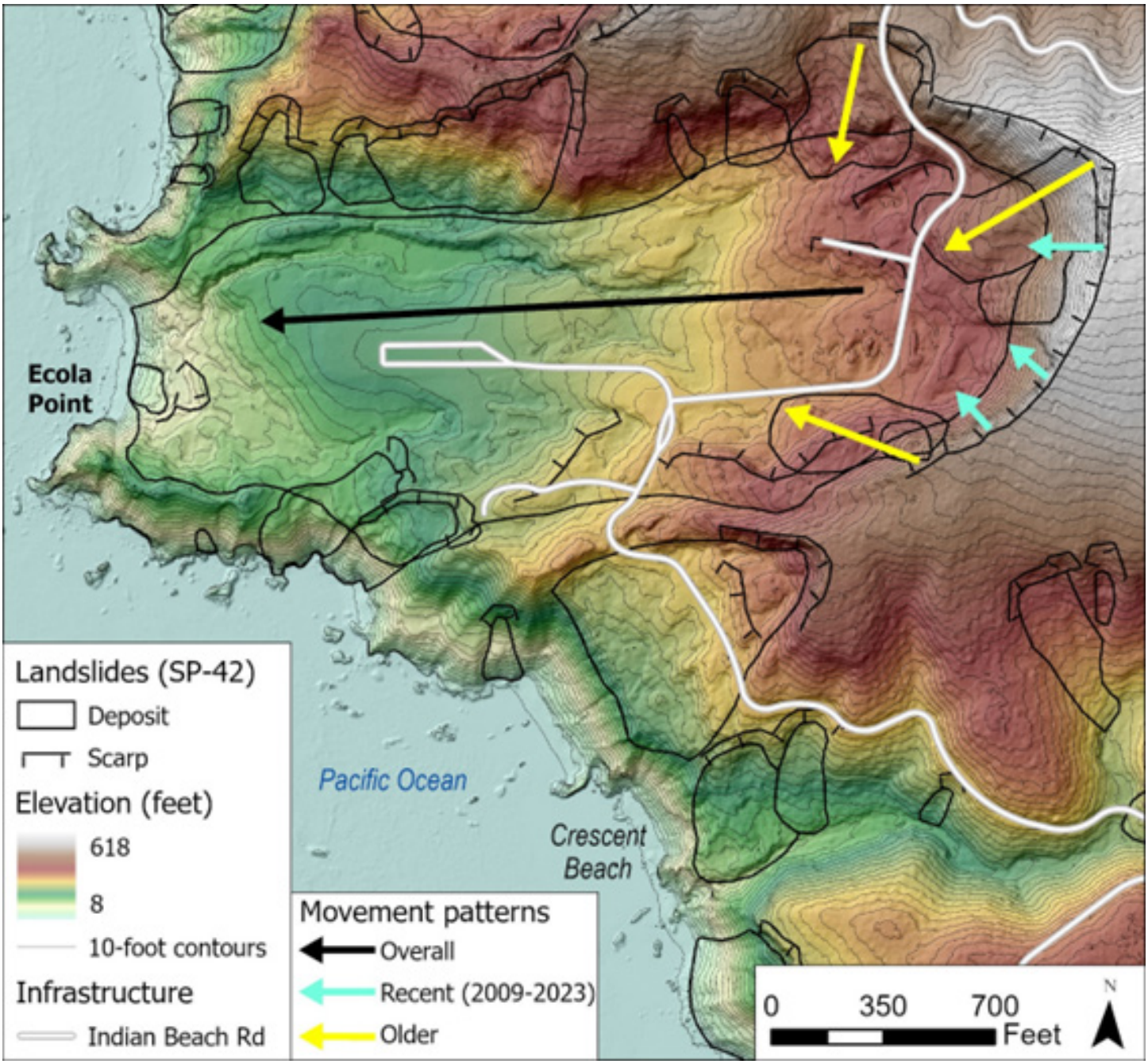


Figure 3. Lidar-based map of the complex Ecola Point Landslide in Ecola State Park.

PENNSYLVANIA

BUREAU OF GEOLOGICAL SURVEY
DEPARTMENT OF CONSERVATION AND NATURAL RESOURCES

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INTRODUCTION

While we are commonly known as the Pennsylvania Geological Survey (PaGS), our official title is the Bureau of Geological Survey, a bureau within the Pennsylvania Department of Conservation and Natural Resources (DCNR). PaGS has been examining Pennsylvania's geology since 1836 under various organizational structures. The present organization dates to 1919, when it was authorized by the General Assembly "to serve the citizens of Pennsylvania by collecting, preserving, and disseminating impartial information on the Commonwealth's geology, geologic resources, and topography in order to contribute to the understanding, wise use, and conservation of its land and included resources."

At the end of this reporting year, the bureau's staff complement is 36: twenty-seven geologists plus two vacant geologist positions, one geospatial specialist, four administrative/clerical staff plus one vacant administrative position, and one librarian. One position was added during the reporting period.

GEOLOGIC MAPPING

Bedrock and Surficial Mapping

PaGS published eleven geologic and derivative maps between July 2023 and July 2024. Surficial geologic maps published during this period included two 1:50,000-scale maps of Wayne and Pike County, a 1:24,000-scale map of the Corry quadrangle in Erie County, and the 7.5-minute Fannettsburg quadrangle spanning Franklin, Fulton, and Huntingdon counties. Bedrock geologic maps published included three quadrangles in Erie County, the 7.5-minute quadrangle of Fannettsburg, and a 1:24,000-scale map of the South Mountain region spanning portions of Franklin, Fulton, and Huntingdon Counties. A compilation map of nine 7.5-minute quadrangles in central Pennsylvania was published as part of STATEMAP 2022. Mapping efforts are focused on the reconciliation of stratigraphic and structural discrepancies, nomenclature, and edge-matching issues of open-file bedrock maps published between 2004 and 2011.

Geologic mapping is currently being conducted in south central Pennsylvania in the western portion of the Broad Top coal field. This is the third and final phase of a six-year project to support the Pennsylvania Department of Environmental Protection to correlate coal seams across the basin.

3D Mapping

PaGS published drift-thickness and depth-to-bedrock maps of five 7.5-minute quadrangles in Beaver, Butler, and Lawrence Counties in northwestern Pennsylvania as part of the Great Lakes Geologic Mapping Coalition program. These products highlight the lithologic variability and sequence of glacial tills in the subsurface, and locations of buried valleys. Results directly contribute to Pennsylvania's overall strategy to develop a statewide three-dimensional approach to geologic mapping. The methodology developed for modeling the unconsolidated sediment cover thickness will support future PaGS work and goals of the US GeoFramework Initiative.

Other Maps

PaGS created a derivative map highlighting the distribution of sinkholes and karst-related closed depressions for the Fannettsburg 7.5-minute quadrangle.

OTHER PROGRAM HIGHLIGHTS

Rock Sample Library

PaGS successfully completed a Geophysical Wireline Well Logs and Core Storage Expansion project in fulfillment of a 2023 NGGDPP grant. Geology students participating in a summer internship program scanned 294 historic well logs. By erecting new shelving units, additional storage space was created in the Rock Sample Library for 1,470 recently donated core boxes to be inventoried, photographed, and palletized, thus adding to a publicly accessible geologic archive.

Earth MRI and Geochemistry

PaGS has begun to pursue geochemical analysis of Devonian shales across Pennsylvania, West Virginia, and Maryland to explore vanadium, molybdenum, and rare earth element mineralization and have further information on variations of bulk geochemistry of these units across this region. A second Earth MRI project assesses geochemistry of the south-central Pennsylvania Valley and Ridge province as ground truth data for a multi-state aeromagnetic and radiometric survey.

We continued modernization and refreshing of our laboratory facilities, with an environmental SEM-EDS, portable XRF, powder XRD installed, and an automated lithium borate fusion bead instrument, EBSD, ultrapure water system, and clean laboratory space on the way. We are open to scientific collaboration with folks in the academic and state survey sectors, so please do not hesitate to contact us!

Subsurface and Petroleum Geology

PaGS continues to maintain the state's geodatabase of oil and gas well records, the Exploration and Development Wells Information Network (EDWIN). We continue to consider innovative ways to provide EDWIN service that improve access to those that regularly benefit from it as well as our own staff who make use of this data in our subsurface work.

PaGS plans to carry out the second year of the Central Appalachian Partnership (CAP) for Carbon Storage Devel-

opment Project, a DOE-funded desktop study in partnership with West Virginia Geological and Economic Survey and Battelle to study and characterize rocks in the deepest part of the Rome Trough. The Subsurface Section will host eight interns in summer 2025, six of which will be funded by the CAP project.

SOUTH CAROLINA

SOUTH CAROLINA GEOLOGICAL SURVEY

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INTRODUCTION

The South Carolina Geological Survey (SCGS) is the second-oldest geological survey in the United States (1825). SCGS is housed within the South Carolina Department of Natural Resources – Land, Water, and Conservation Division (SCDNR-LWCD), and maintains a primary office in Columbia and a field office in Charleston. The mission of the Survey is to provide reliable geologic information to decision makers. Current staff consists of ten geologists and one GIS analyst working in cartography and data management. SCGS operates a drilling program in support of Coastal Plain mapping with a full-time driller and drill crew. The Survey also maintains a 7,000-square-foot core and sample repository that curates more than 1,000 cores acquired through Federally-funded projects and private industry.

SCGS's primary focus area is geologic mapping. Mapping initiatives cover all physiographic provinces within the state (Blue Ridge, Piedmont, Coastal Plain), and offshore. Piedmont and Coastal Plain projects receive support from the USGS STATEMAP and Earth MRI programs. Shoreline change studies and offshore projects receive support from the Bureau of Ocean Energy Management (BOEM) and others. SCGS maintains strong relationships with State academic institutions who provide their expertise in mapping, geophysical modelling, geochemistry, and geochronology to support SCGS mapping projects.

GEOLOGIC MAPPING

Piedmont Mapping

STATEMAP bedrock mapping along the South Carolina-Georgia border is working towards delineating relationships between Neoproterozoic–Cambrian metamorphic terranes juxtaposed within the Late Paleozoic dextral Eastern Piedmont fault system (EPFS). Mapping indicates that reactivation of EPFS structures is likely responsible for a recent earthquake swarm in Kershaw County. Earth MRI bedrock mapping in the Carolina terrane northeast of Columbia is contributing to critical mineral research of REE (Fig. 1). Mining in this region has focused on gold in porphyry Cu-Mo-Au and VMS deposits, but critical minerals copper, zinc, lead, antimony, arsenic, fluorine, and topaz are also known to exist within those systems. SCGS is participating in an Earth MRI funded geochemical reconnaissance project with North Carolina and Virginia investigating the potential for Pennsylvanian-Permian granitoid regolith deposits to host REE deposits.

Coastal Plain Mapping

Recent STATEMAP Coastal Plain mapping projects are ongoing in two areas of South Carolina. Mapping in the Lower to Middle Coastal Plain provinces (Pliocene to Pleistocene sediments at the surface) was completed in Dillion, Horry, and Marion Counties along the North Carolina state line. The South Carolina Department of Transportation (SCDOT) requested geologic mapping to support their engineering projects related to building the future I-73 corridor, a planned interstate connecting Myrtle Beach, South Carolina with Sault Ste. Marie, Michigan. Geologic mapping detailed the late Pliocene and early Pleistocene highstand coastal barrier systems and the related Great Pee Dee, Little Pee Dee, and Waccamaw river systems. STATEMAP Coastal Plain work is now supporting SCDOT efforts to widen I-95 across the State, starting along the South Carolina-Georgia border. Mapping commenced in Beaufort, Colleton, Hampton, and Jasper Counties. In this region, Miocene-Pleistocene sediments record a complex history of sea-level changes.

Earth MRI Coastal Plain projects are mapping Cretaceous-Quaternary sediments of the Upper Coastal Plain between Columbia and Orangeburg, identifying potential heavy-mineral placer deposits. The mapping includes the Piedmont–Coastal Plain transition providing an examination of REE sources and proximal sink areas. Early efforts in Calhoun, Lexington, Orangeburg, and Richland Counties identified Cretaceous and Eocene sediments as sink targets for exploration. A new Earth MRI project will extend this work into adjacent Aiken and Edgefield Counties. Airborne geophysical surveys and geochemical sampling support the mapping, and geochronology is being done to identify potential heavy mineral source terranes in the Piedmont.

Cooperative work with BOEM identified potential sand resources for beach nourishment projects, and SCGS partnered with College of Charleston at Botany Bay Wildlife Management Area to investigate the preservation potential of a Native American shell ring (~4.3 ka) in the nearshore zone seaward of a rapidly transgressing shoreline. Current work with BOEM involves geotechnical, geochemical, and geochronological analyses of a set of vibracores collected in Long Bay (offshore of the Myrtle Beach area in Georgetown and Horry Counties) to better understand the distribution and character of the shallow offshore stratigraphy and surficial sand and gravel deposits.

OTHER MAJOR PROJECTS

SCGS is investigating shoreline-change rates and associated physical processes in modern estuarine systems at two SCDNR-managed coastal Wildlife Management Areas (WMAs). These two areas consist of late Pleistocene-modern barrier island systems and associated estuarine marshes. The long-term (1851–2022) erosion rate at Botany Bay WMA, near Edisto Beach, South Carolina, is high enough (average of -4.8 m/yr and has increased to -9.10 m/yr in the past 10 years) to have completely eroded the 1850's barrier strand (Botany Bay Island). The current retreating barrier island (Pockoy Island) at the property is late Pleistocene in age. In 2024, multi-year collaborative work between SCGS and other SCDNR researchers in Archaeology and Wildlife Biology

at Botany Bay was published in the journal Advances in Archaeological Practice.

SCGS maintains a network of 25 Surface Elevation Tables (SETs) in the tidal zone from North Carolina to Georgia. The first ten stations were installed in 1997 and the network has expanded several times since then. In 2023 SCGS published the results of 20+ years of SET data. In 2024 SCGS secured funding for 6 additional stations for the Charleston Harbor area in cooperation with the Southeast Coastal Ocean Observing Regional Association (SECOORA) and assists The Citadel and the Port Royal Sound Foundation with their SECOORA-supported SET installations.

Yawkey Wildlife Center (YWC) WMA, on Cat Island near Georgetown, SC, is another SCDNR-managed property. YWC is located on the south side of Winyah Bay and has been altered by the creation of the AIWW on its landward side and by a jetty built in 1904 on its seaward side. Shoreline change work for this property is also ongoing.

SCGS is leading a cooperative effort with Virginia, North Carolina, Georgia, and Florida to reconcile stratigraphic nomenclature and mapping criteria across the southeastern Atlantic Coastal Plain. A separate effort for the Piedmont is in the planning stages.

The SCGS Digital Information Program (DIP) continues to catalogue, organize, and upgrade quadrangle Geologic Map Schema (GeMS) geodatabases to the National Geologic Map Database (NGMDB). This includes creating new GeMS databases for older data that may be still located in older file formats or coordinate systems which need to be projected or corrected. DIP staff are part of a national working group funded through NGMDB to improve GeMS for all users.

DIP staff developed a comprehensive database for SCGS symbology to keep cartography consistent between map products. One key development has been the creation of KML databases for the geologic maps of the ACE Basin, the I-73 Corridor, and the Charleston peninsula. The KML format allows for greater data dissemination and public use while we are converting older map products to GeMS.

SOUTH DAKOTA

SOUTH DAKOTA GEOLOGICAL SURVEY

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INTRODUCTION

The South Dakota Geological Survey (SDGS) is a Program in the South Dakota Department of Agriculture and Natural Resources. The SDGS performs surface and subsurface geologic mapping throughout the state. Aquifer mapping and modeling is also a significant part of the activities at SDGS. With two drill rigs that are owned by the agency, the SDGS collects a wealth of new subsurface geologic and hydrogeologic information each year that is used to produce maps and reports used by both the public and private sector. The SDGS also maintains a statewide ground water quality monitoring network that is sampled regularly to monitor the water quality characteristics of the state's major surface aquifers.

The SDGS has 22 full-time employees that consist of geologists, hydrogeologists, technicians, drillers, and other support staff. In addition, the SDGS hires several geology interns each year to assist with drilling test holes, installing observation wells, ground water sampling, and GIS-based aquifer mapping.

GEOLOGIC MAPPING

The SDGS is producing 1:24,000-scale geologic maps in the Black Hills region. South Dakota's flagship state park, Custer State Park in the heart of the Black Hills, is currently one of the areas SDGS is mapping.

The primary use of these maps is to:

- Address concerns regarding quantity and quality of water in the aquifers in the Black Hills region.
- Properly address issues related to geologic hazards, floodway analysis, and mining.
- Understand the development of caves in the Black Hills and to protect the cave resources, such as Wind Cave National Park and Jewel Cave National Monument.
- Allow sound development practices to be implemented and wise land management decisions to be made.

One geologic quadrangle map was published in Fiscal Year 2024. A status graphic of geologic mapping in the Black Hills and links to the published maps are available at https://bit.ly/3Abdvpd. The SDGS is also publishing 1:250,000-scale geologic maps in western South Dakota. Each map covers a large area and can be used for regional and statewide planning. These maps are beneficial in making land use decisions such as determining the suitability of an area for development, planning major construction projects, identifying shallow sources of ground water, and identifying potential mineral resource deposits. Two maps of this series were in progress Fiscal Year 2024. A status graphic of this series, along with links to the published map is available at https://bit.ly/3iOrRFV.

Figure 1 shows an example from one of the 1:24,000-scale geologic maps in the Black Hills region of the state.

OTHER PROGRAM HIGHLIGHTS

Mapping Ground Water Resources

Work related to understanding and documenting ground-water resources in the glaciated part of South Dakota continues to be a primary focus for the SDGS. Drilling resources were used to drill test holes and install observation wells in multiple aquifers this past year. New data generated from this drilling program, as well as review of historical data, is used in the interpretation of aquifer occurrence. Products that come from this effort are:

- Aquifer extent maps
- Depth to aquifer maps
- Revised bedrock geology maps
- Revised surface geologic maps

South Dakota Flood Information System

The SDGS manages the development and use of the South Dakota Flood Information System. The SDFIS saw use as a valuable tool during the record floods of June 2024 in South Dakota. The SDFIS was used to plan for and respond to the floods that occurred on four of the state's major rivers. Figure 2 shows example output from the SDFIS.

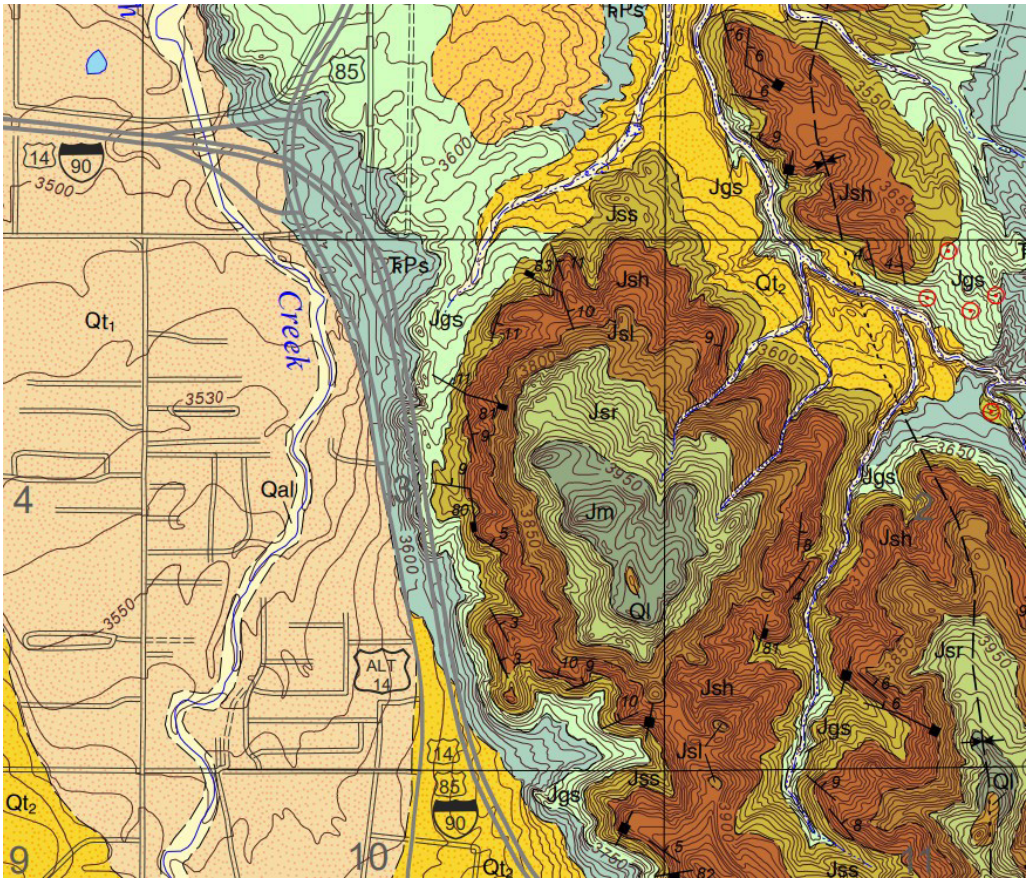

Figure 1. Portion of a published 1:24,000-scale geologic map in the Black Hills region.

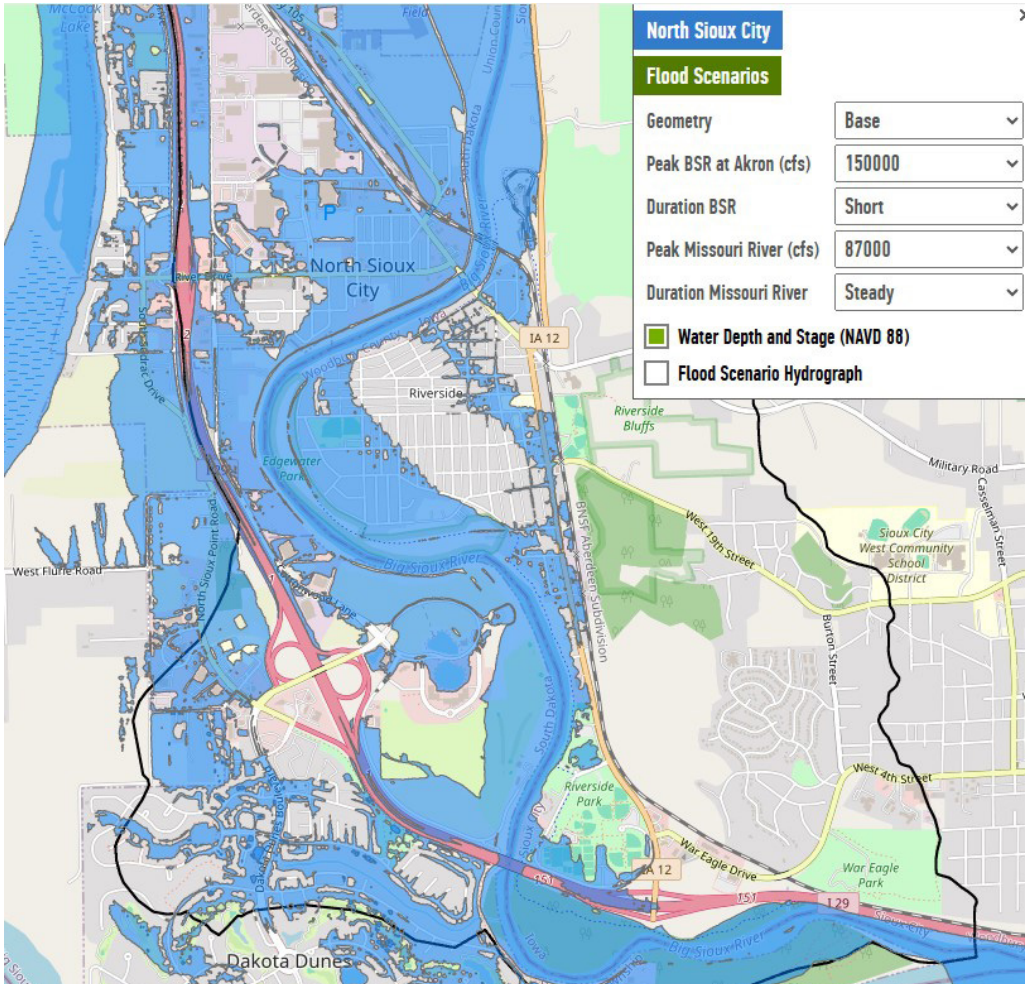

Figure 2. Example output from the SDFIS.

TENNESSEE

TENNESSEE GEOLOGICAL SURVEY

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INTRODUCTION

Tennessee's diverse geology is expressed today in its distinct physiographic provinces, from the Coastal Plain in the West to the Central Basin and Cumberland Plateau in Middle Tennessee, to the Valley and Ridge and Blue Ridge in the East (Fig. 1). The Tennessee Geological Survey (TGS) was established in 1831 to advise local organizations, other state agencies, and the federal government on matters relating to Tennessee geology. In 2022, TGS was merged with three other programs (Oil and Gas, Mining, and Abandoned Mine Lands) to form the new Division of Mineral and Geologic Resources within the Tennessee Department of Environment and Conservation. The mission of TGS is to encourage and promote the prudent development and conservation of Tennessee's geological, energy, and mineral resources by developing and maintaining databases, maps, and technical services; providing accurate geologic hazard assessments; and disseminating geologic information through publications and educational outreach activities. Recent retirements of the State Geologist, Assistant State Geologist, and West Tennessee Geologist have resulted in staff changes. Currently, TGS consists of four geologists (Dr. Peter Lemiszki, Mr. Ron Clendening, Mrs. Valarie Harrison, and Dr. Claudia Richbourg), a GIS Coordinator (Mr. Andrew Wunderlich), and the State Geologist (Dr. William Jackson).

GEOLOGIC MAPPING

Since 1960, TGS has engaged in detailed geologic mapping at the 7.5-minute quadrangle scale, completing 468 maps to date (Fig. 2). These maps are the basic source of information for people engaged in environmental regulatory work, mineral and (or) oil and gas exploration, geologic hazard assessment and mitigation, building site evaluation (including dams and highways), and many other practical and scientific uses that provide for human needs with respect to water, energy, materials, and security. Since 1994, TGS has received $2,070,411 in funding through the U.S. Geological Survey (USGS) State Geological Mapping Program element (STATEMAP) of the National Cooperative Geologic Mapping Program (NCGMP), completing 67 new geologic maps and converting 24 unpublished geologic maps to digital coverages under this program.

During fiscal year 2023–2024, TGS received support under cooperative agreement G23AC00467, which funded eight projects in Tennessee focused on new geologic mapping, a drilling investigation, mineral resources derivative maps, and applying Geologic Map Schema (GeMS) to unpublished 7.5-minute quadrangle maps. TGS completed (1) new geologic mapping of the southeast half of the Chestnut Hill, Russellville, and Wilder 7.5-minute quadrangles, (2) drilling two boreholes in the Miston 7.5-minute quadrangle (Fig. 3), (3) new geologic mapping of the Lane 7.5-minute quadrangle, (4) a mineral resources summary and derivative map of the Windrock 7.5-minute quadrangle, and (5) two GeMS geodatabases and geologic maps for the Friendship and Bacon Gap 7.5-minute quadrangles. These projects were selected by the Tennessee Mapping Advisory Committee to fulfill an established, long-range mapping plan for three defined project areas. These ongoing mapping efforts address the main objective of the National Geologic Mapping Act, "to establish the geologic framework of areas determined to be vital to the economic, social, environmental, or scientific welfare." All geologic map products are digital born, geographic information system based, high-quality Portable Document Format (PDF) files. GeMS geodatabases have either been completed or will be completed within one year from the deliverable date.

Map Citations July 2023 through June 2024:

- Clendening, R.C., 2024, Geologic map of the Wilder quadrangle: Tennessee Geological Survey, Geologic Quadrangle Map 334-SE, scale 1:24,000.
- Harrison, V.J., 2024, Geologic map of the Lane quadrangle: Tennessee Geological Survey, Geologic Quadrangle Map 420-NE, scale 1:24,000.
- Lemiszki, P.J., and Greene, R.C., 2024, Geologic map of the Chestnut Hill quadrangle: Tennessee Geological Survey, Geologic Quadrangle Map 164-NE, scale 1:24,000.
- Smith, J.W., Miller, B.W., and Sanders, J.E., 2024, Geologic map of the Russellville quadrangle: Tennessee Geological Survey, Geologic Quadrangle Map 171-SE, scale 1:24,000.
- Miller, B.W., Lemiszki, P.J., and Wunderlich, A.W., 2024, Mineral resources summary of the Windrock quadrangle: Tennessee Geological Survey, Geologic Quadrangle Map 129-SE scale 1:24,000.
- Antonacci, V., 2017, Geologic Map and mineral resources summary of the Friendship quadrangle: Tennessee Geological Survey, Geologic Quadrangle Map 429-NW, scale 1:24,000.
- Lemiszki, P.J., 2018 (revised 2024), Geologic Map and mineral resources summary of the Bacon Gap Quadrangle: Tennessee Geological Survey, Geologic Quadrangle Map 123-SE, scale 1:24,000.

OTHER PROGRAM HIGHLIGHTS

Data Preservation

For Fiscal Year 2023, the U.S. Geological Survey (USGS) National Geological and Geophysical Data Preservation Program (NGGDPP) awarded TGS funds to preserve geoscience data and materials, for digital and physical infrastructure development, and for critical minerals data preservation. Work completed through this grant includes:

- Creating the item level metadata and converting to a digital format 514 maps in the Collection of Coal Geology Maps from Tennessee.
- Converting the unpublished Brayton 7.5-minute quadrangle geologic map to Level 3 GeMS. geodatabases and uploading the files to the National Cooperative Geologic Mapping Program GeMS portal.
- Developing an ArcGIS on-line web map interface pilot project that hosts all the documents in the Collection of Zinc Mining Maps and Reports from Tennessee.
- Installing 135 feet of two-shelf racks for the storage of bedrock core at the Ellington Warehouse Data Repository in Nashville.
- Compiling 407 mineral exploration boreholes in the Copper Ridge Zinc District using the National Index of Borehole Information (NIBI) metadata template.

Where applicable, all of the collection metadata and item level metadata, corresponding to the projects above, were revised and uploaded to the U.S. Geological Survey's Registry of Scientific Collections (ReSciColl) website.

Gulf Strat Working Group

TGS participated in the West Gulf Coastal Plain Stratigraphic Reconciliation Initiative, a collaborative working group of Gulf Coast state geological survey's, led by the Geological Survey of Alabama through U.S. Geological Survey cooperative agreement G22AC00494. The primary objective of this work is to develop a consistent, regional stratigraphic nomenclature framework and advance USGS goals for Geolex and the Geologic Names Committee. TGS created regional borehole stratigraphic correlation charts and updated the unit names and descriptions for Cenozoic and Mesozoic strata in western Tennessee.

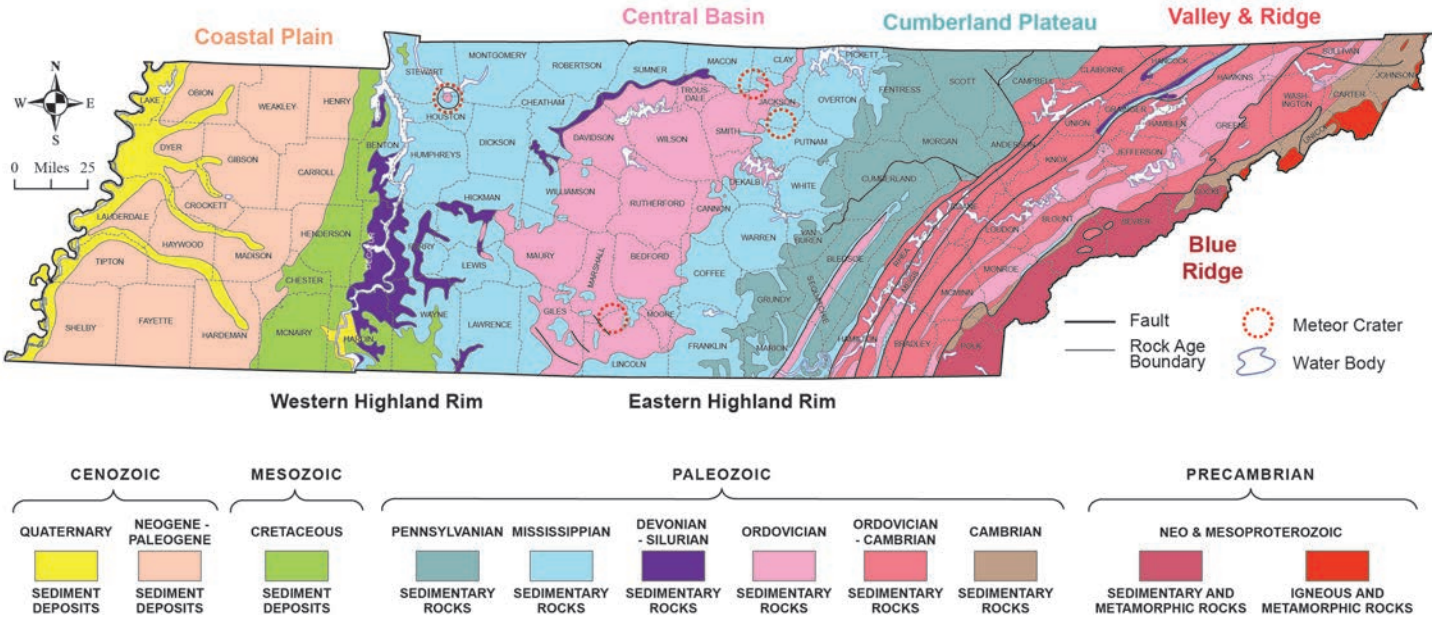

Figure 1. Generalized physiographic map of Tennessee with surficial rock type and age.

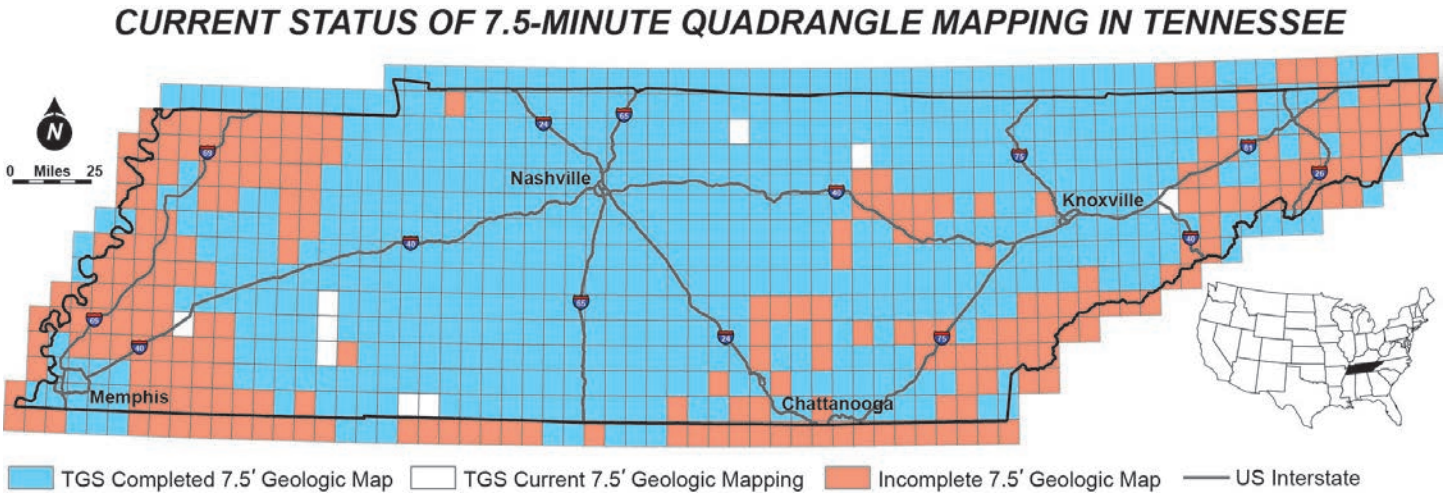

Figure 2. Map depicting the status of geologic mapping of 7.5-minute quadrangles in Tennessee.

Figure 3. Field photos from the drilling investigation of Quaternary and Eocene strata in the Miston 7.5-minute quadrangle, western Tennessee.

TEXAS

BUREAU OF ECONOMIC GEOLOGY

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INTRODUCTION

The Bureau of Economic Geology (Bureau) is the State Geological Survey of Texas and the oldest organized research unit at The University of Texas at Austin. The Bureau is one of three units in the Jackson School of Geosciences at UT Austin.

Bureau researchers spearhead basic and applied research projects globally in energy resources, technologies and economics, coastal and environmental studies, land resources and use, geologic and mineral mapping, hydrogeology, geochemistry, and subsurface nanotechnology. Our staff of more than 200 includes scientists, engineers, economists, and graduate students, representing 27 countries, often working in integrated, multidisciplinary research teams.

The Bureau's facilities and state-of-the-art equipment include 19 individual laboratories hosting researchers investigating topics such as organic and inorganic geochemistry, salt tectonics, rock mechanics, nanogeosciences, hydrology, fluid inclusions, and shale porosity and permeability. The Bureau also maintains two major well core research and storage facilities, in Houston and Austin, together believed to be one of the largest archives of subsurface rock material in the world as well as the state's wireline log library.

GEOLOGIC MAPPING

Recent increases in available National Cooperative Geologic Mapping Program (NCGMP) funds continue to expand coastal-, groundwater-, geohazards-, and minerals-related geologic mapping in Texas under the cooperative STATEMAP program. These funds supported hiring of geologists for the expanded mapping program, new detailed mapping in six project areas (Fig. 1), preparing maps in the distributable USGS/AASG Geologic Map Schema (GeMS), and compiling statewide salt distribution data. In addition, multiple cooperative Earth MRI projects are supplementing the STATEMAP geologic mapping efforts related to critical minerals in the Trans-Pecos region.

Between July 2023 and June 2024, Bureau researchers completed nine new, quadrangle-scale Open-File Maps (OFM), three multi-quadrangle GeMS compilation maps, and a subsurface salt distribution map as part of the cooperative STATEMAP and state-funded State of Texas Advanced Resource Recovery (STARR) program.

Map Citations

Andrews, J. A., 2023, Diapiric and thickly bedded salt in Texas: Open-File Map No. 278, map scale 1:1,000,000.

Caudle, T. L., and Paine, J. G., 2023, Geologic map of the Anahuac quadrangle, Texas Gulf of Mexico coast: Open-File Map No. 266, map scale 1:24,000.

Caudle, T. L., and Paine, J. G., 2023, Geologic map of Galveston East Bay, upper Texas Gulf of Mexico coast: Open-File Map No. 275, map scale 1:50,000.

Elliott, B. A., 2023, Geologic map of the Small quadrangle, Hudspeth County, Texas: Open-File Map No. 274, map scale 1:24,000.

Helper, M. A., Hunt, B. B., and Barnes, V. E., 2023, Geologic map of the Marble Falls, Dunman Mountain, Click, Cap Mountain, Kingsland, and Longhorn Cavern quadrangles, Blanco, Burnet, and Llano Counties, Texas: Open-File Map No. 277, map scale 1:50,000.

Hunt, B. B., Andrews, J. R., and Paine, J. G., 2023, Geologic map of the Dolan Springs quadrangle, Val Verde County, Texas: Open-File Map No. 272, map scale 1:24,000.

Hunt, B. B., 2023, Geologic map of the Monument Mountain SE quadrangle, Mason County, Texas: Open-File Map No. 271, map scale 1:24,000.

Hunt, B. B., 2023, Geologic map of the Panther Creek quadrangle, Mason County, Texas: Open-File Map No. 270, map scale 1:24,000.

Paine, J. G., Grunau, B. A., and Morris, J. N., 2023, Geologic map of the central Matagorda Bay area, Texas Gulf of Mexico coast: Open-File Map No. 276, map scale 1:62,500.

Paine, J. G., Grunau, B. A., and Morris, J. N., 2023, Geologic map of the Tivoli SW quadrangle, Texas Gulf of Mexico coast: Open-File Map No. 268, map scale 1:24,000.

Paine, J. G., Morris, J. N., and Grunau, B. A., 2023, Geologic map of the Rockport quadrangle, Texas Gulf of Mexico coast: Open-File Map No. 269, map scale 1:24,000.

Paine, J. G., Morris, J. N., and Grunau, B. A., 2023, Geologic map of the Tivoli SE quadrangle, Texas Gulf of Mexico coast: Open-File Map No. 267, map scale 1:24,000.

Woodruff, C. M., Jr., and Morris, J. N., 2023, Geologic map of the Montopolis quadrangle, Travis County, Texas: Open-File Map No. 273, map scale 1:24,000.

RESEARCH AT THE BUREAU OF ECONOMIC GEOLOGY

The STARR program is actively studying reservoirs throughout Texas to inform oil and gas development, carbon storage, and development of energy storage systems. For example, in collaboration with the $GeoH_2$ industrial affiliates program,

STARR has conducted an extensive characterization of the Castile and Salado Formations in the Permian Basin. STARR researchers intend to characterize these geologic formations to identify areas that are suitable for the construction of salt caverns for energy storage.

The TexNet Seismic Monitoring and Seismology Research Program managed by the Bureau monitored and analyzed earthquake activity through a network of over 200 seismometers. TexNet's catalog of earthquakes is a primary information resource for the public, government, and industry on seismic activity across the state. In areas of high earthquake potential, TexNet has developed analysis and reporting workflows to report all seismicity of $M_L \geq 1$ the next business day.

The Bureau initiated the Texas Imperative program in 2024 to conduct focused studies and provide updates on key resource topics across the state. These topics include minerals, Central Texas hydrology, geologic helium and hydrogen, and geothermal energy in the Gulf Coast and East Texas regions (Fig. 2).

In addition to the Texas-focused research programs such as STARR and TexNet, twelve industrial affiliate and Federal grant-based research programs conducted thematic research on topics including carbon capture and storage, carbonate stratigraphy, siliciclastic depositional systems, mudrock systems, unconventional oil and gas resources, computational seismology, salt tectonics, fractures, injection and seismicity, hydrogen, geothermal, life-cycle analysis of electricity generation, and nano- and microsensor materials for subsurface monitoring.

OTHER PROGRAM HIGHLIGHTS

Researchers from the Bureau's Near Surface Observatory conducted an airborne lidar survey campaign covering the beaches, barrier islands, and shallow offshore along the entire Texas Gulf shoreline. This project, funded by the Texas General Land Office, was the first major data acquisition project using the Bureau's new Leica Chiroptera Mark 5 airborne system. Preliminary results indicated higher spatial resolution of topography, and deeper water bottom mapping in the nearshore environment, than the previous system could achieve (Fig. 3).

Dr. James Thompson, from the Bureau's STARR program, was awarded a $1.3 million grant by NASA to develop technology to address the active-fire stage of wildfire management.

Bureau researchers were honored with the following awards:

- Kitty Milliken received the 2024 SEPM Francis J. Pettijohn Medal for Excellence in Sedimentology.
- Michael Young was named a Fellow of the American Society of Agronomy (ASA).
- Shuvajit Bhattacharya (and his collaborator Sumit Verma) received the GeoGulf '24 Gulf Coast Section's A.I. Levorsen Memorial Award in the Best Oral Presentation category.
- Bob Loucks and Rob Reed received the GeoGulf '24 President's Award for Outstanding Paper in the GCAGS Journal, Volume 12 (2023).
- Stephen E. Laubach received Honorary Membership in the American Association of Petroleum Geologists (AAPG).
- Sergey B. Fomel and his students won the AAPG-SEG 2023 "Best Paper in Interpretation."
- Gwen Hebert received the Staff Excellence Award.

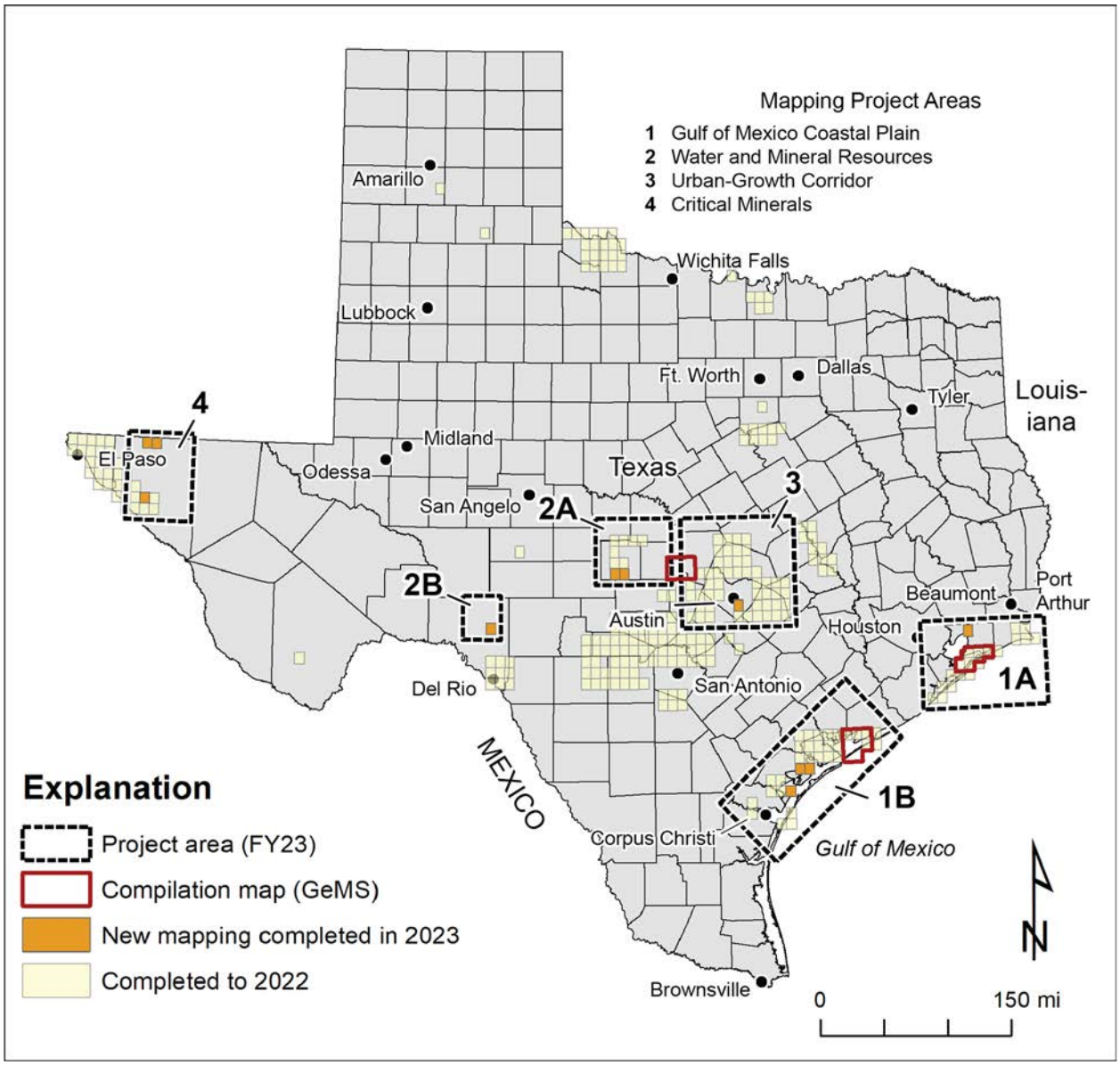

Figure 1. Location of geologic mapping project areas on the Texas Coastal Plain (1A and 1B), in the central (2A) and western (2B) Texas groundwater- and mineral-resource areas, in the central Texas urban-growth corridor (3), and in the Trans-Pecos critical minerals resource area (4). Also shown are outlines of compilation maps completed in 2023.

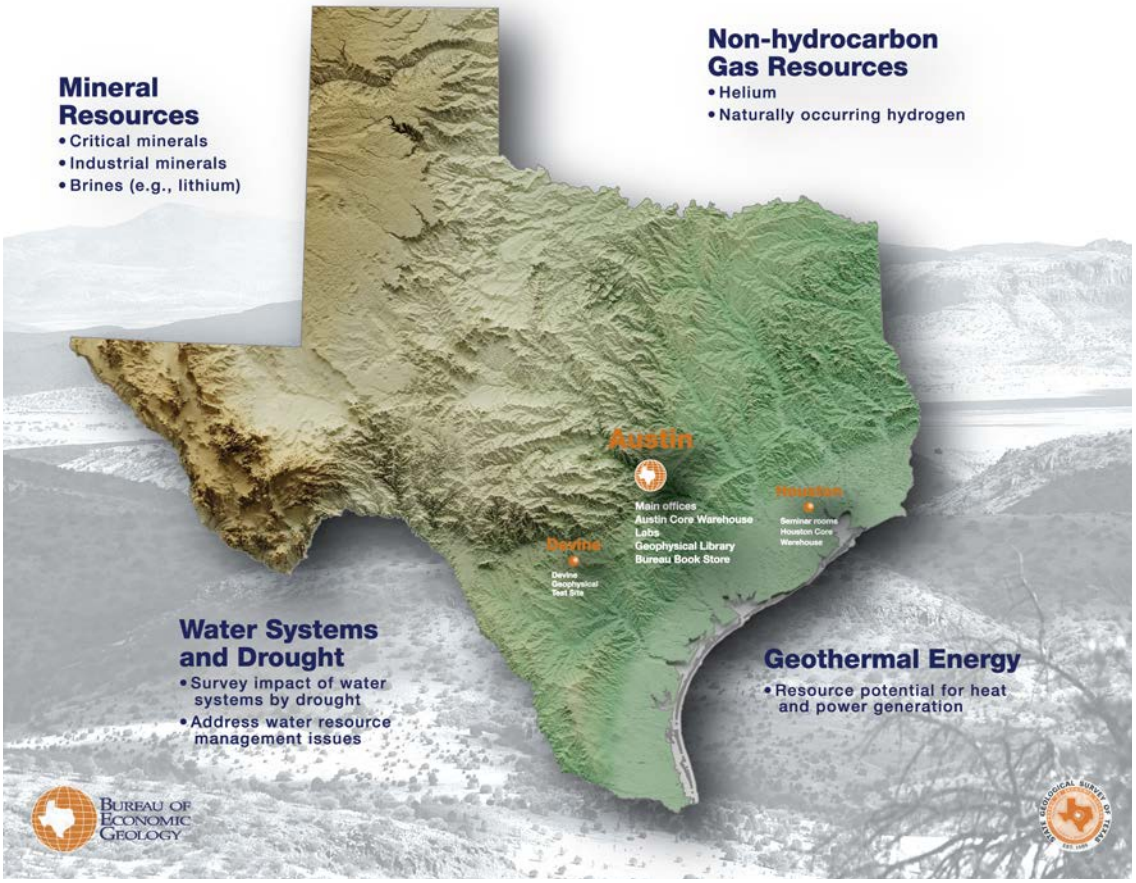

Figure 2. The Texas Imperative program focuses on key resource topics across the state, including minerals, Central Texas hydrology, geologic helium and hydrogen, and geothermal energy in the Gulf Coast and East Texas regions.

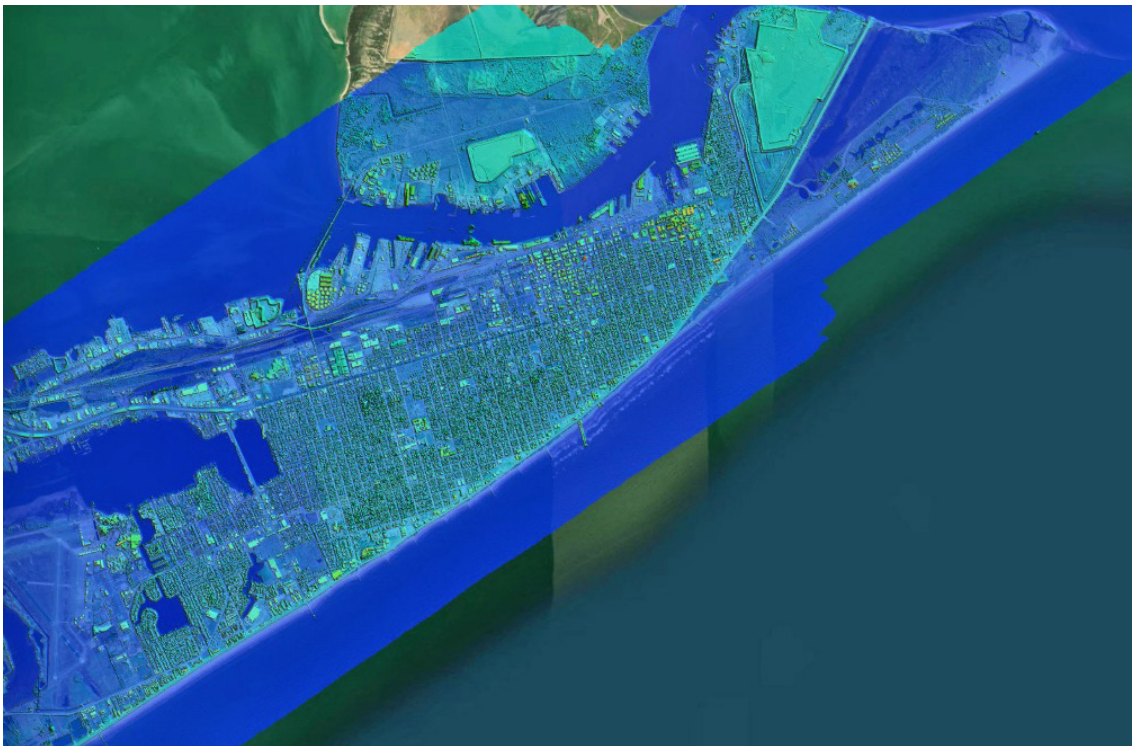

Figure 3. Galveston Island topographic map derived from near-infrared lidar. The data was collected at an altitude of 1,300 m (4,300 ft) above sea level.

VERMONT

VERMONT GEOLOGICAL SURVEY

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INTRODUCTION

The Vermont Geological Survey (VGS), a Division within the Department of Environmental Conservation in Vermont's Agency of Natural Resources, is guided by a mission to protect the environment and human health and safety. Under statute, the VGS provides geologic information, expertise, and advice to assist towns, regulatory agencies, and other "clients" in making complex environmental, natural resource, and hazard mitigation decisions. It has been an active year for our small survey; intense storms led to severe flooding and significant landslide hazards over large swaths of the state in July of 2023 and July of 2024 that required the undivided attention of the VGS for many months. These experiences motivated hiring one staff member with a primary focus on geologic hazards. In the midst of our response work we have also progressed on STATEMAP mapping projects, data preservation tasks, and a host of other projects in collaboration with state and academic collaborators in service to sister divisions, other agencies, and Vermonters. A few highlights are provided below.

GEOLOGIC MAPPING

The VGS is currently active on a STATEMAP agreement within the focus area of our new long-range mapping plan in Vermont's Northeast Kingdom ("NEK" - see Fig. 1). This is an area that, despite having pressing needs for geologic data to address a number of societal challenges, has remained underserved for decades because it has a relatively low population density. The VGS is additionally working on larger-scale "boutique" mapping projects largely in support of sister divisions and agencies, as detailed below.

Surficial Mapping

The VGS, along with our mappers from Norwich University and the University of Vermont, are proud to have completed a seamless compilation of 32 quadrangles in the Montpelier one-degree sheet in 2024, which concludes a long-range mapping plan set over a decade ago. The mapping that went into this product significantly improved our understanding of the deglaciation of central Vermont and helped to link this history with that of the Connecticut River valley to the east and the Champlain Valley to the west.

Having since turned our attention to the NEK, three 7.5-minute quadrangles are near completion owing to the support of our mapping partner from the University of Vermont. The mapping is proving highly valuable to a watershed association in setting and implementing Clean Water project goals, and it is also helping to determine the history of a significant proglacial lake system that extended from northern Vermont into the lowlands of southern Quebec (Fig. 2).

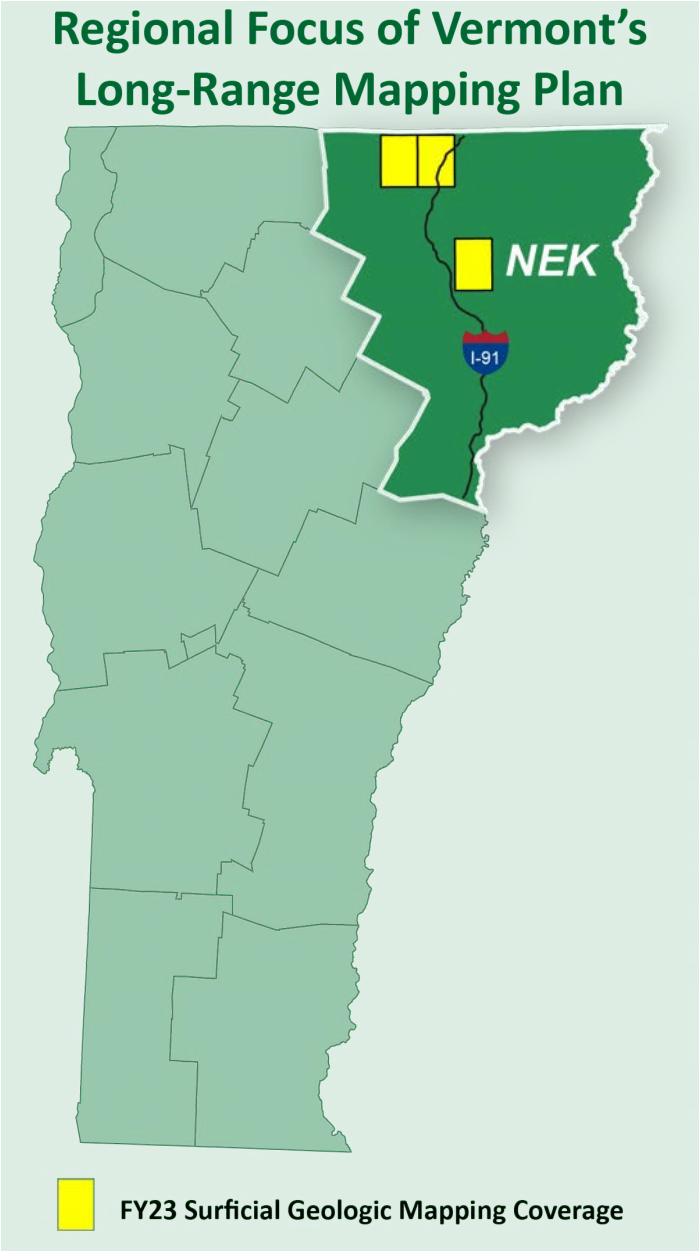

Figure 1. The focus area of Vermont's Long-Range Mapping Plan in the "Northeast Kingdom" of Vermont. The highlighted areas indicate the first 3 mapped quadrangles that have been our focus over the past year.

Bedrock and 3-Dimensional Mapping

As part of our STATEMAP agreement, the VGS is also mapping the bedrock of one quadrangle in the NEK as well as logging borehole geophysical data a on a number of wells to build out the 3-dimensional geologic framework of Vermont's fractured bedrock system. Larger scale mapping is being performed around large farms to help mitigate nitrate contamination in support of Vermont's Agency of Agriculture, Farms, and Markets; around an airport and fire training academy to better understand fate and transport of PFAS in fractured bedrock aquifers; and in areas near small municipalities for detailed aquifer characterization and the pursuit of favorable locations for water supply wells.

Figure 2. A geologist inspects sedimentary structures in a delta deposit in Glacial Lake Memphremagog in Newport, Vermont.

HAZARDS

The VGS has been very active on landslide response. Vermont was significantly impacted by landslide hazards following extreme precipitation events in July 2023 and July 2024, both of which resulted in federal disaster declarations. While we have worked on landslide-related issues for many decades, these storms revealed a magnitude of slope failures that we did not previously know. The VGS responded to over 150 individual requests for landslide hazard assessments in 64 towns primarily located along the corridors of greatest rainfall (Fig. 3) and supported Vermont Emergency Management in technical evaluations for 16 residential buyouts through the Federal Emergency Management Agency. These experiences prompted multiple inquiries into Vermont's landslide hazard susceptibility from homeowners, regional planners, and state lawmakers, particularly with increasing extreme weather events. In response, the VGS applied for and received a grant to perform statewide landslide susceptibility modeling to take a more proactive stance. The VGS added one staff member in 2024 to support our increasing reactive and proactive geologic hazards workload.

DATA PRESERVATION

Data preservation tasks have also been ongoing. We received an award through the USGS National Geologic and Geophysical Data Preservation Program to preserve maps, photographs, and notebooks from retired mappers at Norwich University; maps, cross sections, and lithology information from the Elizabeth Copper Mine in east-central Vermont that were donated in dozens of map folios; and seismic data for dozens of sites collected in the 1970s for environmental geology reports. The wide-ranging geologic data preserved from these sources would be prohibitively expensive to re-collect, and we are excited to serve them out on our website to make them more widely available for future geologic investigations.

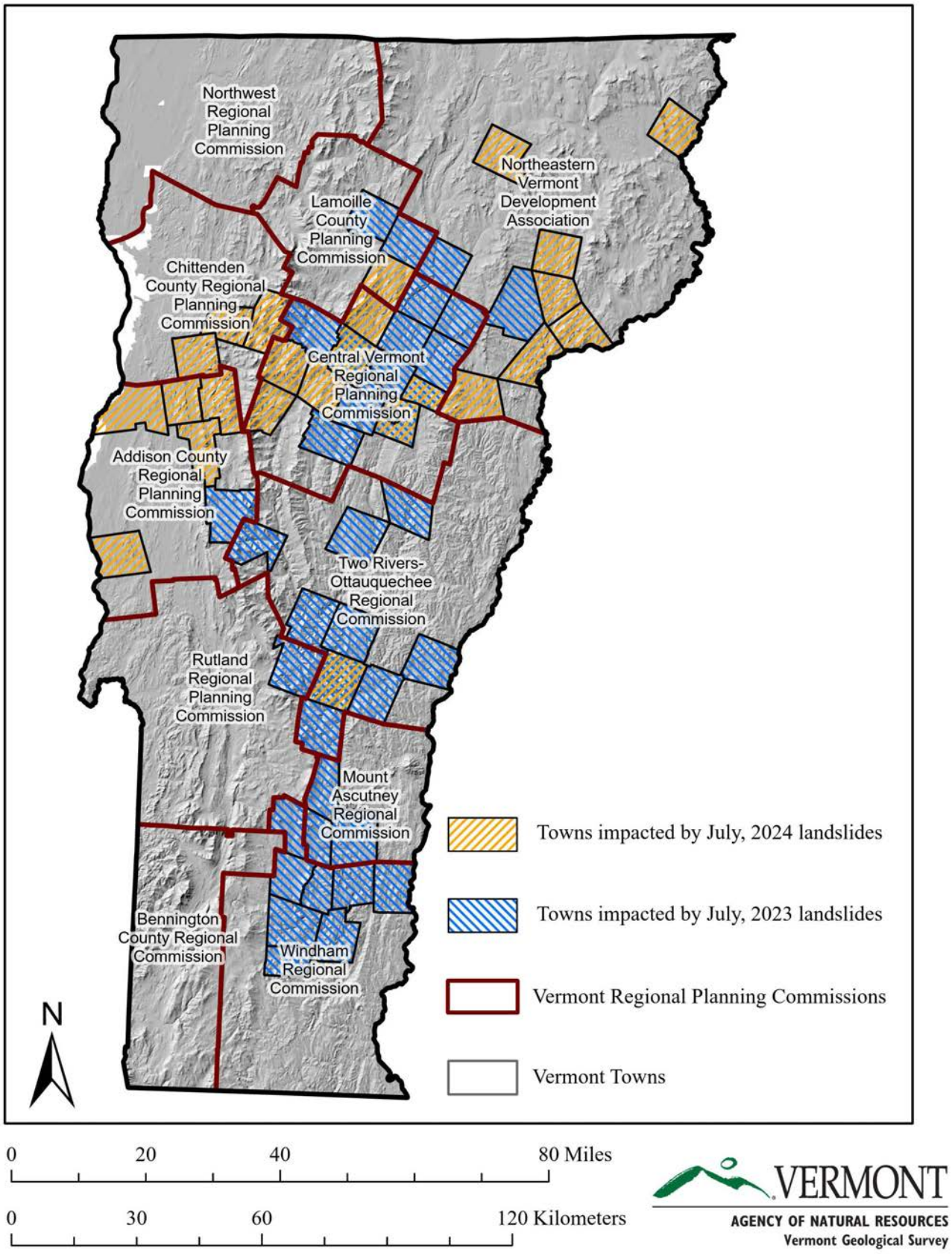

Figure 3. Towns requiring landslide evaluations by the VGS following intense storms in July 2023 and July 2024. These towns fall within 8 of Vermont's 11 Regional Planning Commissions.

VIRGINIA

GEOLOGY AND MINERAL RESOURCES PROGRAM

Department of Energy
Geology and Mineral Resources Program
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INTRODUCTION

The Geology and Mineral Resources Program (GMR) is part of the Department of Energy (DE), a Commonwealth of Virginia agency whose mission is to "lead the Commonwealth to a reliable and responsible energy future." The GMR serves as Virginia's geological survey. Located in Charlottesville, the GMR performs geological and mineral resource investigations aimed at reducing the risk from geologic hazards and encouraging sustainable economic development through the wise use of mineral, land, water, and energy resources. Program staff include sixteen full-time geoscientists, one full-time office manager, and several external contractors. In Fiscal Year 2023, funding for the GMR came from state-appropriated recurring general funds (58%) and federal grants (42%).

Most of the GMR's geologic mapping is conducted under the STATEMAP program, funded by the U.S. Geological Survey's (USGS's) National Cooperative Geologic Mapping Program. Projects are prioritized according to the Program's long-range mapping plan and approved by our Geologic Mapping Advisory Committee, a panel composed of representatives from the mining industry, academia, the consulting community, land-use planners, and state and federal government agencies. Two continuing mapping projects are underway along the Interstate 81 corridor and in the Richmond Metropolitan Statistical Area (MSA). In the past year, the GMR performed new geologic mapping in the Bland, Cedar Springs, Crockett, Long Spur, and Rural Retreat 7.5-minute quadrangles in the Interstate 81 corridor (Fig. 1). In the Richmond MSA, geologic mapping was performed in the Carson, Dabneys, Dinwiddie, and Winterpock 7.5-minute quadrangles. All new mapping in long term mapping areas was at 1:24,000 scale and compiled in ArcGIS Pro using the Geologic Map Schema (GeMS) geodatabase data model. Major map compilation efforts during the year were updating the Virginia portion of the Front Royal 30- x 60-minute quadrangle and the Charlottesville 30- x 60-minute quadrangle and completing 1:100,000-scale geologic mapping to prepare for GeMS compilation of the Dillwyn 30- x 60-minute quadrangle. Lidar data were used to improve bedrock geology and to map surficial deposits and landslides. In addition, we worked towards the completion of the second phase of a karst derivative mapping project along Interstate 81 providing simplified and targeted geologic map information along with lidar-derived sinkhole data.

Rain-induced landslide events continue to be a significant geologic hazard, in terms of potential loss of life and infrastructure. With a Pre-Disaster Mitigation Grant from the Federal Emergency Management Agency, GMR geoscientists continued mapping prehistoric and historic landslides in

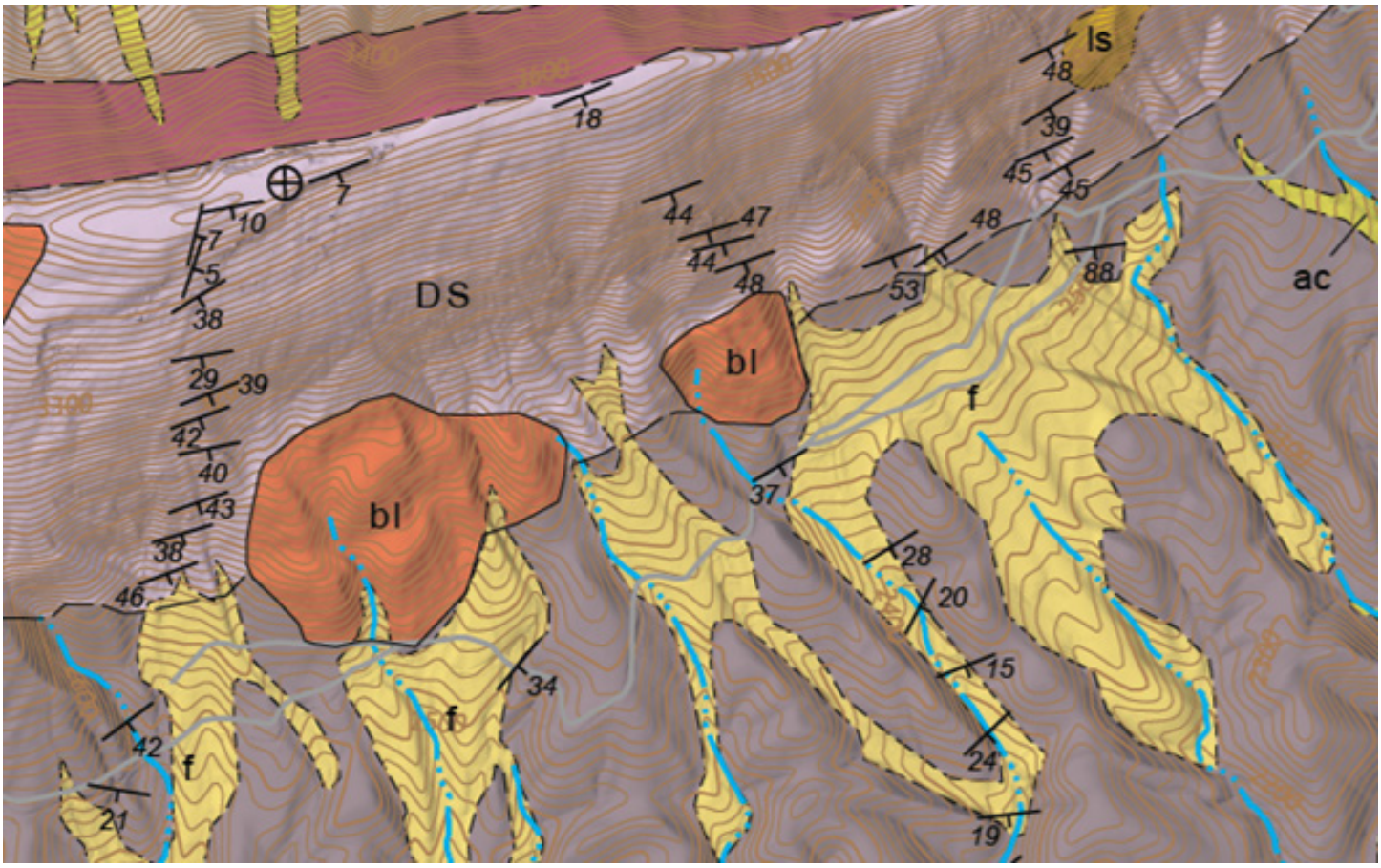

Figure 1. A portion of the Long Spur geologic map completed through the STATEMAP Program, showing large intact block slides on a bedrock dip slope (bl).

Albemarle and Nelson Counties, two of the more populous counties in the Blue Ridge. Our geoscientists continue to work with emergency responders, local government, and the Virginia Department of Emergency Management to update regional hazard mitigation plans to address geologic hazards.

OTHER PROGRAM HIGHLIGHTS

The USGS Earth Mapping Resources Initiative (Earth MRI) provides continuing support for activities conducted by the Applied Geology Section. A second phase of geologic mapping and geochemical investigation of heavy mineral paleo-placer occurrences in the Fall Zone of Virginia was continued during the past year. This project leverages newly available high resolution airborne geophysical data collected in 2021. Mapping and sampling are focused in five 7.5-minute quadrangles in the Fall Zone (Fig. 2), assessing potential source rocks for heavy minerals and heavy mineral sands containing critical minerals in the adjacent Coastal Plain sediments. We also completed an inventory of mine waste stockpiles with critical mineral potential and identified a subset of these sites for future field-based characterization and sample collection.

Virginia Energy completed a project with the U.S. Bureau of Ocean Energy Management (BOEM) to assess the feasibility of extracting economic minerals from sand deposits located on the outer continental shelf (OCS) offshore of Virginia. This study evaluated alternative methods for the separation and recovery of heavy minerals containing critical elements, ideally as an integral part of coastal remediation projects. The Open-file Report is available online.

We collected data for a project funded through the NOAA Coastal Zone Management Program that focuses on identifying and mapping aggregate resources in the Middle Peninsula Planning District of eastern Virginia. This project is designed to identify materials that can be used as part of coastal resiliency projects.

With funding from the USGS through the National Geological and Geophysical Data Preservation Program (NGGDPP), our Applied Geology Section added 16,222 metadata records to our collections, scanned 10,842 images and documents, photographed 1,860 specimens (Fig. 3), and procured 4 museum quality fossil cabinets to ensure preservation of specimens and access to the public, and presented our fossil preservation strategy at the 2022 workshop in Montana. In addition, GMR published the

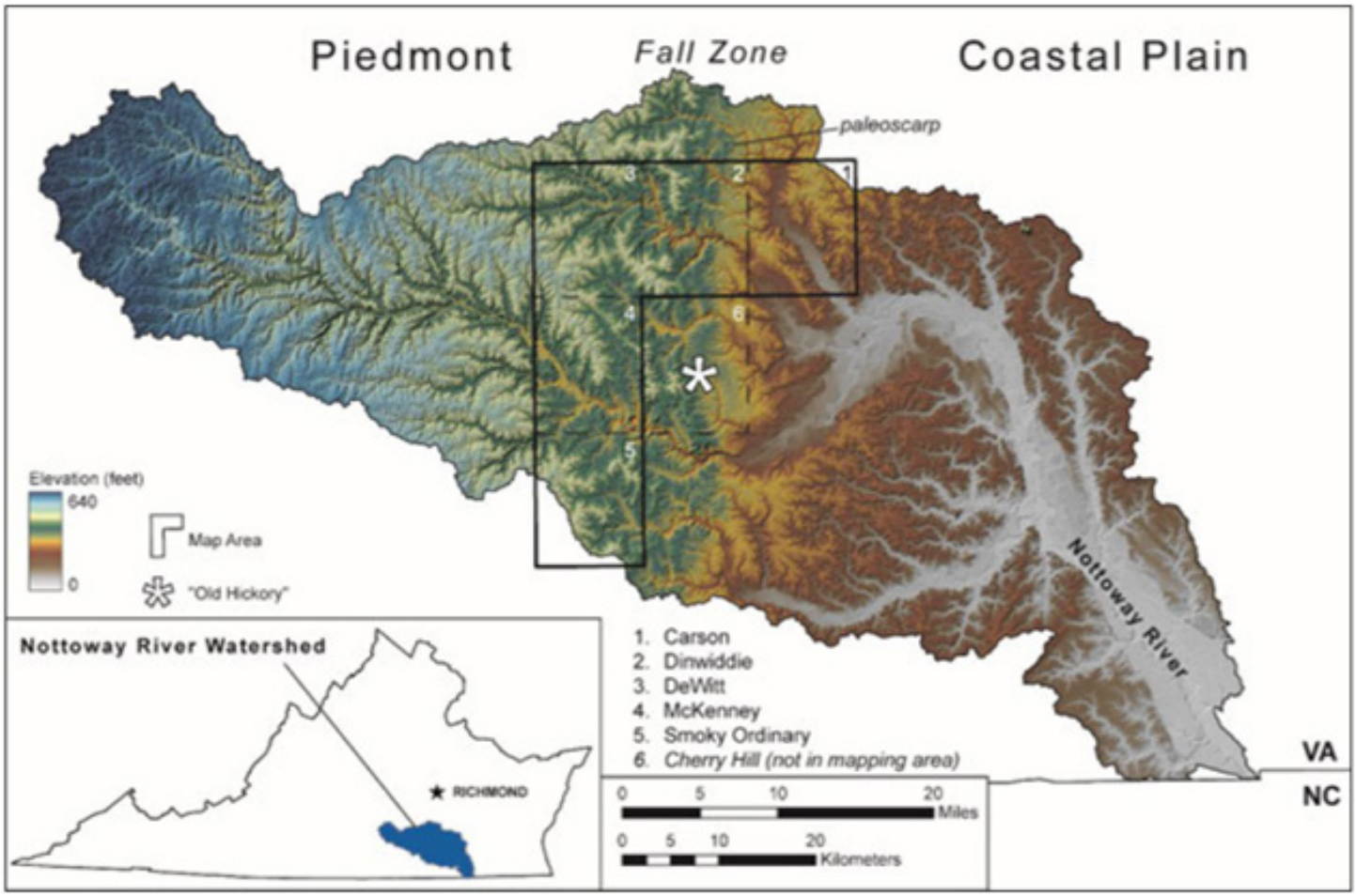

Figure 2. Location for 1:100,000-scale mapping of five 7.5-minute quadrangles in the Earth MRI Virginia Fall Zone Placer Ti-Zr-REE focus area.

Morefield Gem Mine story map, updated our critical mineral webpage series in accordance with our long-range critical mineral preservation strategy, and attended the 2023 Critical Mineral workshop. We are currently working on additional digitization, georeferencing, and GeMS conversion projects as part of our 2023–2025 project.

We have also partnered with Virginia Tech and the federal Department of Energy to assess the potential for carbon mineralization in mafic and ultramafic rocks in the Commonwealth. The goal of the project is to identify source rocks for permanent, leak-free storage of carbon dioxide, while also recovering Ni and Co during the carbon mineralization process. Our geologists have been identifying areas of mafic/ultramafic rocks with the greatest potential for elevated concentrations of Ni/Co, and collecting outcrop samples to provide feedstocks for Virginia Tech.

WASHINGTON

WASHINGTON GEOLOGICAL SURVEY

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WASHINGTON STATE DEPT OF NATURAL RESOURCES
WASHINGTON GEOLOGICAL SURVEY

INTRODUCTION

Since 1890, the Washington Geological Survey (WGS) has provided geological data and services that benefit the people of Washington. The Survey's vision is to foster a safer, more productive, and resilient society that incorporates geology into its regular thought and decision-making processes. WGS is Washington's primary state science agency for earthquake, tsunami, and landslide research; environmental geology; geologic mapping; lidar acquisition; and earth resources. Its mission is to collect, develop, use, distribute, and preserve geologic information to promote the safety, health, and welfare of the people of Washington, protect the environment, and support the economy of the state.

To carry out its responsibilities during the period of July 2023 to June 2024, WGS employed more than 60 full-time staff. The Survey consists of the Geologic Hazards Group (encompassing earthquake and tsunami hazards), the Landslide Hazard Program, the Geologic Mapping Program, the Surface Mine Reclamation Program, the Washington Geology Library, the Washington Lidar Program, the Earth Resource Program, and the Publications Group.

GEOLOGIC MAPPING

The Washington Geological Survey's Geologic Mapping Program is composed of five full-time mappers, three seasonal field assistants, and a mapping supervisor. From July 2023 to June 2024, the team continued its participation in the STATEMAP program, mapping three-and-a-half 7.5-minute quadrangles in Kittitas Valley near Ellensburg, the southeast Puget Lowland near Eatonville, and the Cascade Foothills near Enumclaw. During this period, the group published four quadrangles of new geologic mapping at a 1:24,000 scale in Kittitas Valley and the southeast Puget Lowland. Additionally, an Earth Mapping Resource Initiative project, covering two adjoining 7.5-minute quadrangles in northeast Washington, south of Kettle Falls, was also published.

Several other publications were released, including a new aggregate resources database to accompany an aggregate inventory of Skagit County in the northern Puget Lowland and the North Cascades region. In 2024, in line with STATEMAP grant requirements, WGS began publishing standalone GeMS geodatabases, providing accessible digital geology for the mapping completed during the grant period.

OTHER PROGRAM HIGHLIGHTS

Geologic Hazards

The Geologic Hazards Program released several new tsunami products, including a publication to extend tsunami inundation and current speed maps for a Cascadia subduction zone earthquake scenario up several major rivers in southwest Washington. Other tsunami products released included seven new tsunami evacuation walk time maps and six new tsunami simulation videos for communities on Washington's outer coast. A big achievement this year was the publication of the Survey's Geologic Hazards Clearinghouse, a plan for collection of perishable geologic information following a major natural hazard event in Washington.

The Landslide Hazards Program released a new landslide inventory for parts of two counties in the Columbia Gorge. The Program completed three post-wildfire debris flow assessment rapid reports, documenting potential landslide hazards in areas recently burned by wildfires. The Program also developed a dashboard providing information on post-wildfire debris flows.

Earth Resource Program

In 2024, the Washington Legislature passed ESSB 6039, which, among other things, charted a new path for geothermal research in Washington. Priority work under this law will guide the next several years of Program staff time, including t he addition of a new geothermal geologist and the development of a new Subsurface Program. New work will include geophysical and geochemical characterization of high-priority play areas to delineate accessible resources and the risk for induced seismicity. Aside from geothermal, Program staff completed a groundwater geochemistry investigation of the Columbia Basin for publication in 2025 and will continue 3D seismic investigations in the Columbia Basin for carbon sequestration targets, building on ongoing and new partnerships in funded carbon storage programs, such as CUSP, ARPA-E Miner, Ankeron DAC Hub, CaRBTAP, TrapRock, and Grays Harbor CarbonSAFE.

Washington Lidar Program

Bathymetric lidar continues to be an increasingly important collection method for partners and the state alike. The Program worked with partners to collect three different river systems, with two integrating sonar data with lidar data for more complete bathymetric coverage. The Lidar Program also became a subrecipient for a NOAA Climate Resilience Regional Challenge grant and will be collecting bathymetric data for six river systems in the state over the next few years.

Wide-area collection continued with several large projects, including two USGS 3DEP projects in the eastern portion of the state that concluded in late 2024. A state-led collection over 6,800 square miles began in Fall 2023 that targets full county-wide collections in multiple regions of the state to start a lidar recollection plan. With this collection, six full counties will be fully re-collected with new, consistent, high-quality lidar data.

Publications

The Publications Group worked with other programs across the Survey to update several databases, including a major update to the Subsurface Database with data compiled as

part of a National Geological and Geophysical Data Preservation Program (NGGDPP) grant. The Group also released a new Data Preservation website providing access to a large collection of scanned historical photographs, coal mine maps, field notebooks, and thin sections. A new interactive map was produced that provides easier access to published geologic maps in PDF or image form, including search functionality and the ability to view mapping at all available scales in one interactive tool.

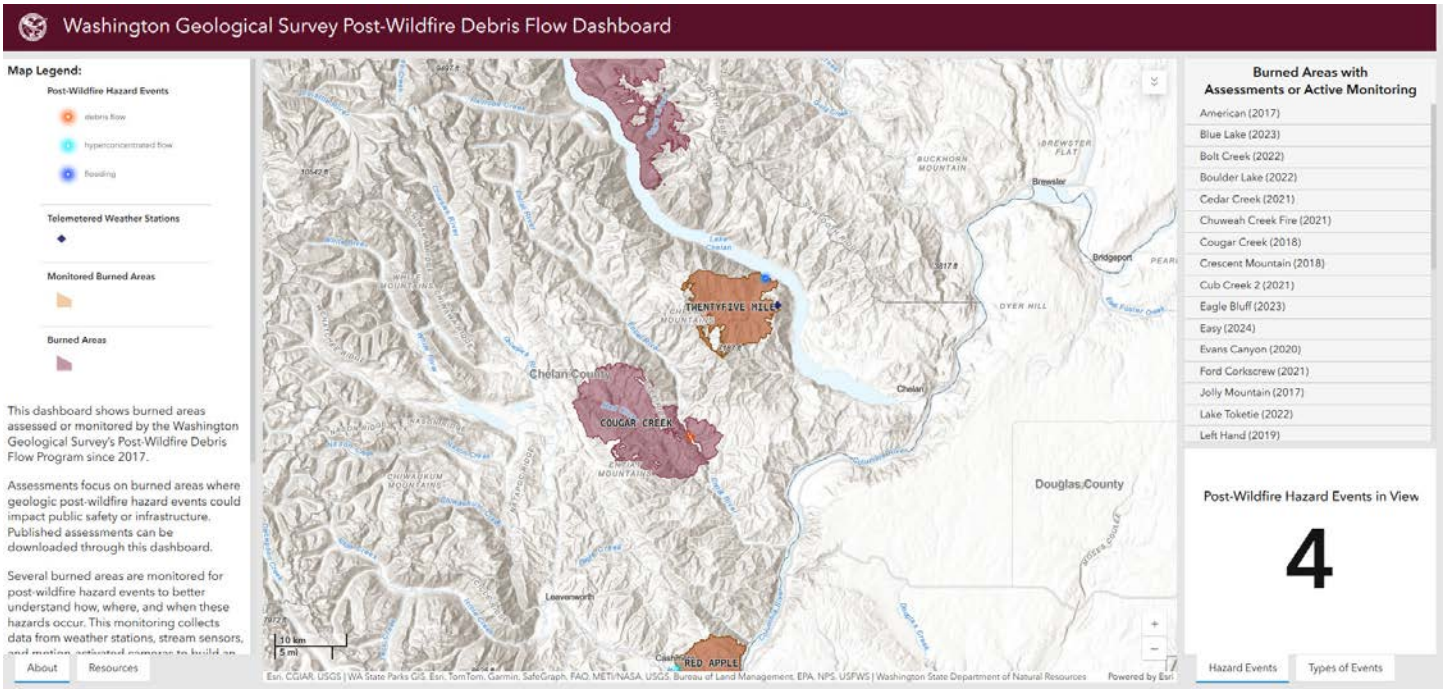

Figure 2. A dashboard for the Survey's post-wildfire debris flow hazard assessment work.

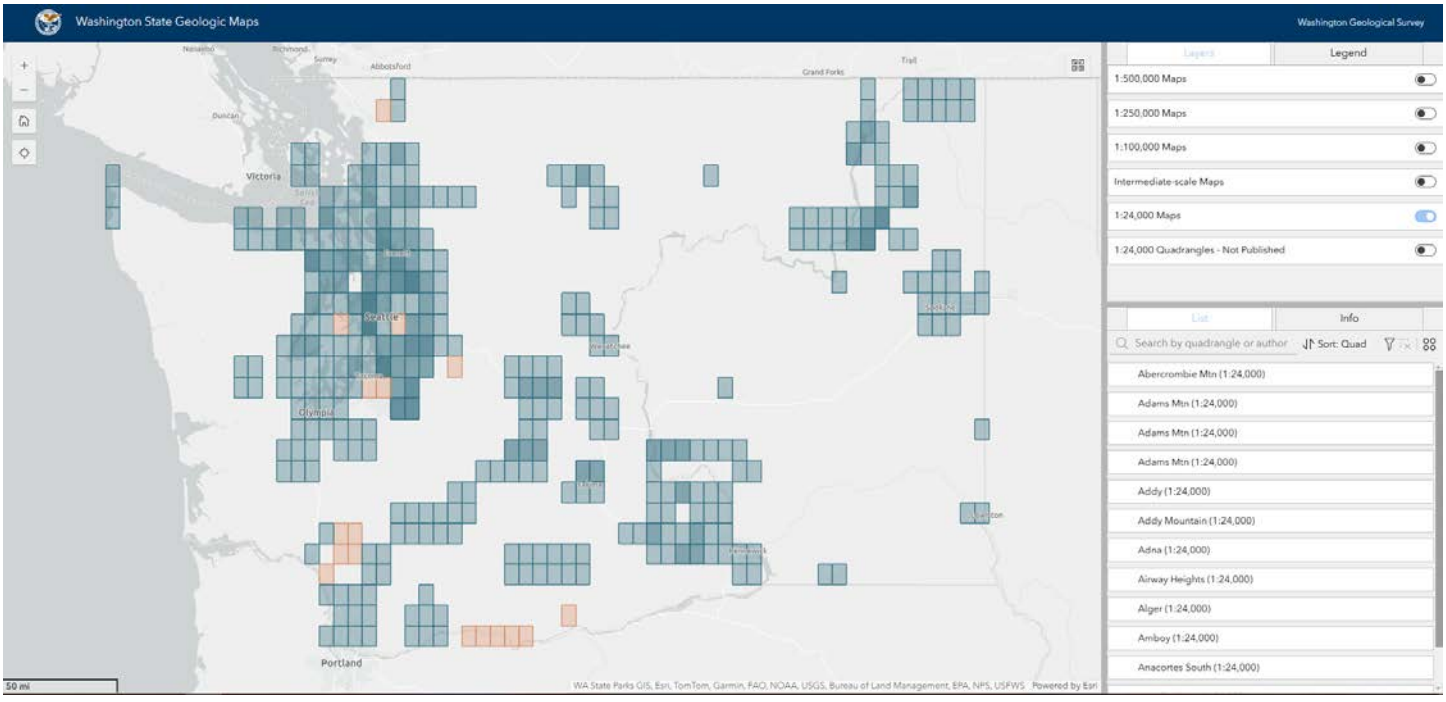

Figure 3. A new interactive tool providing access to map sheets for available published geologic mapping in Washington.

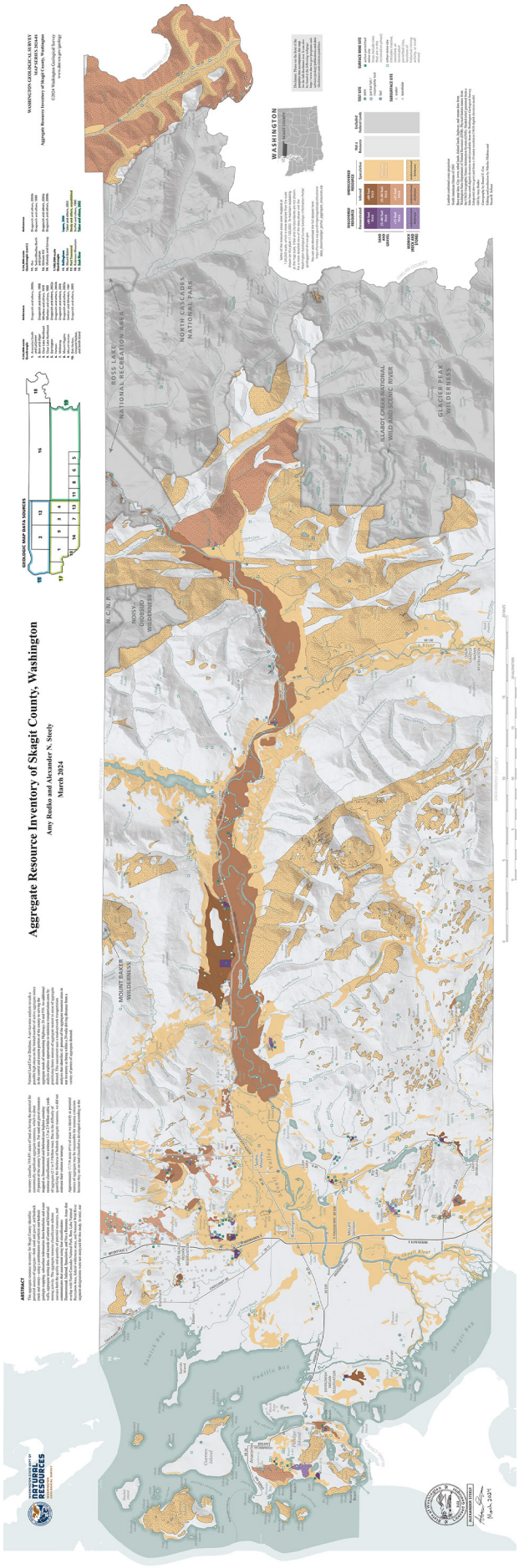

Figure 1. Map sheet for an aggregate inventory of Skagit County in northern Washington.

WISCONSIN

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

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Wisconsin Geological and Natural History Survey
DIVISION OF EXTENSION
UNIVERSITY OF WISCONSIN–MADISON

INTRODUCTION

The Wisconsin Geological and Natural History Survey (WGNHS), part of the Division of Extension at the University of Wisconsin–Madison, is an interdisciplinary organization that conducts natural resource surveys and geological research to produce information used for decision-making, problem-solving, planning, management, development, and education. WGNHS was created by the Wisconsin Legislature in 1897, with earlier state geological surveys in Wisconsin dating back to 1854. Our primary office is in Madison, and our Core Repository (Research Collections and Education Center) is nearby in Mount Horeb. During the past year, the WGNHS employed 30 geologists, hydrogeologists, GIS specialists, and support personnel, plus about 20 students.

In 2023–2024, the WGNHS engaged in a variety of efforts designed to better understand the geology, environment, and hydrogeological issues facing Wisconsin. Projects involved statewide mapping of Quaternary geology and depth to bedrock; statewide groundwater monitoring; geologic, geomorphologic, and hydrogeologic mapping at the county level; and analysis of groundwater-surface water interactions. Work was conducted in collaboration with county and local governments and federal and state partners, including the U.S. Geological Survey, U.S. Forest Service, Wisconsin Department of Natural Resources, and Wisconsin Department of Agriculture, Trade, and Consumer Protection.

GEOLOGIC MAPPING

WGNHS published six 1:24,000-scale geologic maps in the historic Lead-Zinc Mining District of Wisconsin. The maps include the Fennimore, Mt. Hope, Stitzer, and western half of the Montfort 7.5-minute quadrangles in Grant County, and the Highland West and Highland East quadrangles in Iowa County. The mapping areas were chosen to assess small-scale bedrock structures and mineralization associated with the mining district. Also in 2023-24, the Grant County maps, along with earlier WGNHS publications and historic U.S. Geological Survey (USGS) maps, were compiled into a county-wide 1:100,000-scale bedrock geologic map. This map, which is currently in press, was constructed as a fully three-dimensional product, with supplementary data that include raster datasets.

The WGNHS published a 1:100,000-scale bedrock geologic map for Jefferson County. In this part of southeastern Wisconsin, bedrock is mostly buried by glacial deposits and comprises folded Precambrian rocks overlain by east-dipping Cambrian-Ordovician siliciclastics and carbonates. Ongoing derivative mapping, including depth-to-bedrock, depth-structure, and isopach maps, will complement the geologic map, be useful as inputs to groundwater models, and inform land-use decisions by providing information on the thickness and characteristics of the buried bedrock layers (Fig. 1).

Also published in 2023–2024 is the Durwards Glen 7.5-minute quadrangle map, located in Columbia and Sauk counties and including the eastern Baraboo Hills—a focus of research and geoscience education for almost two centuries. The map area includes Precambrian through Quaternary units. New mapping focused on subdividing the Baraboo Quartzite into four separate members and delineating Quaternary deposits in greater detail than prior work.

Geologic Map of the Fennimore and Mount Hope 7.5-Minute Quadrangles, Grant County, Wisconsin, WGNHS Open File Report 2023-04

Geologic map of the Stitzer and western part of the Montfort 7.5-minute quadrangles, Grant County, Wisconsin, WGNHS Open File Report 2023-03

Geologic Map of the Highland West and Highland East 7.5-Minute Quadrangles, Grant and Iowa Counties, Wisconsin, WGNHS Map 510

Bedrock Geology of Jefferson County, Wisconsin, WGNHS Map 511

Geologic Map of the Durwards Glen 7.5-Minute Quadrangle, Columbia and Sauk Counties, Wisconsin, WGNHS Open File Report 2024-02

WGNHS Quaternary geologists made significant progress on the compilation of a statewide 1:500,000-scale surficial map of Wisconsin. This will be an entirely new product in our mapping inventory, with entirely new linework tuned to the scale. The map is currently in press, with publication planned for early 2025. Two publications were released in 2023–2024 including a Quaternary geologic map of Waupaca County and an Educational Series entitled, The Driftless Area: The extent of unglaciated and similar terrains in Wisconsin, Illinois, Iowa, and Minnesota. This pamphlet was a collaborative effort between the four neighboring state geological surveys. It describes and outlines the boundary of the unglaciated Driftless Area based on modern geologic evidence (Fig. 2).

Quaternary Geology of Waupaca County, Wisconsin, WGNHS Map 509

The Driftless Area: The extent of unglaciated and similar terrains in Wisconsin, Illinois, Iowa, and Minnesota, WGNHS Educational Series 057

OTHER PROGRAM HIGHLIGHTS

Wisconsin Groundwater–Level Monitoring Network.

The WGNHS continues to participate in the Wisconsin Groundwater–Level Monitoring Network with support from the USGS National Ground-Water Monitoring Network program. Working in close coordination with our network

partners at the USGS Upper Midwest Water Science Center and the Wisconsin Department of Natural Resources, WGNHS staff installed 6 new monitoring wells and instrumented 15 wells to monitor groundwater levels more continuously and to see smaller changes that occur daily or even hourly in response to precipitation, evapotranspiration, and pumping withdrawals.

Depth to Bedrock Mapping for Groundwater Protection

WGNHS completed depth-to-bedrock (DTB) mapping in northeastern Wisconsin where the Silurian-aged, fractured carbonate bedrock creates an aquifer that is vulnerable to contamination. Revisions to Wisconsin state rules to regulate manure spreading over shallow bedrock prompted the need for the map. Data for the mapping included airborne electromagnetics collected by helicopter flight via SkyTEM Canada Inc. in collaboration with the United States Geological Survey in 2021. The WGNHS created the map using Empirical Bayesian Kriging with Regression Prediction. We first modeled the bedrock elevation and then estimated DTB by subtracting the bedrock elevation surface from land surface. Applying these geostatistical techniques to the novel subsurface data allowed the WGNHS project team to generate a DTB map for the Silurian dolomite in Wisconsin with higher resolution and more accuracy than previous efforts. The map is currently in press, with publication planned for early 2025.

Groundwater-Surface Water Interactions

The WGNHS published an inventory of flowing artesian wells in Bayfield County, on the south shore of Lake Superior, as a WGNHS open-file report in early 2024. The report compiles well characteristics and flow rates, provides baseline water quality data, and describes water sources to the flowing wells. The information from this study will be used by the county to establish protection zones that will be incorporated into a county zoning ordinance.

Inventory and Analysis of Flowing Artesian Wells in Bayfield County, Wisconsin, WGNHS Open File Report 2024-01

WGNHS hydrogeologists continued several groundwater studies in the nearby Chequamegon-Nicolet National Forest. They continue to monitor lake level and water quality trends at Pigeon Lake and surrounding seepage lakes in Bayfield County. Pigeon Lake experienced extreme flooding in 2018. Lake levels are dropping steadily but remain high. In the next year, field data will be incorporated into a groundwater flow model, which is intended to inform the lake system's response to future climate scenarios. The

Figure 1. WGNHS geologists box drill core from Jefferson County. Photo Credit: Shazwan Hamid

WGNHS also continued a project along the North Fork of the Yellow River in Taylor County to improve understanding of the local hydrogeology and to document baseline water chemistry. This project addresses a need for local hydrogeological characterization in the immediate vicinity of the Bend Copper-Gold Deposit where there has been a history of proposed mineral exploration and mining.

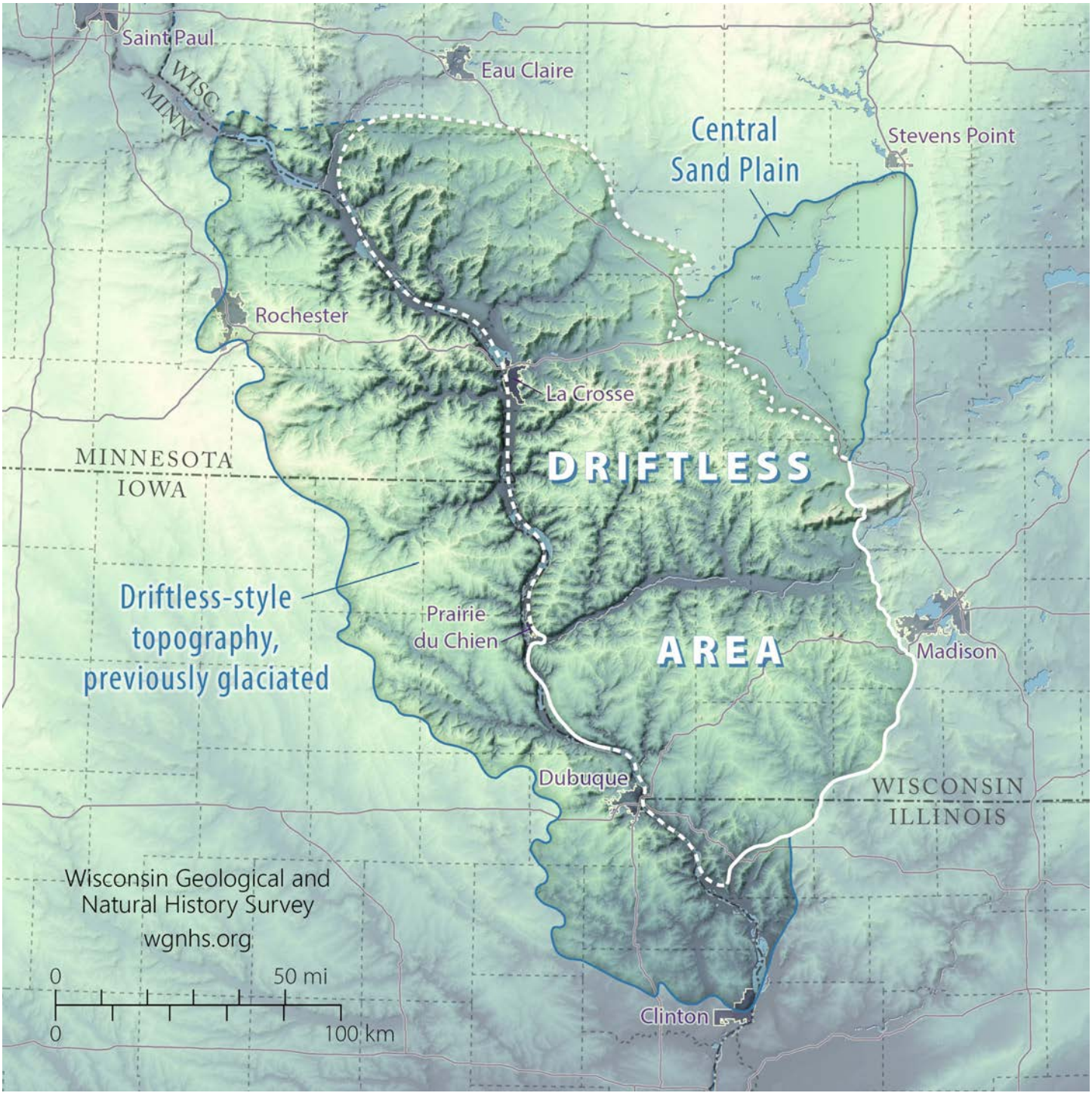

Figure 2. Extent of the unglaciated Driftless Area in southwestern Wisconsin and northwestern Illinois, and similar landscapes that were glaciated in adjacent areas of Minnesota and Iowa. From the WGNHS Educational Series publication "The Driftless Area" authored by Eric Carson and collaborators, published in 2023.

WYOMING

WYOMING STATE GEOLOGICAL SURVEY

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WSGS
Exploring the Past, Empowering the Future

INTRODUCTION

The mission of the WSGS is to promote the beneficial and responsible use of Wyoming's vast geologic, mineral, and energy resources while helping to protect the public from geologic hazards. By providing accurate information and expanding knowledge through the application of geologic principles, the WSGS contributes to the economic growth of the state and improves the quality of life of Wyoming's residents.

The WSGS works to (1) study, examine, and understand the geology, mineral resources, and physical features of the state; (2) prepare, publish, and distribute (free or for sale) reports and maps of the state's geology, mineral resources, and physical features; and (3) provide information, advice, and services related to the geology, energy and mineral resources, hazards, and physical features of the state.

GEOLOGIC MAPPING

Interactive Online Maps

Mineral Resources Map: The Wyoming State Geological Survey (WSGS) has developed a new interactive map that will make it easier to research the state's extensive mineral resources. The map is an update and expansion of the WSGS's 2018 Mines and Minerals map. New features include an interactive index of downloadable uranium logs, and locations of geochemistry results from reports and STATEMAP projects. External information detailing current mining, such as Wyoming Department of Environmental Quality active mines layers, and federal and state mineral leases have also been added. Also included are several statewide minerals maps published by the WSGS that have been made interactive and a series of layers showing study areas for WSGS mining district publications.

Radon Map: The Wyoming State Geological Survey recently added new layers to its interactive Wyoming Geologic Hazards Map, making it easier to visualize radon potential throughout the state. Radon is a colorless, odorless, and tasteless radioactive gas that can build up to hazardous concentrations in enclosed spaces. Exposure to radon over time can cause lung cancer, and it is the second leading cause of the disease in the United States. Radon gas comes from the natural decay of uranium, and it can emit from rock, soil, and groundwater. The radon layers displayed on the WSGS online map show locations where radon occurrence may be elevated due to geologic conditions. These layers were created using data from a previous WSGS publication and observation statistics provided by the Wyoming Department of Health.

Airborne Geophysical Surveys

Central Wyoming Airborne Geophysical Survey Data Release: Magnetic and radiometric data over central Wyoming, from South Pass at the southern end of the Wind River Range and over the Granite Mountains to west of Pathfinder Reservoir, were released in Fiscal Year 2024. The purpose of the survey is to support mapping to and understand the regional geology and mineralization of central Wyoming. The region is known for historic and current mineral exploration, and there are several areas that are of high interest for their mineral potential. This region also has incompletely understood earthquake hazards.

Covering more than 3,300 square miles, the new geophysical survey uses the latest technological developments that will allow scientists to develop high-resolution three-dimensional representations of geology to depths over 3,200 feet (1 kilometer) below the surface. The 3D models and maps produced from the survey will help understand the distribution of groundwater, mineral and energy resources, as well as the potential for natural hazards.

OTHER SELECT PUBLICATIONS

Critical-Mineral-Bearing Paleoplacers in the Basal Cambrian Flathead Sandstone and Other Radioactive Conglomerates, Wyoming

This report is a preliminary look at the critical mineral potential of various radioactive conglomerate deposits throughout Wyoming. While the report focuses on new geochemical data for monazite-bearing paleoplacers in the 500-million-year-old Flathead Sandstone, it also investigates similar deposits as old as 2.5 billion years in the Medicine Bow Mountains and Sierra Madre, and as recent as 50 million years in the Shirley Basin.

Upper Cretaceous Fossil Beach Placers of Wyoming: Geochemistry, Mineralogy and Economics

This study examines critical mineral potential of sandstones rich in heavy minerals that were deposited along the shore of the Cretaceous Western Interior Seaway that covered Wyoming about 80 million years ago. These ancient beach placers can contain as much as 90 percent heavy minerals, mostly altered titanium-bearing minerals of low value, such as titanohematite. Rare-earth-element-bearing monazite is common in some deposits described in the report, alongside elevated thorium concentrations.

Helium Public Information Circular

Wyoming is one of the largest producers of helium in the world—all of it a by-product of natural gas production in the LaBarge-Big Piney area of Sublette County. This publication covers helium production, the federal helium program, the global helium market, and helium occurrences in the state. Accompanying the circular is a dataset of natural

gas compositions sampled from oil and gas wells across the state. Analyses are compiled from the U.S. Geological Survey, U.S. Bureau of Mines, Bureau of Land Management, and Wyoming Oil and Gas Conservation Commission.

2023 Oil and Natural Gas Summary Report

This annual summary report by the WSGS offers a brief synopsis of the state's oil and natural gas industry in 2023. This summary also includes information on pore space and carbon capture, use, and storage (CCUS). The report provides a brief overview of the geology of carbon capture and storage, the legal framework, planned CCUS projects in Wyoming, as well as several links for additional CCUS-related resources.

2023 Uranium Summary Report

Improved uranium prices, combined with growing support for nuclear energy as well as geopolitical events, boosted interest in U.S. uranium last year. This is good news for Wyoming, which holds the largest-known economic uranium ore reserves in the United States. With the positive shift, uranium companies have refocused on Wyoming mines by increasing staff, expanding facilities, and investing in additional exploration. This report summarizes historical production, global and national impact on uranium production, and the prospect for future uranium production across the state.

Geology of South Pass Area Information Pamphlet

This pamphlet explores South Pass, an area known for its rich history of mining. The pamphlet is the twelfth in a series that shares geology of Wyoming state parks, but the South Pass publication is the first to focus on a state historic site. South Pass has a wide range of known and potential mineral resources, such as gold, copper, and iron. The pamphlet includes a geologic map and provides an overview of South Pass's geologic history.

Figure 1. Helicopters staged for airborne geophysical data collection in central Wyoming. *Photo by Ben Drenth, USGS.*

AWARDS

FRYE AWARD

The 2023 John C. Frye Environmental Geology Award is presented to the Geological Survey of Alabama for "An Aquifer Recharge Potential Model for Alabama" by Gregory M. Guthrie, Mary Hastings Puckett, and Gary A. Hastert. This was published as Geological Survey of Alabama Bulletin 192 in 2022.

MANKIN AWARD

The 2023 Charles J. Mankin Memorial Award for work in energy and mineral resources is presented to the Oklahoma Geological Survey for "Woodford Shale (Upper Devonian to Lower Mississippian): From Hydrocarbon Source Rock to Reservoir" by Brian Cardott and John Comer. This was published as Oklahoma Geological Survey Bulletin 152 in 2021.

PICK AND GAVEL AWARD

The Pick and Gavel Award was first awarded by the Association of American State Geologists in 1999. The purpose of the award is to honor people who have made significant contributions to advancing the role of geoscience in public policy and who have supported AASG's goals in government affairs.

The image etched into the award symbolizes its meaning: the geologist's pick; a trademark of the geological enterprise; the gavel signifying the governmental deliberative process; and the nation's Capital where the two come together in formulating informed public policy. The message of the award is completed by a mounted, one-of-a-kind rock specimen symbolizing the Earth, of which we must all be responsible stewards. The rock specimen on the 2024 award is from the central ore zone of the Butte Mining District in Butte, Montana. The specimen is the essence of the Butte Mines: chalcopyrite surrounded by covellite and bornite – all high-grade copper ores that contributed to the success of Montana as well as the United States for more than 120 years.

The 2024 Pick and Gavel Award was presented to Montana Senators Jon Tester and Steve Daines for their widely known spirit of bipartisanship. The routinely worked together on legislation related to water conservation, tribal issues, and Federal land management.

U.S. Senator Jon Tester is a third-generation Montana farmer, a proud grandfather, and a former school teacher. The Senator and his wife still farm the same land near the town of Big Sandy, Montana that was homesteaded by Jon's grandparents in 1912. Jon was elected to the Montana Senate in 1998 and to the US Senate in 2006, 2012, and 2018. The Senator is Chairman of the Senate Veterans Affairs Committee and Chairman of the Senate Appropriations Subcommittee on Defense. He also serves on the Senate Banking Committee, the Senate Commerce Committee, and the Senate Committee on Indian Affairs.

Senator Steve Daines is a fifth-generation Montanan from Bozeman; he attended Montana State University from which he earned a B.S. in Chemical Engineering. The Senator brings 28 years of private-sector business that included a management for Procter & Gamble, construction business, and VP at RightNow Technologies, a Bozeman-based cloud computing start-up company that was eventually acquired by Oracle in 2012 and remains one of Montana's largest commercial employers. Senator Daines Steve was first elected to serve as Montana's United States Representative in 2012 and represented Montana's at-large congressional district in the U.S. House of Representatives from 2013 to 2015. In 2015 he was elected to serve as the junior United States senator from Montana and presently serves on Senate Finance Committee, the Senate Committee on Banking, Housing and Urban Affairs, the Senate Energy and Natural Resources Committee, and the Senate Indian Affairs Committee.

DISTINGUISHED SERVICE AWARD

Vicki Cowart was State Geologist of Colorado, 1992–2003; AASG Past President, 2002–2003; President, 2001–2002; President Elect, 2000–2001; Vice President, 1999–2000; Treasurer, 1999–2000; Annual Meeting Host, 1997; Statistician, 1996–1999.

Nelia Dunbar was State Geologist of New Mexico, 2016–2023; Secretary, 2018–2023.

Rich Ortt, Maryland was State Geologist of Maryland, 2013–2023; Past President, 2020–2021; President, 2019–2020; President Elect, 2018–2019 Vice President, 2017–2018.

Harvey Thorleifson was State Geologist of Minnesota, 2003–2023; Acting Secretary, 2022; Treasurer, 2017–2020; Past President, 2013–2014; President, 2012–2013; President Elect, 2011–2012; Vice President, 2010–2011; Treasurer, 2008–2010; Statistician, 2006–2009.

Scott Tinker was State Geologist of Texas, 2000–2023; Past President, 2007–2008; President, 2006–2007; President Elect, 2005–2006; Vice President, 2004–2005; Annual Meeting Host, 2012

PRESIDENTIAL AWARD

The AASG Presidential Award is presented by the AASG President to particularly helpful, constructive, and worthy members or friends of AASG for extraordinary service to the objectives of AASG. In 2022, AASG President John Metesh presented AASG Presidential Awards to David Wunsch (State Geologist of Delaware) and Kevin Gallagher (Assistant Director, USGS Core Science Systems).

David Wunsch has served AASG in many official capacities, but his routine engagement on all aspects of AASG and its mission has been especially commendable.

Kevin Gallagher readily engaged AASG members and the Executive Committee to support and expand the National Cooperative Mapping Program; his efforts greatly improved the relationship and demonstrated "good government".

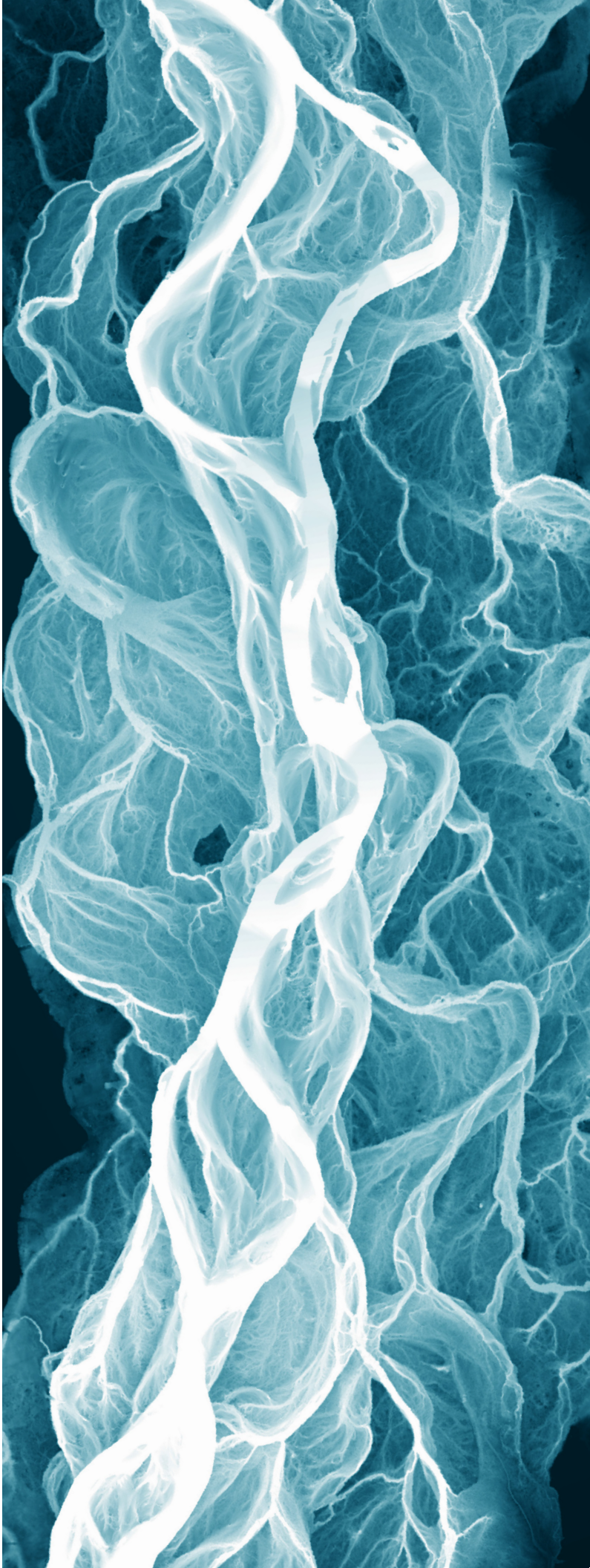
ADDITIONAL AWARDS

Ian Campbell Medal

The 2024 Ian Campbell Medal was awarded to David Wunsch

Heroy

The Institute gave the 2024 Heroy Award to David Curtiss and Susan Sullivan



Lidar-derived image of the Suak River, Washington. Credit: Daniel Coe, Washington Geological Survey.