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Airborne Geophysics in Wyoming: Methods for Exploring Subsurface Geology

Christopher J. Doorn and Natalie Y. Carter

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WYOMING STATE GEOLOGICAL SURVEY

Airborne Geophysics in Wyoming: Methods for Exploring Subsurface Geology

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Cover photograph: Helicopter with visible magnetometer landing at the Rawlins Municipal Airport.

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Data-collection helicopters in the hanger at the Rawlins Municipal Airport. Photo: Benjamin Drenth

OVERVIEW

Wyoming's unique geology hosts an array of mineral resources, from hydrocarbons and uranium to rare earth elements and precious metals. Many of these resources have been mined for over a century. However some mineral deposits are difficult to access or are hidden beneath the surface, meaning the surrounding geology remains poorly understood.

Layers of soil and sedimentary rock, known as overburden, often obscure the underlying geology and potential mineral resources. Airborne geophysical surveys provide a cost-effective way to collect data on the physical properties of rocks across large areas. This information helps geologists understand subsurface geology that cannot be directly observed. These surveys often use magnetic and radiometric methods to investigate mineral deposits, variation in bedrock geology, and surficial geologic processes, while also assisting in geologic mapping.

The Wyoming State Geological Survey (WSGS), in collaboration with the U.S. Geological Survey (USGS) and private industry, has planned, funded, and facilitated airborne geophysical data collection across central, southeast, and north-east Wyoming. Figure 1 shows the locations of completed, ongoing, and planned geophysical surveys, with data collection beginning in 2023. Table 1 outlines their status and coverage. The geophysical data resulting from these surveys will help the State of Wyoming and private industry better assess mineral resources and geologic hazards over a large portion of the state.

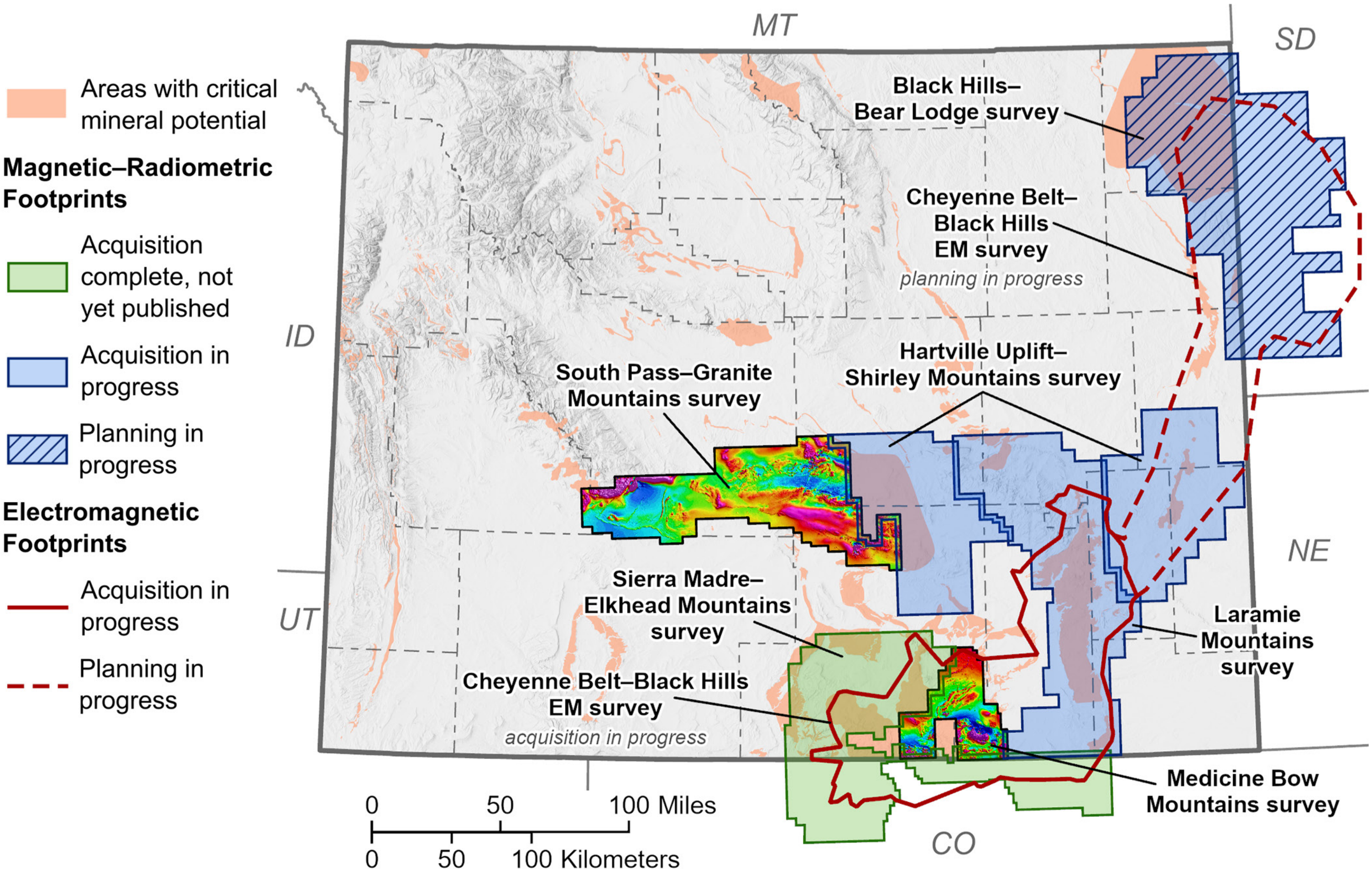

Figure 1. Locations of recent, ongoing, and planned geophysical surveys in Wyoming. Except for the Cheyenne Belt–Black Hills electromagnetic (EM) survey, all surveys focus on collecting magnetic and radiometric data. Total magnetic field anomaly maps are shown for the two completed and published surveys. The remaining outlined and shaded areas are the footprints of ongoing and planned geophysical surveys. Orange shading indicates areas with critical mineral potential (Dicken and others, 2022).

Table 1. Parameters for recent, ongoing, and planned geophysical surveys in Wyoming.

Geophysical Survey	Status	Area (km^2)	Flight line distance (km)
South Pass–Granite Mountains	Completed, data released 2/14/2024	8,639	47,974
Medicine Bow Mountains	Completed, data released 8/21/2024	2,710	16,400
Sierra Madre–Elkhead Mountains[a,b]	Data processing in progress	6,800	37,600
Laramie Mountains[a]	Data acquisition in progress	12,900	71,200
Hartville Uplift–Shirley Mountains[a]	Data acquisition in progress	14,900	82,500
Black Hills–Bear Lodge[a,b]	Planning in progress	7,100	39,000
Cheyenne Belt–Black Hills[a,b,c]	Planning in progress	26,600	–

[a] The proposed survey parameters are provisional and subject to revision upon completion of the planning process or the data release.
[b] Survey areas and estimated flight line distances reflect portions of geophysical surveys within Wyoming.
[c] Electromagnetic survey. All others are magnetic and radiometric surveys.

AIRBORNE GEOPHYSICAL SURVEYS FOR CRITICAL MINERAL EXPLORATION

The primary goal of collecting high-quality geophysical data in Wyoming is to establish a publicly available, high-resolution dataset to support critical mineral exploration. Critical minerals are elements and minerals essential for national security and manufacturing. Many of these materials are imported from foreign nations and are vulnerable to supply chain disruptions. As of this writing, the U.S. Department of the Interior lists 50 critical minerals, with the list updated every three years (see "Helpful Links" below; U.S. Geological Survey, 2022). These materials span a wide range of elements across the periodic table, including rare earth elements, platinum group elements, base metals, and non-metals. They are essential for modern technology, like smart phones, batteries, and vehicles.

A variety of rock types across Wyoming have the potential to host critical mineral deposits (orange areas, fig. 1). These include the ancient Precambrian crystalline cores of Wyoming's mountains (e.g., Webber and others, 2022), Phanerozoic sedimentary formations (e.g., Lichtner and others, 2023a, b), and Paleogene-aged alkaline igneous complexes (e.g., Hutchinson and others, 2022). Further exploration is required to determine which locations contain viable critical mineral resources and to accurately map their distribution within these geologic settings.

The diverse range of critical elements occurs in various types of ore deposits. Different types of deposits have distinct physical characteristics that produce detectable signals in geophysical surveys. Two commonly employed methods are airborne magnetic and radiometric surveys.

Magnetic surveys record the total magnetic intensity for a survey area, making them particularly effective for locating critical mineral deposits associated with magnetite-rich formations. For example, mafic magmatic deposits often contain zones enriched in sulfide and oxide minerals, which can host critical minerals such as titanium, vanadium, and platinum group elements (Latypov and others, 2024). Because these igneous bodies also tend to contain large amounts of magnetite, they often appear as prominent anomalies in airborne magnetic survey data.

Radiometric surveys measure gamma rays naturally emitted by the radioactive decay of potassium, thorium, and uranium. These surveys are particularly useful for identifying surface-exposed mineral deposits. Rare earth elements, a group of 17 elements ranging from lanthanum to lutetium and including scandium and yttrium, commonly occur in minerals like monazite and allanite that often contain the radioactive element thorium. When thorium-bearing rare earth element deposits are exposed at the surface, they can appear as areas with elevated thorium concentrations in radiometric survey maps (e.g., Wang and others, 2023). Radiometric data are particularly valuable for critical mineral exploration in Wyoming due to ongoing interest in rare earth element mineralization in the Laramie Mountains (southeast Wyoming) and the Bear Lodge Mountains (northeast Wyoming).

IMPORTANCE OF PUBLICLY AVAILABLE AIRBORNE GEOPHYSICAL DATA

Recent and ongoing geophysical surveys jointly organized by the WSGS and USGS are the first high-quality, publicly available surveys of their kind in Wyoming. Airborne magnetic surveys are classified from rank 1 to rank 5; as data quality increases, the rank number decreases (Drenth and Grauch, 2019). Low-resolution, rank 5 magnetic data are available across all of Wyoming, and intermediate-resolution rank 4 to rank 2 data cover sporadic patches of the state (Drenth and Grauch, 2019). These new geophysical surveys stand apart from previous publicly available data due to tighter flight-line spacing and lower-altitude flights, which produce high-resolution rank 1 datasets. Rank 1 magnetic data support both qualitative and quantitative interpretation, and are an essential tool for a wide range of geologic applications, including critical mineral exploration (Drenth and Grauch, 2019). These datasets also meet modern, internationally recognized standards for resolution and quality, making them valuable to exploration geologists familiar with similar datasets worldwide. By the end of 2024, rank 1 magnetic data had been acquired over 8 percent of Wyoming (fig. 2). With the completion of ongoing and planned surveys, high-resolution rank 1 geophysical data will cover approximately 20 percent of the state.

Making these data publicly available allows exploration geologists to interpret foundational geology and establish a framework for discovering previously unknown mineral deposits. Public access to geophysical data is a critical step in the mineral exploration process, reducing the risks associated with early-stage exploration and helping assess the economic viability of deposits. This, in turn, encourages greater investment in Wyoming (e.g., Hutchins and others, 2007; Rainsford, 2019). Beyond exploration, geophysical datasets also provide valuable information for assessing geologic hazards, groundwater resources, and geologic mapping.

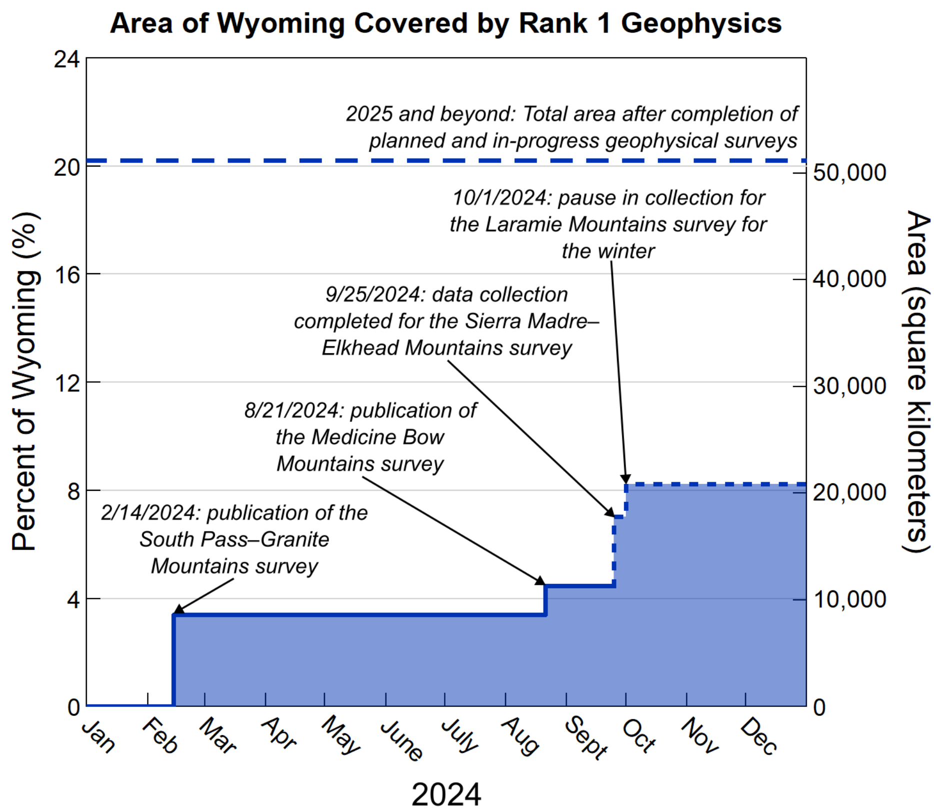

Figure 2. Plot showing the increase in the area of Wyoming covered by high-resolution, rank 1 airborne magnetic and radiometric surveys through 2024. See figure 1 for the geographic distribution of completed, ongoing, and planned surveys. Short dashed line represents data not yet released.

AIRBORNE GEOPHYSICAL METHODS

Geophysics involves measuring the physical properties of the Earth. Airborne geophysical methods are a cost-effective and non-invasive way to study physical properties over large areas. In Wyoming, three types of airborne geophysical surveys are being conducted: magnetic, radiometric, and electromagnetic. Magnetic and radiometric surveys are collected together, and data for two of six magnetic-radiometric surveys have been published (U.S. Geological Survey 2024a, b). The Cheyenne Belt–Black Hills electromagnetic survey will be conducted separately, with data expected to be published in several years.

Magnetic Method

Earth's magnetic field intensity is measured in nanoteslas (nT) and varies in both direction and strength over time. Its intensity ranges from approximately 25,000 nT at the equator to about 70,000 nT at the poles (Isles and Rankin, 2013). The International Geomagnetic Reference Field (IGRF) is a mathematical model designed to represent the strength and direction of Earth's magnetic field at any location, accounting for both short-term and long-term variations. (Alken and others, 2021). The IGRF is updated every five years, with the current model (IGRF-13) estimating that Wyoming's magnetic field strength is about 52,000 nT (Alken and others, 2021).

Paleomagnetic studies provide evidence that Earth's magnetic field has reversed polarity multiple times, meaning that the magnetic poles have flipped. This reversal has occurred over intervals ranging from 50,000 to 5 million years. While these long-term variations do not impact magnetic surveys, short-term fluctuations must be considered when processing survey data (Reeves, 2005; Dentith and Mudge, 2014).

Diurnal variations (up to 30 nT) occur due to daily changes in Earth's position relative to the sun. Magnetic storms originating from sunspots can also cause up to 1,000 nT variations. Micropulsations (less than 10 nT) occur randomly at intervals ranging from a few seconds to several minutes (Reeves, 2005; Dentith and Mudge, 2014). If these variations are not accounted for during processing, they can obscure magnetic anomalies caused by geologic features, which typically range from tens to hundreds of nanoteslas (Reeves, 2005; Dentith and Mudge, 2014).

Rocks containing iron-rich minerals typically cause magnetic anomalies in Earth's crust. Magnetite, a common form of iron oxide, has the highest magnetic susceptibility of all minerals. Magnetic susceptibility is a unitless measure of a material's ability to be magnetized in response to an applied magnetic field—the higher the value, the more easily a rock can become magnetized. This property can be measured in the field and is commonly used to identify rock outcrops that produce strong magnetic anomalies in the airborne geophysical surveys (Reeves, 2005; Dentith and Mudge, 2014). Magnetic surveys use a magnetometer to measure the total magnetic intensity (TMI) of the Earth's magnetic field in nanoteslas. Airborne magnetic surveys are most sensitive to magnetic signals from the upper few kilometers of Earth's crust, though magnetic signals can be as deep as the Curie point—the temperature at which rocks lose their magnetism. The depth to the Curie point depends on the geothermal gradient at a given location and can be modeled using airborne magnetic survey data (Li and others, 2017).

During a survey, a magnetometer, combined with high-precision Global Positioning System (GPS) and digital recording equipment, is mounted on a helicopter or fixed-wing aircraft and flown along predetermined traverse lines (figs. 3A and 4). Because Earth's TMI is much larger than the magnetic anomalies produced by geologic features, the IGRF

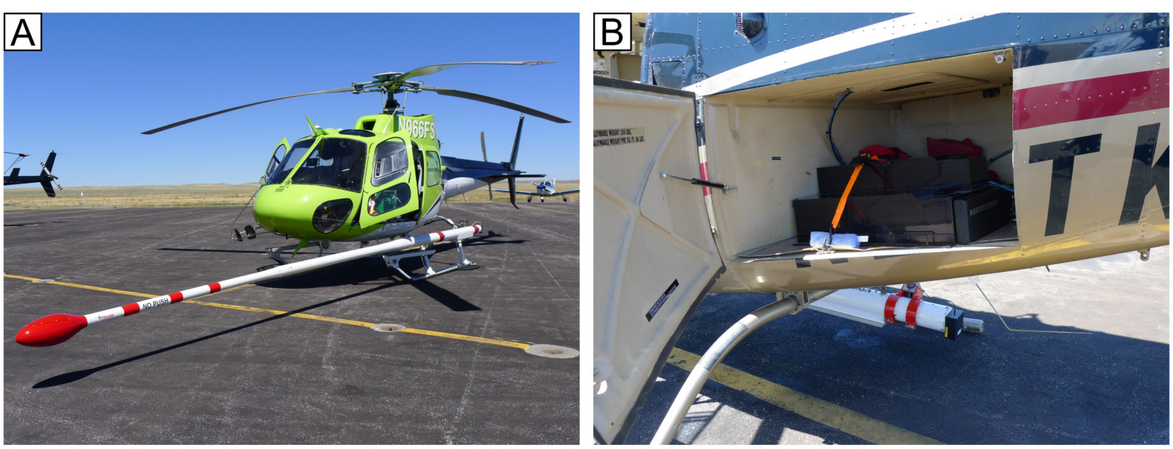

Figure 3. A) Helicopter with stinger-shaped magnetometer (white with red tip). B) Gamma ray spectrometer (black boxes) mounted inside a helicopter.

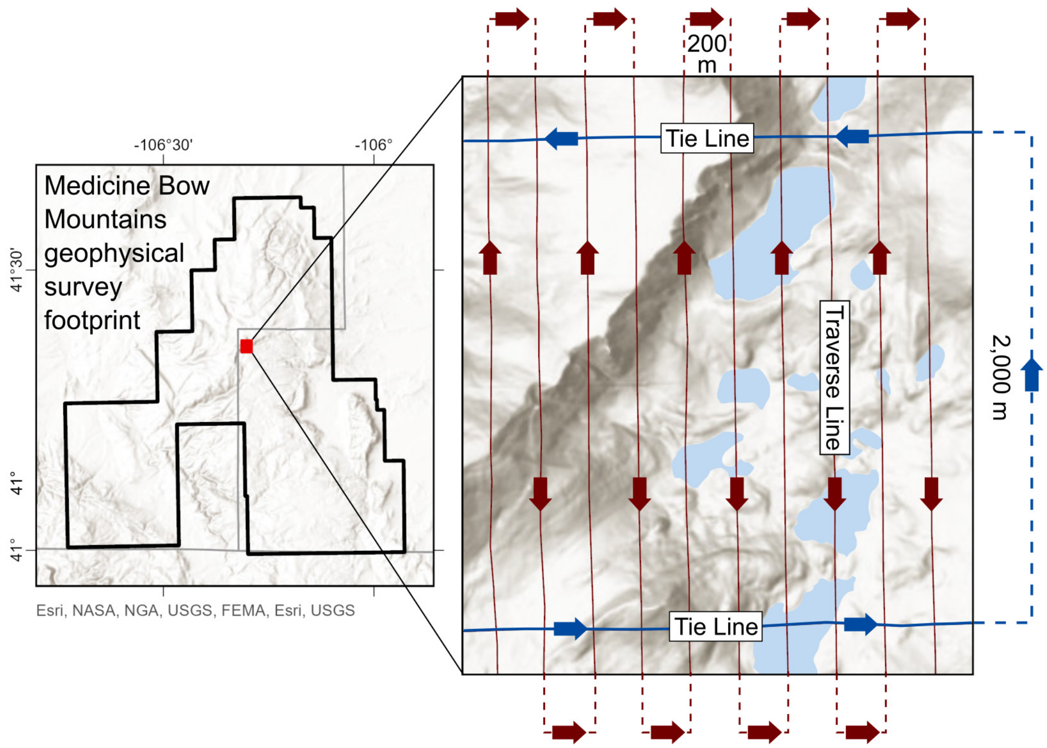

Figure 4. Map showing an example of traverse lines and tie lines from the Medicine Bow Mountains geophysical survey, focusing on the Snowy Range area. Dashed lines are for illustrative purposes only and do not show the full extent of the flight lines. Basemap: Esri (2005).

is subtracted from the measured data. This process isolates total-field anomalies (TFA), revealing variations in Earth's magnetic field caused by geologic features (Reeves, 2005; Dentith and Mudge, 2014). The resulting data are gridded and interpolated into a two-dimensional image, where each grid cell is color-coded to represent TFA in nanoteslas.

Radiometric Method

Rocks and soils in Earth's crust contain radioactive elements that emit radiation through natural radioactive decay. Natural radioactive decay is the process by which an unstable atom breaks down and releases energy in the form of radiation. The three primary radioactive elements in Earth's crust are potassium (K), thorium (Th), and uranium (U). Of these, potassium is the most abundant, with an average crustal abundance of 15,000 parts per million (ppm). In comparison, thorium and uranium are far less common, with average crustal abundances of 5.6 ppm and 1.3 ppm, respectively (Rudnick and Gao, 2014).

Radioactive isotopes are atoms of the same element that have different atomic masses. The primary radioactive isotopes of potassium, thorium, and uranium are ^{40}K, ^{232}Th, and ^{238}U, respectively. These isotopes emit high-frequency, high-energy gamma rays which can penetrate about 20–30 cm (about one foot) through rock and travel hundreds of meters through air. Each isotope emits gamma rays with a distinct energy signature, allowing a gamma ray spectrometer to differentiate signals from potassium, thorium, and uranium. The gamma ray spectrometer counts the number of gamma rays at each distinct energy level and converts it to concentration of potassium, thorium, and uranium (Minty, 1997; Dentith and Mudge, 2014).

Airborne radiometric surveys are flown at the same time as magnetic surveys with the spectrometer mounted inside the aircraft (fig. 3B). The aircraft travels along predetermined traverse lines (fig. 4) to collect radioactive element concentration data. These data are traditionally displayed as a ternary (three-part color scale) image where potassium is red, thorium is green, and uranium is blue. The color of each pixel is assigned by combining red, green, and blue in proportion to the concentrations of potassium, thorium, and uranium, respectively. Alternatively, radiometric data can be displayed as separate maps, each showing the concentration of a single element or ratios of multiple elements.

Survey Planning

Survey design primarily considers line spacing, line orientation, and aircraft terrain clearance (height above the ground surface). Traverse lines and tie lines define the flight paths along which the aircraft collects airborne geophysical data.

Traverse lines are chosen to target areas of geologic interest and are generally oriented perpendicular to major geologic features, such as faults, dikes, or metamorphic fabric. However, in regions with complex geologic deformation and multiple fault and fold orientations, traverse lines may not align perfectly. In these cases, tighter line spacing helps compensate for deviations and improves data resolution (Reeves, 2005).

Tighter line spacing (shorter distances between parallel traverse lines) increases the density of data points, improving the lateral resolution of magnetic and radiometric data. Selecting an appropriate line spacing is essential for resolving features in the dataset. Wider spacing decreases resolution, while narrower spacing significantly increases survey costs.

Tie lines, which run perpendicular to traverse lines, are typically spaced ten times the distance of traverse lines. They are used to monitor noise and correct for errors in the measured data (Isles and Rankin, 2013; Dentith and Mudge, 2014). Figure 4 illustrates survey and tie lines in a section of the Medicine Bow Mountains geophysical survey.

Recently completed, ongoing, and planned magnetic and radiometric surveys in Wyoming typically use traverse and tie line spacings of 200 m and 2,000 m, respectively (fig. 4).

Helicopter surveys typically operate at speeds of 250 kilometers per hour (160 miles per hour), and altitudes of 60 to 150 meters (200 to 500 feet) above the ground. Data are collected at preset time intervals, meaning the distance between measurement points depends on the aircraft's speed. Lower flight altitudes and consistent speeds improve data quality. However, maintaining a constant speed is challenging in mountainous regions due to variations in terrain (e.g., fig. 5; Dentith and Mudge, 2014).

Figure 5. Photograph of the Snowy Range in the Medicine Bow Mountains, which is the approximate area shown in figure 4.

COMPLETED GEOPHYSICAL SURVEYS

Medicine Bow Mountains Geophysical Survey

The Medicine Bow Mountains survey was conducted from August to September 2023, with the geophysical data published by the USGS in August 2024. This survey collected magnetic and radiometric data across most of the Medicine Bow Mountains, as well as parts of the Saratoga Valley and Sierra Madre (fig. 1).

Figure 6A illustrates the total magnetic field anomalies measured during the survey (U.S. Geological Survey, 2024a). Magnetite-rich rock formations produce prominent positive anomalies in magnetic datasets. Figure 6B highlights strong magnetic anomalies (bright pink and deep blue colors) associated with magnetite-rich horizons in a layered mafic intrusion known as the Lake Owen Complex (southern Medicine Bow Mountains).

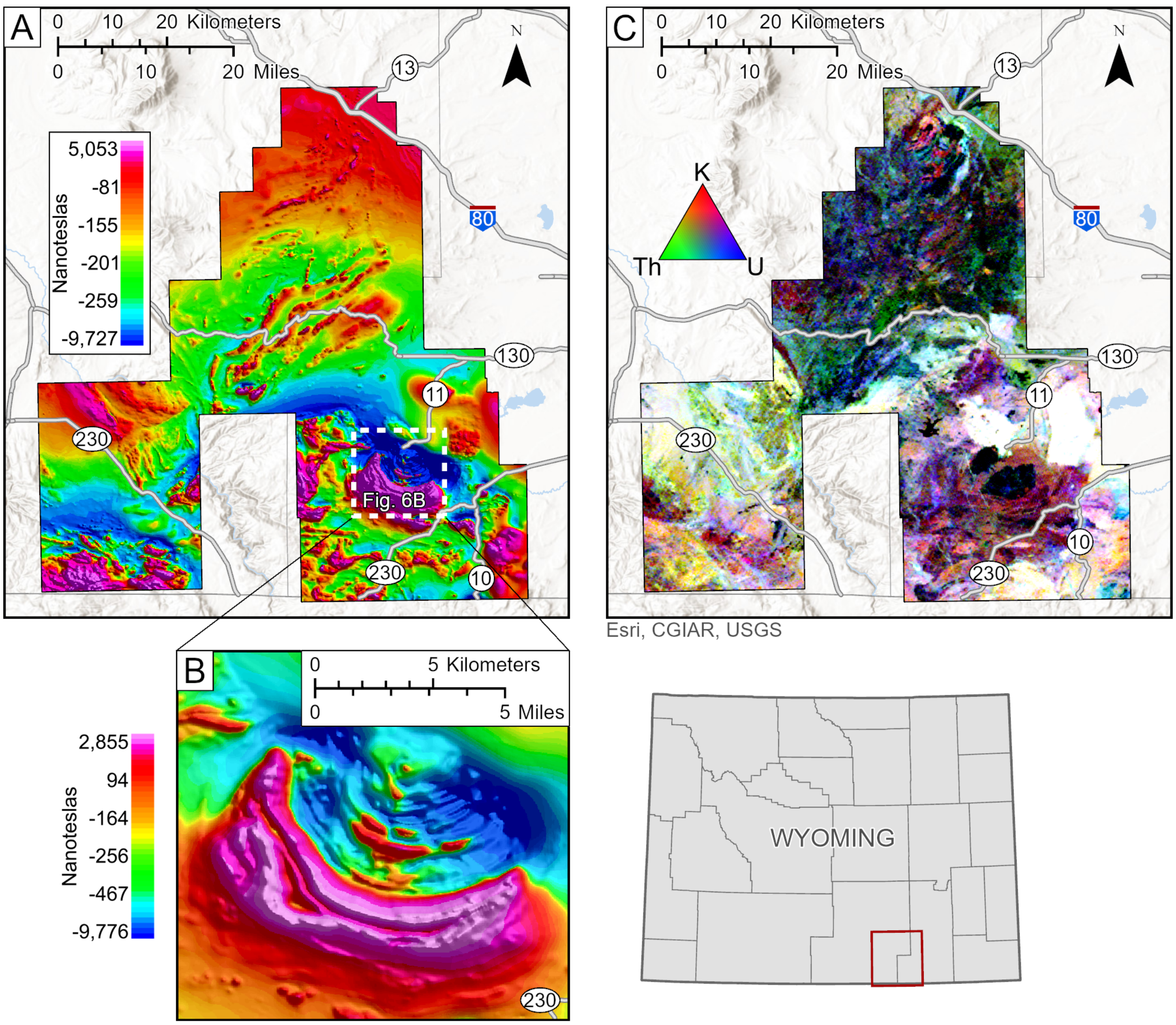

Figure 6. Geophysical anomaly maps from the Medicine Bow Mountains survey. A) Total magnetic field anomaly map. The dashed box shows the location of (B). B) Total magnetic field anomaly map over the Lake Owen Complex layered mafic intrusion. C) Ternary-color radiometric map showing relative normalized concentrations of potassium (red), thorium (green), and uranium (blue) estimated from radiometric data. Areas with high concentrations of all three elements appear white, and areas lacking these elements, including bodies of water, appear black. Basemap: Esri (2005).

The Lake Owen Complex (fig. 7A) has the potential for hosting zones of vanadium-bearing magnetite and platinum group element-bearing sulfides. To capture higher-resolution data over this intrusive body, traverse and tie lines were more tightly spaced at 100 m and 1,000 m, respectively.

Figure 6C presents a ternary-color map displaying the normalized and relative concentrations of potassium (red), thorium (green), and uranium (blue) from the Medicine Bow Mountains radiometric survey. Radiometric surveys measure surface-level radiation, making them useful for studying surficial geologic processes, identifying geologic hazards, and assisting with geologic mapping, particularly in vegetated areas.

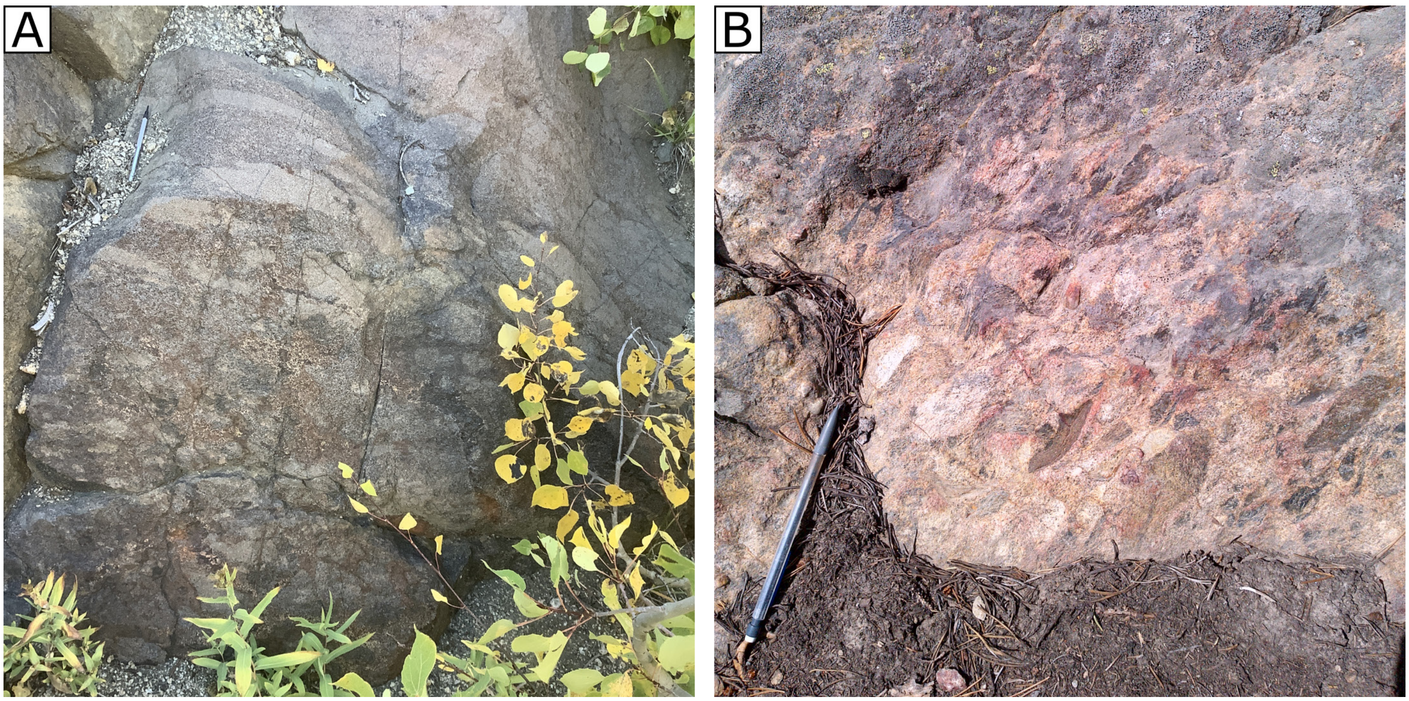

Figure 7. Photographs showing outcrops of the Lake Owen Complex (A) and the Magnolia Formation (B) in the Medicine Bow Mountains.

Radiometric maps depicting uranium distribution can help assess radon risk in a given area (Mousavi Aghdam and others, 2021). Radon gas, produced by the radioactive decay of uranium in soil and bedrock, can accumulate in indoor air and pose health risks. In the Medicine Bow Mountains, uranium concentration data from the radiometric survey may help local communities evaluate potential radon exposure risks.

Radiometric data from the Medicine Bow Mountains survey may also be a valuable tool for mineral exploration and geologic mapping. Thorium and uranium concentration maps could be particularly useful for studying the Magnolia Formation in the northern Medicine Bow Mountains (fig. 7B), which contains a radioactive conglomerate with elevated uranium and thorium concentrations (Lichtner and others, 2023a).

As noted previously, thorium often co-occurs with certain rare earth element deposits, so thorium anomaly maps can help locate these deposits exposed at the surface. These data could aid exploration of the Big Creek pegmatite in the southwestern Medicine Bow Mountains, a site historically mined for rare earth elements (Sutherland and Cola, 2016).

Potassium concentrations vary widely in rocks across the Medicine Bow Mountains. Mafic rocks in the region typically contain low potassium levels, whereas felsic intrusive rocks, feldspar-rich quartzites, and juvenile sediments can contain several percent potassium by weight. Estimated potassium concentration data can assist in differentiating rock types and refining geologic mapping.

South Pass–Granite Mountains Geophysical Survey

The South Pass–Granite Mountains survey was conducted from July to September 2023, with the geophysical data published by the USGS in February 2024. This survey covers a diverse range of geologic features, including the South Pass–Atlantic City area in the west, the Granite Mountains in the center, the Rattlesnake Hills in the northeast, and the edge of the Shirley Mountains in the southeast.

This region includes both historical deposits and potential occurrences of commodities including gold, copper, iron, uranium, nickel, and lithium. The magnetic and radiometric data are well-suited for assessing potential deposit locations. For example, banded iron formation occurs in both South Pass and the Seminoe Mountains, producing large positive magnetic anomalies (Fig 8A).

Unlike the Medicine Bow Mountains, the Granite Mountains region contains extensive Paleogene and Neogene cover that obscures much of the Precambrian rocks—the primary host for critical mineral deposits. Magnetic data are particularly valuable for identifying geological and structural features buried under this younger cover, such as faults and mafic intrusions.

The South Granite Mountains fault system is a series of Quaternary-aged normal faults (less than 2.58 million-years-old) that bound the southern end of the Granite Mountains graben and lie within the survey area (white line, fig. 8A). Magnetic data can help assess the earthquake hazard associated with this geologically young structure. Since magnetic

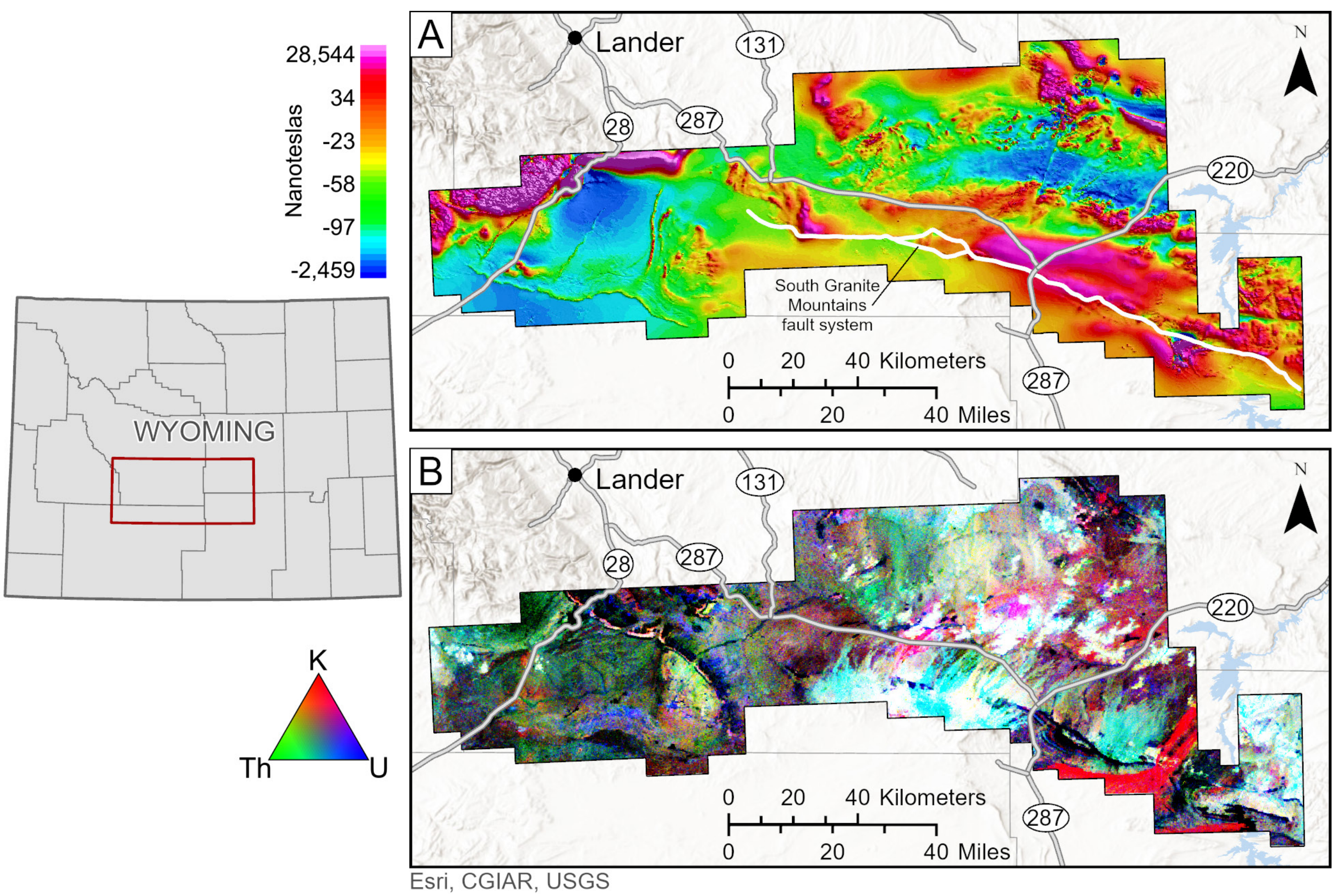

Figure 8. Geophysical anomaly maps from the South Pass–Granite Mountains survey. A) Total magnetic field anomaly map. The white line shows the approximate location of the South Granite Mountains fault system. B) Ternary-color radiometric map showing relative normalized concentrations of potassium (red), thorium (green), and uranium (blue) calculated from radiometric data. Areas with high concentrations of all three elements appear white, and areas lacking these elements appear black. Basemap: Esri (2005).

anomalies reflect variations in rock properties, the juxtaposition of contrasting rock types along the fault system appears as a zone of magnetic contrast.

Geologists can use these data to locate the fault in the subsurface and correlate its position at-depth with surface offset markers identified through field mapping (e.g., Shah and others, 2023). This provides a more complete understanding of the fault's dip angle and along-strike length, both of which are essential for probabilistic seismic hazard models.

Radiometric data from the South Pass–Granite Mountains survey can aid in interpreting surficial geologic features. Elevated potassium concentrations, which appear as bright red areas in figure 8B, may correspond to alluvial fans and drainages that transport juvenile sediment from nearby potassium-rich granitic intrusions.

Radiometric data are also valuable for studying uranium mineralization and hazards in the region. The Crooks Gap and the Gas Hills areas—located within and adjacent to the survey area—both host known uranium deposits (Anderson, 1969; Bailey, 1969). Uranium concentration maps derived from the radiometric dataset could support future uranium exploration and help assess radon risks associated with elevated uranium levels.

ONGOING AND FUTURE GEOPHYSICAL SURVEYS IN WYOMING

In addition to the published surveys covering the Medicine Bow Mountains and central Wyoming (figs. 6 and 8), geophysical surveys are currently underway or in the planning stages across eastern Wyoming. These efforts include airborne magnetic and radiometric surveys, as well as one electromagnetic survey.

Completed, ongoing, and future geophysical surveys have been supported through a combination of funds from the USGS Earth Mapping Resource Initiative and the State of Wyoming, with additional contributions from private industry.

The Sierra Madre–Elkhead Mountains magnetic and radiometric survey straddles the Wyoming–Colorado border, covering the Sierra Madre in southeast Wyoming (fig. 1). Data acquisition for this survey was completed during summer 2024, and data processing for this survey is ongoing.

The Sierra Madre is a Precambrian-cored mountain range that includes the historical Encampment mining district. Mineral deposits within the district include copper-bearing quartzites, volcanogenic massive sulfides, paleoplacers, orogenic veins, pegmatites, and contact metamorphic deposits (Hausel, 1986). In addition to base and precious metals, these deposits may also host critical minerals. Data from the Sierra Madre–Elkhead Mountains survey could help identify new deposits in this mineral-rich area.

Data collection for the Laramie Mountains magnetic and radiometric survey is ongoing. This survey extends from the Wyoming–Colorado border in the south, through the Laramie Mountains, to Casper Mountain in the north (fig. 1). Its southern edges connect to both the Medicine Bow and Sierra Madre–Elkhead Mountains survey areas.

Like the Medicine Bow Mountains and Sierra Madre, the Laramie Mountains consist primarily of Precambrian igneous and metamorphic rocks with known critical mineral occurrences, including the rare earth element enrichment in the Red Mountain Pluton (e.g., Webber and others, 2022). Flights for the Laramie Mountains survey began in summer 2024, paused for the winter season, and resumed during spring 2025.

The combined Hartville Uplift–Shirley Mountains magnetic and radiometric survey covers two separate areas, both located at the north end of the ongoing Laramie Mountains survey (fig. 1). The eastern section extends from the northern Laramie Mountains to Lusk in the northeast, including Precambrian rocks exposed in the Hartville Uplift. The western section spans the area between Pathfinder Reservoir, the Shirley Mountains, Casper Mountain, and the Hanna Basin. This survey area connects with the east boundary of the South Pass–Granite Mountains survey.

In addition to linking the Laramie Mountains and South Pass–Granite Mountains surveys, the Shirley Mountains portion also covers an area known to host uranium deposits and heavy mineral sandstones and gravels containing elevated concentrations of multiple critical minerals (Harshman, 1972; Lichtner and others, 2023a, b). Geophysical data over this region may assist with mapping potential eastern extensions of the North and South Granite Mountains fault systems.

The Black Hills–Bear Lodge airborne magnetic and radiometric survey is the most recently planned and will straddle the Wyoming–South Dakota border (fig. 1). The northwest section of the survey area will overlap rare earth element deposits in the Bear Lodge Mountains, which contain carbonatite intrusions enriched in rare earth elements within a Paleogene-aged alkaline igneous complex (Hutchinson and others, 2022).

In addition to the magnetic and radiometric surveys described above, the USGS is flying the southern part and planning the northern part of an electromagnetic survey covering a large swath of eastern Wyoming. The Cheyenne Belt–Black Hills electromagnetic survey (area outlined in red, fig. 1), will primarily take place in Wyoming along the Cheyenne Belt, an ancient tectonic boundary. The Cheyenne Belt is a zone of continental accretion with potential mineralization, active between 1.78 and 1.74 billion years ago (Chamberlain, 1998). It extends from the Sierra Madre in the southwest, to the Medicine Bow Mountains, Laramie Mountains, Hartville Uplift, and northeast to the Black Hills.

Electromagnetic surveys measure the electrical conductivity of the subsurface. The Cheyenne Belt–Black Hills electromagnetic survey and resulting 3D modeling will help characterize the geophysical properties of this ancient suture zone while potentially providing insights into groundwater distribution and mineral deposits.

Upon completion of ongoing and future geophysical surveys, approximately 20 percent of Wyoming will be covered by high-resolution, rank 1 magnetic and radiometric data (fig. 2), and a large portion of the state will also have overlapping electromagnetic data.

These datasets will enhance our understanding of the complex geologic history of Wyoming and help exploration geologists identify potential critical mineral deposits. The high-quality magnetic and ratiometric surveys will also support geologic mapping at various scales, and serve as valuable resources for a wide variety of future geologic studies across the state.

USEFUL LINKS

Medicine Bow Mountains survey: News Release, Data Download

South Pass–Granite Mountains survey: News Release, Data Download

Cheyenne Belt–Black Hills EM Survey: News Release

Interactive maps: Earth MRI (USGS), Mineral Resources in Wyoming (WSGS)

USGS: Earth MRI, List of Critical Minerals, Earth MRI Focus Areas

WSGS: Publications

Geoscience Australia: Background on Geophysical Methods

National Oceanic and Atmospheric Administration: International Geomagnetic Reference Field

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