AER/AGS Open File Report 2026-04

Summary of 2025 Field Activities: North Shore of Lake Athabasca, Leland Lakes and Colin Lake Areas, Northeastern Alberta

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Belosevic, M.B.K.

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Alberta Energy Regulator
Alberta Geological Survey
2nd Floor, Twin Atria Building
4999 – 98th Avenue
Edmonton, AB T6B 2X3
Canada

Tel:	780.638.4491
Fax:	780.422.1459
E-mail:	AGS-Info@aer.ca
Website:	ags.aer.ca

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Abstract

This report presents an interim overview of field activities completed during the summer of 2025 as part of a multi-year Alberta Geological Survey (AGS) program focused on characterizing mineral systems on the Canadian Shield of northeastern Alberta. In support of the Government of Alberta's initiative to expand publicly accessible geoscience data related to critical mineral potential, AGS crews visited more than 370 sites and collected 320 rock samples for laboratory analysis. This report also summarizes additional datasets acquired during the field program and outlines planned publications.

This work was completed under the Mineral Grant provided by the Government of Alberta on June 22, 2021.

1 Introduction

In Alberta, the Canadian Shield (or, the Shield) is exposed at the northeastern corner of the province, where it extends from exposures in the Northwest Territories and Saskatchewan. Across Canada, the Shield is known to host a wide variety of mineral deposits and showings. Similarly, numerous mineral occurrences have been documented on Alberta's portion of the Shield (Morley et al., 2025), although historical exploration has focused primarily on uranium. In recent years, mineral exploration across much of Alberta's portion of the Shield has been limited when compared with that in neighbouring jurisdictions. As a result of increasing global demand for critical minerals and the need to strengthen domestic supply chains, many jurisdictions have implemented critical minerals strategies aimed at improving knowledge of local resources and supporting their development.

In 2021, the Government of Alberta released the report called "Renewing Alberta's Mineral Future: A Strategy to Re-energize Alberta's Minerals Sector" (Ministry of Energy and Minerals, 2021), which is intended to advance efforts to strengthen and diversify the province's economy. The strategy is designed to stimulate growth in Alberta's minerals industry through six key areas. The first of these actions focuses on enhancing the public geoscience knowledgebase for critical minerals in Alberta. In support of this objective, the Alberta Geological Survey (AGS) launched a multi-year initiative to assess the critical mineral potential of the Canadian Shield in northeastern Alberta.

Early phases of the initiative focused on compiling, digitizing, and analyzing extensive historical datasets and samples, including drill core, rock samples, reports, maps, and geoscience databases. These efforts were complemented by the acquisition of new high-resolution airborne magnetic survey data and satellite-based multispectral remote sensing datasets from across the Shield.

Apart from the extensive mapping and sampling programs undertaken by the AGS in the 1950s to the 1970s (e.g., Godfrey, 1986), limited mineral-focused investigations were completed during the early 1990s (e.g., Langenberg et al., 1994) and late 2000s (Pană and Prior, 2010). In 2023, the AGS undertook a field program to better evaluate the critical mineral potential of the Leland Lakes and Andrew Lake areas of the Canadian Shield (Belosevic et al., 2024; Montenegro et al., 2026a,b). Building on the results of the 2023 program, the AGS conducted a 36-day field campaign during the summer of 2025 across four key areas of the Shield. The program was designed to investigate anomalous results identified during the 2023 fieldwork and to assess newly identified prospective targets that emerged from subsequent interpretation and analysis.

This publication presents an interim summary of field data collected during the 2025 field program, summarizes additional datasets acquired during the field program, and outlines planned future publications, in which detailed interpretations and conclusions derived from this work will be reported.

2 Background

2.1 Regional Geology

Alberta is underlain by numerous domains of Precambrian crystalline basement. In the northeastern corner of the province, the exposed basement, the Canadian Shield, is composed of variably metamorphosed and deformed Archean to Paleoproterozoic quartzofeldspathic basement gneisses, metaplutonic complexes, and supracrustal assemblages. To the west and south of the Shield, the crystalline basement extends beneath the Phanerozoic sedimentary succession belonging to the Western Canada Sedimentary Basin. The Canadian Shield in northeastern Alberta can be subdivided into three major components: the Taltson basement complex (TBC), Taltson magmatic zone (TMZ), and Athabasca Group, as well as several subordinate metasedimentary successions, including the Rutledge River complex, Waugh Lake complex, and Burntwood complex. Figure 1 shows the simplified geological map of the major lithological subdivisions, herein described.

2.1.1 Taltson Basement Complex

In Alberta, the TBC forms an older, curvilinear belt of high-grade gneisses that generally separates granitic plutons of the younger TMZ to the west from plutonic assemblages of the older TMZ to the east. The TBC is interpreted as the westernmost expression of the relict Rae craton (e.g., Ross et al., 1991; McDonough et al., 2000) and consists predominantly of Arrowsmith orogeny-aged orthogneiss (2.5–2.3 Ga), with less common occurrences of Archean orthogneiss dated at approximately 3.2, 3.1, and 2.6 Ga (Goff et al., 1986; McDonough et al., 2000; McNicoll et al., 2000). Recent studies of >3 Ga components of the western Rae craton indicate that these ancient crustal signatures are associated with the Perry River terrane, a ~1000 km-long and ~100 km-wide belt of extensively reworked crust extending from the Snowbird tectonic zone to the Queen Maud block (Neil et al., 2023).

2.1.2 Taltson Magmatic Zone

The variably deformed TMZ has been subdivided on the basis of geochronology, geochemistry, and mineralogy into early-stage I-type granites, which are generally metaluminous to weakly peraluminous, and late-stage, primarily peraluminous S-type granitoids (e.g., Bostock et al., 1991; Chacko et al., 2000; McDonough et al., 2000). In Alberta, the early TMZ (1971–1959 Ma; McDonough and McNicoll, 1997; McDonough et al., 2000; Stern et al., 2003) includes the Colin Lake granitoid, Wylie Lake granodiorite, Fishing Creek granodiorite, and Andrew Lake granodiorite. The late TMZ (1960–1934 Ma; McDonough et al., 2000) comprises the Arch Lake granitoid, Slave granitoid, Chipewyan granite, and Wallace Island granite. In addition to these subdivisions, a suite of granitoids of uncertain tectonic affinity occurs within the TMZ, including the Charles Lake granitoid, Thesis Lake granite, La Butte granodiorite, and Francis granite.

2.1.3 Metasedimentary Units

There are widespread enclaves of pelitic and semipelitic gneisses in the TBC and TMZ that are interpreted as remnants of the Rutledge River basin (e.g., Bostock and van Breemen, 1994; McDonough et al., 2000). Recent work on the Rutledge River complex in the Pelican Rapids area (~40 km west of the Leland Lakes study area) indicates that at least part of the basin fill was deposited between 2.03 and 1.97 Ga (Thiessen et al., 2024). In addition to these paragneisses, enclaves of mafic lithologies, including amphibolite and hornblendite, are present throughout the TBC and are interpreted as obducted ophiolitic fragments incorporated into the complex (McNicoll et al., 2000). The Waugh Lake complex, located in the northeastern portion of the Shield, comprises a package of relatively low-grade, sheared igneous and supracrustal rocks that are interpreted to have formed in a back-arc or intra-arc basin during the Taltson orogeny (e.g., Iannelli et al., 1995; McDonough and McNicoll, 1997; McDonough et al., 2000) or perhaps as a complex heterogeneous basin where the lower units were generated in a foreland basin setting, which then evolved into an intra-arc or syn- to post-collisional basin (Deane et al., 2026). The Burntwood complex is a package of variably deformed, lower greenschist facies of interbedded argillites and sandstones exposed along the north shore of Lake Athabasca between Sandy Point and Lapworth Point (Figure 1). Previous investigations have suggested that this unit represents (1) a metasedimentary basin similar to the Waugh Lake complex (Godfrey, 1980), (2) a sedimentary succession belonging to the Fair Point Formation of the Athabasca Group (McDonough and McNicoll, 1997), or (3) a tectonized granitoid of the TMZ (Pană and Olson, 2009).

2.1.4 Athabasca Group

Towards the southern half of the Canadian Shield in northeastern Alberta, the basement rocks of the TMZ and TBC are unconformably overlain by the Athabasca Group, a late Paleoproterozoic to early Mesoproterozoic sedimentary succession deposited in the Athabasca Basin that extends into Saskatchewan. Although only approximately 10% of the basin lies in Alberta, it covers ~40% of the Canadian Shield in the province. The Athabasca Basin hosts several world-class uranium deposits and remains an active area of advanced mineral exploration, particularly in Saskatchewan. In Alberta, the

Athabasca Group attains a maximum thickness of approximately 810 m (Hobson and MacAuley, 1969) and consists of four major unconformity-bounded fluvial sequences that accumulated between 1760 and 1500 Ma (Ramaekers et al., 2007). The lowest unit of the group in Alberta is the Fair Point Formation, an approximately 380 m-thick sequence of coarse sandstones and polymictic conglomerates exposed along the north shore of Lake Athabasca (Ramaekers et al., 2007).

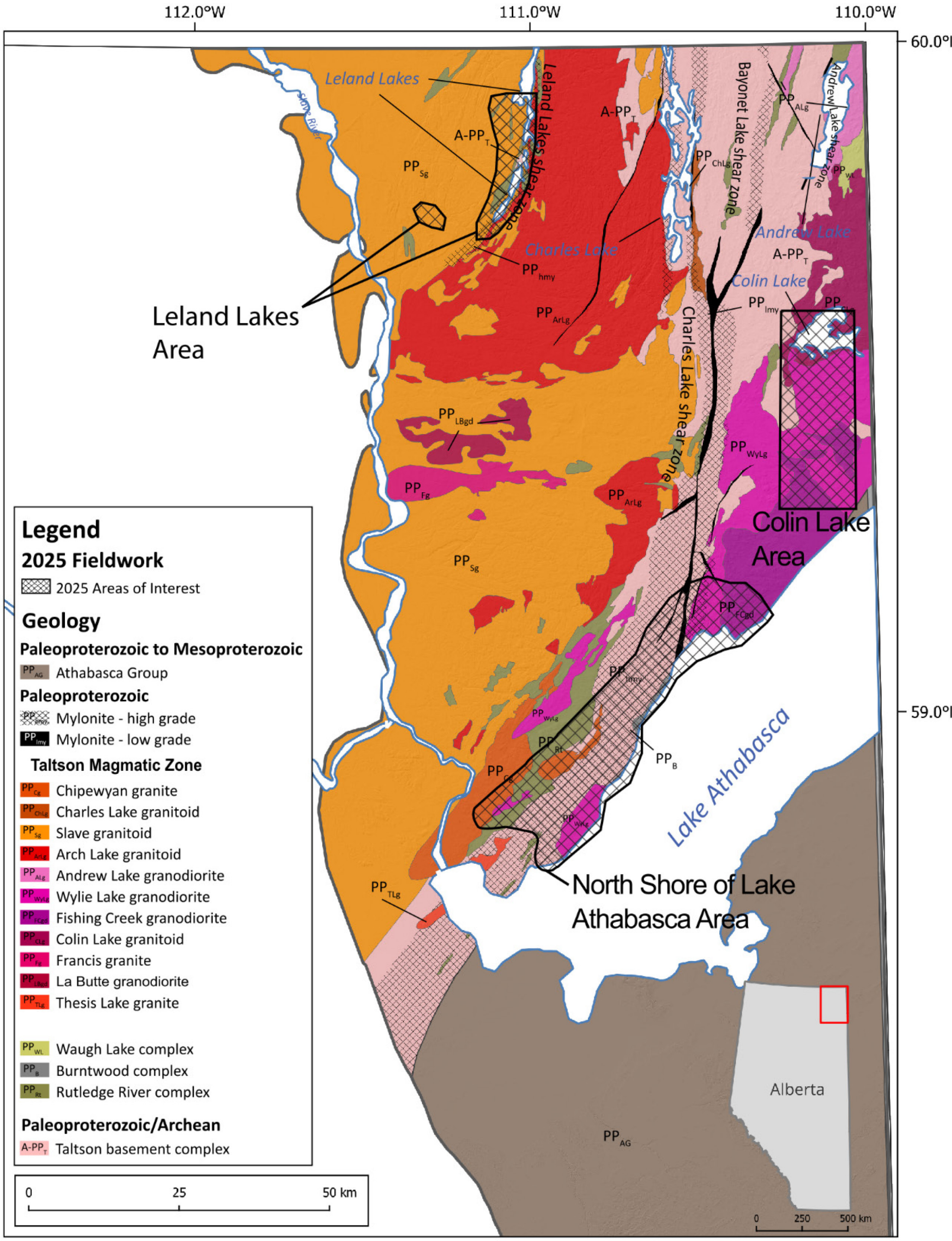

Figure 1. Simplified geological map of the Canadian Shield in northeastern Alberta adapted from Prior et al. (2013) with the areas of interest from the 2025 fieldwork of this report.

2.2 Mineral Occurrences

2.2.1 North Shore of Lake Athabasca

The mineral occurrences in the North Shore of Lake Athabasca study area are dominated by rare-earth elements (REEs) and uranium associated with pegmatites, granitoids, and basement gneisses, and to a lesser extent, with faults and shear zones hosted within granitoid rocks (Figure 2; Morley et al., 2025). Most of these occurrences and anomalies are spatially associated with the Charles Lake shear zone (Figure 1) which extends across much of the exposed Canadian Shield. Total REE concentrations of up to 10,739 ppm have been recorded in radiogenic pegmatites hosted by early TMZ plutons (Dahrouge and Smith, 2007). Elevated uranium concentrations of up to 6,270 ppm have also been recorded in pegmatites hosted in Rutledge River complex metasedimentary rocks and early TMZ plutons (Lehnert-Thiel, 1975). There are numerous uranium occurrences found in glacially-transported boulders consisting of uraninite-mineralized Athabasca Group sedimentary rocks along the north shore of Lake Athabasca although many of these are concentrated further north and east of the area of interest (Lehnert-Thiel, 1975). In addition to REEs and uranium, this study area also contains minor occurrences of gold, copper, lead, and zirconium.

2.2.2 Leland Lakes Area

The mineral occurrences in the Leland Lakes study area are spatially related to the Leland Lakes shear zone, as well as to mylonitized splays and faults in the vicinity (Figure 1 and Figure 3). These occurrences include anomalous copper, gold, uranium, lithium, and lead concentrations in surface rock samples. Aside from the granitoid-hosted anomalous uranium assays and scintillometer readings, the gold and base-metal showings are hosted within gossans and quartz veins, primarily in Rutledge River complex metasedimentary units. Previous AGS investigations have highlighted the potential for this area to host mineralized pegmatites of the lithium-cesium-tantalum subclass (Belosevic et al., 2025; Montenegro et al., 2026a,b).

2.2.3 Colin Lake Area

In the Colin Lake study area, few historical mineral occurrences—primarily uranium—are present, with a small number of occurrences relating to REEs, beryllium, and silver (Figure 4). Uranium is hosted in pegmatites and granitoids spatially related to northwest–southeast (NW–SE)-oriented faults and shear zones. South of Colin Lake, the area is notable for elevated uranium and REE contents in historical lake sediment samples (Friske et al., 1994). These anomalous lake sediment geochemical results are spatially related to NW–SE-trending structures, which are along-strike with uranium-prospective regions in Saskatchewan, such as Maurice Bay.

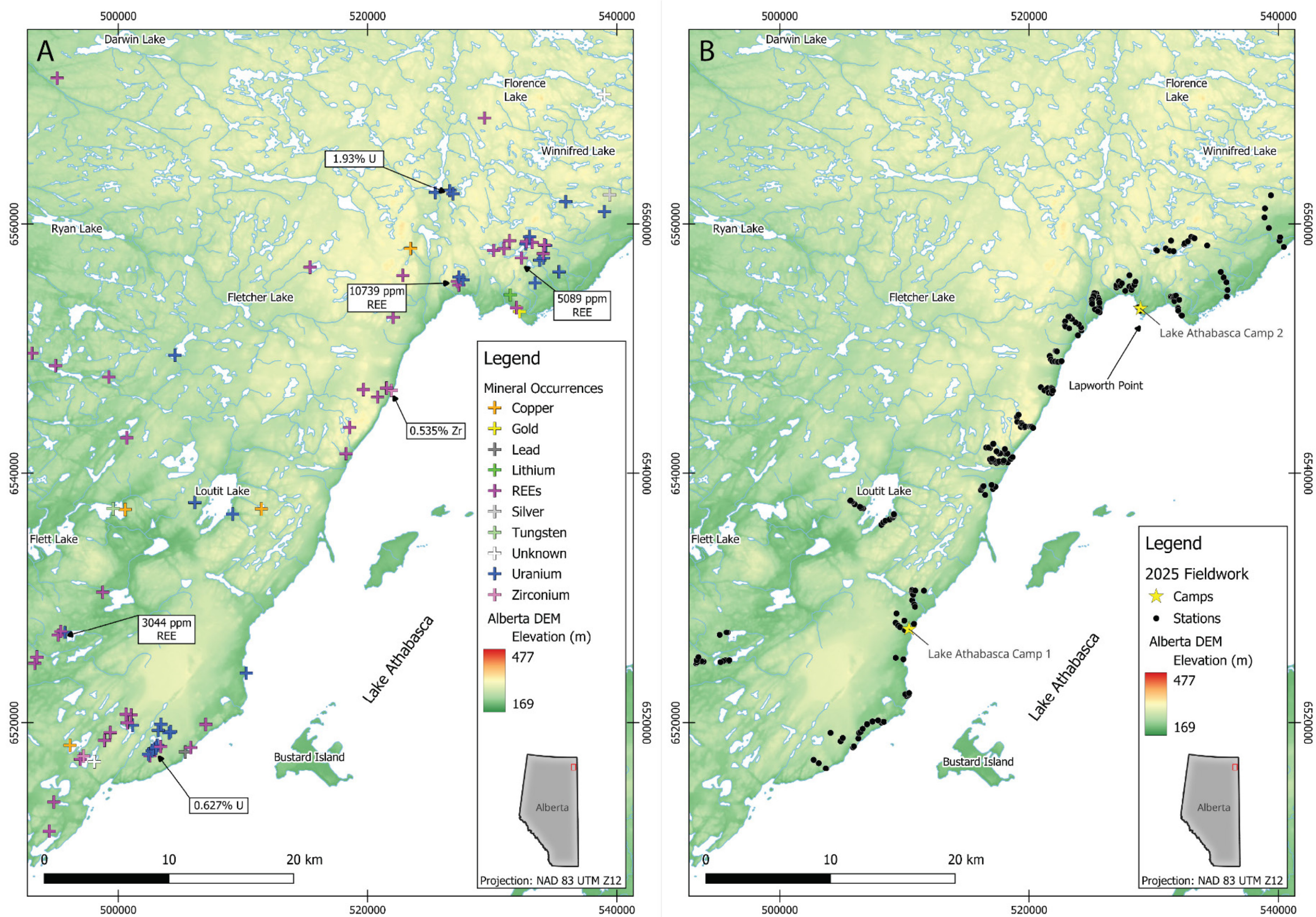

Figure 2. The North Shore of Lake Athabasca area of interest, with mineral occurrences (Panel A; Morley et al., 2025) and station and camp locations (Panel B). Topography sourced from NASA JPL (2013).

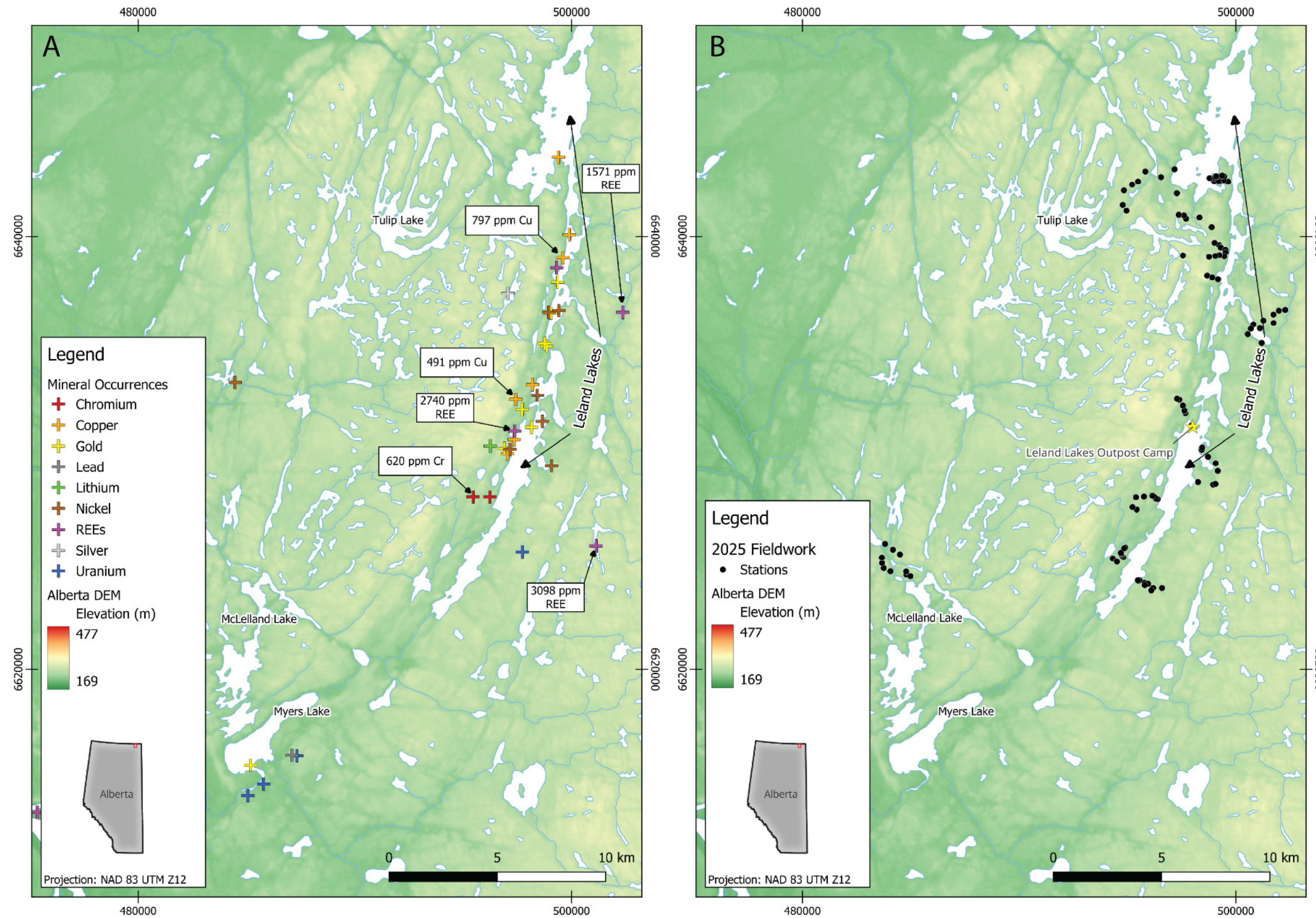

Figure 3. The Leland Lakes area of interest, with mineral occurrences (Panel A; Morley et al., 2025) and station and camp locations (Panel B). Topography sourced from NASA JPL (2013).

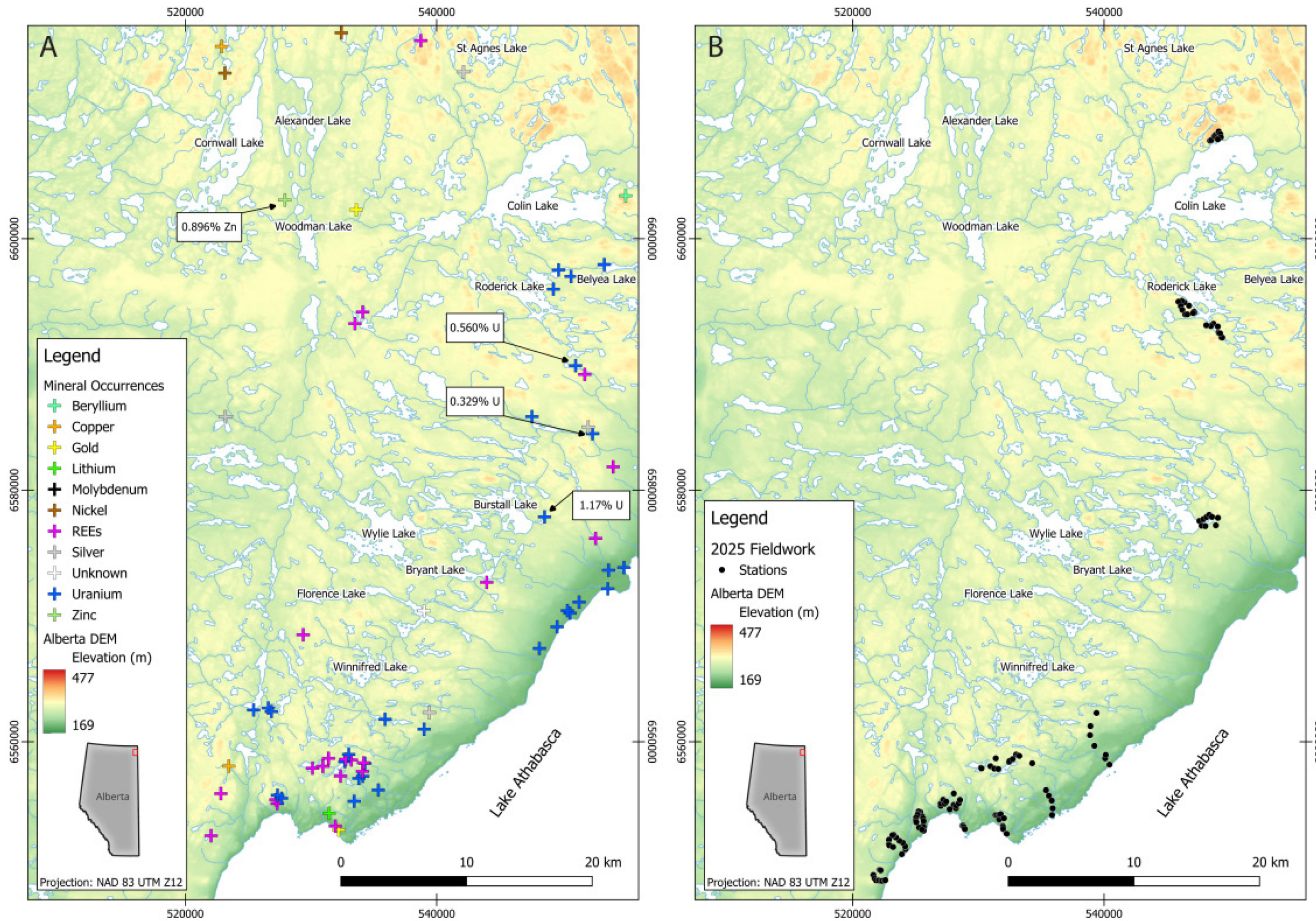

Figure 4. The Colin Lake area of interest, with mineral occurrences (Panel A; Morley et al., 2025) and station and camp locations (Panel B). Topography sourced from NASA JPL (2013).

3 Field Activities

3.1 Indigenous and Stakeholder Engagement

The AGS respectfully acknowledges that the 2025 field activities took place in northeastern Alberta within Treaty 8 Territory, comprising the traditional lands of Indigenous communities including:

- Tthebatthi Dënésułıné Nation
- Fort Chipewyan Métis Nation
- Athabasca Chipewyan First Nation
- Fort McKay Métis Nation
- Fort McKay First Nation
- Mikisew Cree First Nation
- Chipewyan Prairie Dene First Nation

Local authorities (including the Regional Municipality of Wood Buffalo) and current Crown disposition holders were also included in engagement planning. Throughout the planning and execution of the 2025 field program, the AGS, with support from the Engagement and Integrated Communications group at the AER, implemented a proactive and transparent approach to Indigenous and stakeholder engagement, as follows.

Early notification letters were distributed to Indigenous communities and stakeholders that introduced the field program and invited recipients to provide feedback about the proposed plans. As a result, communities expressed interest in meeting with the AGS to learn more about the planned fieldwork, and the AGS scheduled presentations with Tthebatthi Dënésułıné Nation and Athabasca Chipewyan First Nation. These communities provided valuable insights that informed technical, logistical, and safety planning in support of the fieldwork.

As the program continues to progress in the future, the AGS is committed to closing the feedback loop by sharing results with Indigenous communities and continuing to build and strengthen respectful, long-term relationships in the region.

3.2 Access to AGS Field Camps

Access to the remote northeastern corner of Alberta was facilitated via float planes based out of Fort McMurray. A Cessna Caravan was used to mobilize and demobilize camps and transport supplies. Periodic flight support was provided by a Cessna 180.

3.3 North Shore of Lake Athabasca

The AGS conducted fieldwork along the north shore of Lake Athabasca, based out of two camp locations, for 16 days from June 18 to July 3, 2025 (Figure 2). Poor weather on July 3 resulted in a delay of the following field campaign at Leland Lakes. The first camp was located approximately 9 km northwest of Bustard Island and the second camp was located approximately 1 km north of Lapworth Point. The camp facilities consisted of two prospector tents and seven personal tents. Access to traverse lines was conducted by inflatable Zodiac boats or via foot directly from camp locations.

3.4 Leland Lakes Area

The AGS conducted fieldwork along both sides of Leland Lakes (Figure 3). The crew was based out of the Leland Lakes outpost camp for 9 days, from July 8 to July 16, 2025. The crew accessed traverse lines primarily using Zodiac boats, while several flight-supported traverses were also completed in the McLelland Lake and Loutit Lake areas.

3.5 Colin Lake Area

For the last phase of the program, AGS conducted flight-supported traverses out of the Andrew Lake Lodge for 6 days, from July 16 to July 21, 2025. The area of interest spanned from the northern extent of Colin Lake southward to approximately 6 km north of Lapworth Point (Figure 4). Traverse lines were accessed via a Cessna 180.

3.6 Field Methods

Field data were collected with GPS-enabled tablets using the QField program. Field station data included GPS location, as well as lithological, mineralogical, alteration, metamorphism, mineral assemblage, structural, and rock properties data. Samples were collected with hand tools and placed in prelabelled and tagged plastic sample bags. Sample bags with certified reference materials were introduced to the sample stream to verify lab performance.

In addition to geological information, magnetic susceptibility and conductivity data were selectively collected at geological stations using a Terraplus KT-10 meter. Radioactive spectra were collected using a Radiation Solutions Inc. RS-230 instrument. The number of stations, samples, and measurements collected by area of interest are presented in Table 1.

Table 1. Number of stations, samples, and rock properties measurements collected from each area of interest for the 2025 fieldwork.

Area of Interest	Stations	Samples	Magnetic Susceptibility	Conductivity	Radiometric Spectra
North Shore of Lake Athabasca	236	209	125	93	161
Leland Lakes area	101	81	58	57	54
Colin Lake area	39	30	23	23	33

4 Post-Field Analyses

4.1 Current Status

Analysis of samples and data collected from the 2025 field season is underway at the Mineral Core Research Facility in Edmonton. A total of 337 samples, including 19 certified reference materials, were submitted to Activation Laboratories Ltd. (also known as Actlabs) in Ancaster, Ontario, for whole-rock geochemical analysis. Four different analytical packages were selected: (1) the 4LithoResearch whole-rock analysis and trace element package utilizing lithium borate fusion and inductively coupled plasma mass spectrometry (ICP-MS) and optical emissions spectroscopy (ICP-OES) to provide analysis for major oxides and trace elements, (2) the 4B1 package for the analysis of base metals utilizing a four-acid digestion with ICP-OES, (3) the UT-7 package for the analysis of lithium utilizing a sodium peroxide fusion with ICP-MS, and (4), the IC-OES package for the analysis of gold, platinum, and palladium. Together, these packages provide a total of 61 reported major oxides and trace elements for geochemical analysis of samples collected during the 2025 field season.

A subset of 92 samples submitted for whole-rock geochemical analysis was also selected for thin section petrography. Thin section billets were sent to Spectrum Geosciences to create standard-sized (e.g. 25 mm by 45 mm), polished, 30-µm-thick, thin sections. Petrographic descriptions will be used to refine lithologies and the associated map units. A subset of thin sections will be selected for further analytical work, including geochronology and elemental characterization. Additionally, five samples, including three from the Burntwood complex and two from the Fair Point Formation, were submitted for mineral separation of zircon to facilitate future detrital geochronology.

4.2 Deliverables

4.2.1 Geochemistry and Mapping Publications

A series of digital data releases are expected to be released over the next two years. The first of these will be a tabular compilation of basic field observations and geochemical data. Additional dataset releases will include shapefiles of structural data and their associated field observations, 1:30,000 scale bedrock geological maps in each of the three areas of interest, and a compilation of both historical and recent geochronology data from the Canadian Shield of northeastern Alberta.

4.2.2 Burntwood Complex Report

A second report is in preparation that will describe and discuss the origin of the Burntwood complex, a metasedimentary geological unit along the north shore of Lake Athabasca, previously interpreted as either belonging to the Athabasca Group or the TMZ. The report will be an open file report summarizing field investigations and will provide geochronological and geochemical data as well as present a new lithological assignment for the Burntwood complex.

4.2.3 Mineral Potential Report

A third report is planned that will summarize the mineral potential of the North Shore of Lake Athabasca, Leland Lakes area, and Colin Lake area. The report will include a discussion of the units encountered and present revised bedrock geological maps and mineral system models for igneous-hosted critical minerals, as well as provide recommendations for future work to further delineate the mineral potential of the region.

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