

## Regional till and stream sediment geochemistry surveys to support the evaluation of critical mineral potential in Alberta

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### Summary

The Government of Alberta has outlined a Minerals Strategy and Action Plan with a critical objective to increase the availability of public geoscience information (Alberta Energy, 2021). This information equips exploration companies, property owners, and Indigenous Peoples with the knowledge necessary to make informed decisions about Alberta's resources. As the provincial geoscience experts, the Alberta Geological Survey (AGS), a branch of the Alberta Energy Regulator (AER) has initiated a Mineral Mapping Program (Alberta Energy Regulator, 2025). As part of this program, AER and AGS recognize that high-quality and comparable regional-scale geochemical and mineralogical data form an important foundation for successful mineral exploration and are integral to attracting exploration investment to the province.

To provide these critical data, AER and AGS contracted Palmer (now SLR Canada) to oversee and complete regional till and stream sediment sampling surveys in three areas of interest (AOIs) (Figure 1). The ambitious program extends over 142,000 km<sup>2</sup>, reaching the northern and southern borders of the province. The three AOIs include: the foothills of the Rocky Mountains (AOI-1); an area surrounding High Level (AOI-2), and an area between Fort McMurray and Lesser Slave Lake (AOI-3). These areas were chosen because of their prospective geology and the low density of geochemical and mineralogical data that was previously available to inform mineral exploration and resource development initiatives and decisions. This presentation provides an overview of the ambitious sampling programs and summary of the results.

### Methods

Till and stream sediment were selected to determine mineral potential at a regional scale because these materials have a predictable relationship with the underlying bedrock and their geochemical data can provide insight into the bedrock composition over a large area. Till is dominantly a first derivative of bedrock that has been eroded and transported by glaciers and ice flow vectors can be used to trace the anomalies back to a bedrock source. Stream sediment samples represent geochemistry within catchment basins. In upland areas where surficial deposits are thin, streams interact directly with bedrock, resulting in alluvial sediment that is a first derivative of bedrock. In lowland areas, sediment transport history can be more complicated due to the watercourses flowing over bedrock and/or multiple glacial and Holocene deposits. In these areas, a detailed understanding of the landscape evolution and morphology will aid in the evaluation of the data.

Sample locations were identified prior to the field programs. The till survey was designed by creating a preliminary offset grid within each AOI that was oriented perpendicular to the dominant ice flow directions. The proposed grids were compared with existing surficial geology mapping, satellite imagery, and LiDAR, and manually modified to position proposed sample sites where till is likely to occur. For stream sediment samples, higher order stream segments that collectively tested the largest portion of the AOIs were selected for sampling, with consideration to keeping

the overall catchment sizes low. Satellite imagery was used to identify potential sample sites on depositional fluvial landforms in areas proximal to helicopter landing sites.

The initial till and stream sediment survey was conducted using hand-tools. Road- and stream-cut exposures were targeted for till sampling to help reach depths where unweathered subglacial till from the C soil horizon could be collected. The stream sediment sampling targeted depositional fluvial landforms, where material was sieved in the field to remove the coarse size fractions.

A subsequent multi-phase drill-supported till survey was completed within the north-central part of AOI-2 to begin filling data gaps in areas where a mantle of glaciolacustrine material and poor road access hindered surface sampling approaches. A pilot program was completed in January of 2023 to demonstrate that purpose-built, shallow drilling technology can be used to efficiently collect till samples in areas where standard hand sampling methods are inadequate. Following the positive results, the program was extended to provide additional information on the prospectivity of the Great Slave Lake Shear Zone and follow up on a sphalerite-in-till anomaly that was identified in previous regional-scale till surveys (Plouffe et al., 2006).

Leveraging existing seismic lines, sampling sites were planned along existing unvegetated to sparsely vegetated seismic lines that are oriented roughly perpendicular to ice flow direction. Sampling was completed using a rotary-percussion drilling system specifically tooled and engineered for till sampling with minimal environmental impact. A custom flow-through style sampler was used to collect *in situ* material from the boreholes up to about 10 m depth.

All till and stream sediment samples underwent a modified aqua-regia digestion and were analyzed by inductively coupled plasma mass spectrometry for 65 elements (53 elements + REE). Another aliquot was subjected to lithium borate fusion followed by nitric acid digestion. Eighteen major oxides and elements were determined using inductively coupled plasma-emission spectrometry (ICP-ES) and loss-on-ignition was completed by weight difference after ignition at 1000°C (lab method code LF300). In addition, 45 trace elements, including 14 precious and base metal elements, were determined by ICP-MS following the lithium borate fusion.

## Results

The programs yielded 788 till and alluvium samples that have undergone geochemical analysis. Adequate coverage was achieved in many areas, although some regions, especially where access is poor or other materials overlie till, remain under-represented in the geochemical data. Additional drill-supported sampling could improve coverage in these regions. All geochemical samples were analyzed using methods that conform to strict quality control specifications and have resulted in the production of a comprehensive geochemical dataset.

Analytical results from the first year of the program are available in Sacco et al. (2023) and the most recent survey data will be released in a subsequent AGS publication. Preliminary evaluation of the data reveals several clusters of geochemical anomalies that represent compelling exploration targets such as coincident Ag and Cu and Zn anomalies in AOI-2 (Figure 2).

## References

- Alberta Energy. 2025. Unlocking Alberta's Mineral Potential: A Collection of Mineral Data. Ministry of Energy, Government of Alberta. Retrieved from <https://ags.aer.ca/our-science/mineral-resources/mineral-mapping-program>
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- Sacco, D., Howitt, L., Knox, C., DesRosiers, P., Whitney, J., Janzen, B., McCuaig, S., McKillop, R. and Meek, D.M. 2023. Regional till and stream sediment sampling to support the evaluation of critical mineral potential in Alberta; Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Special Report 115.

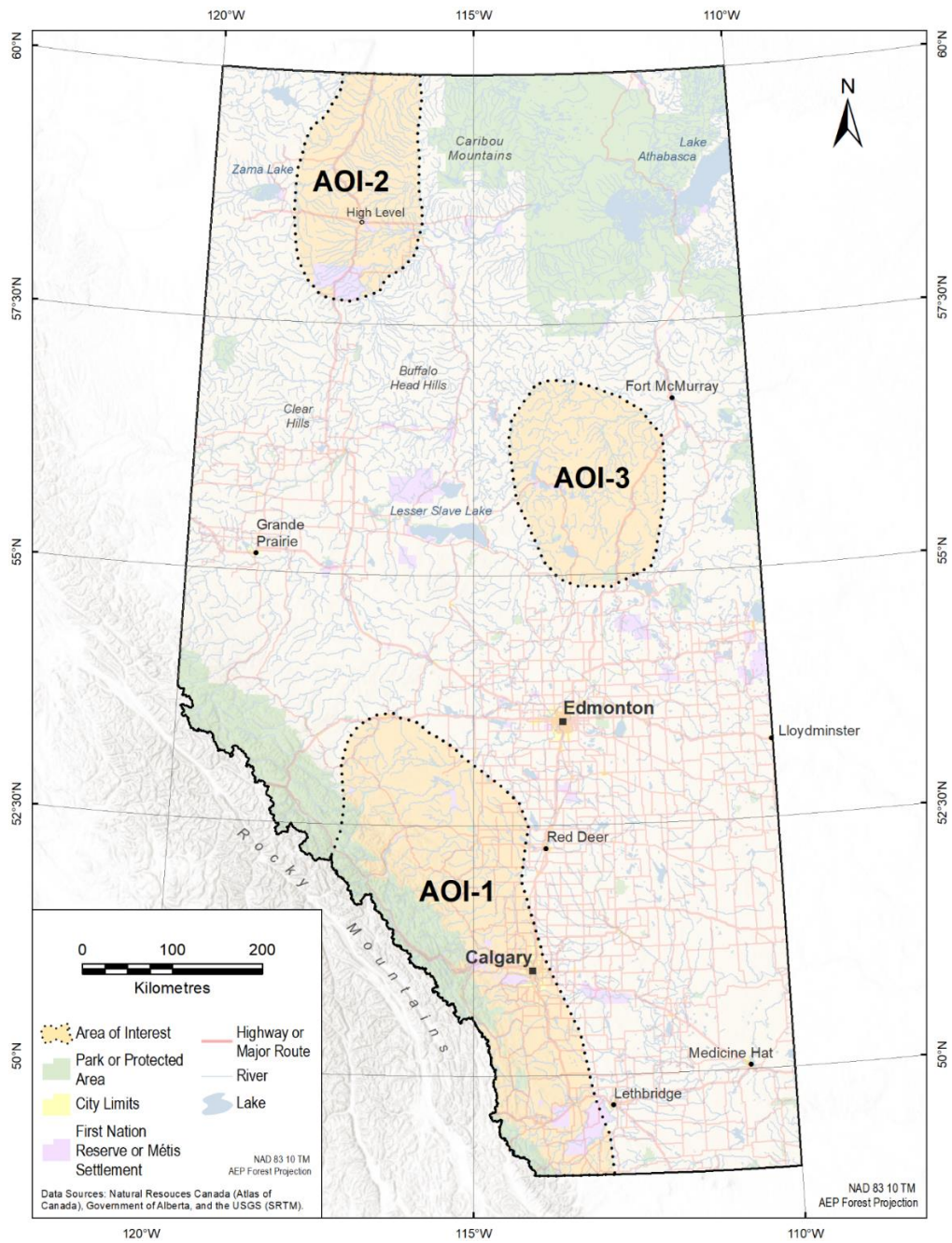


Figure 1: Project areas of Interest (AOIs)

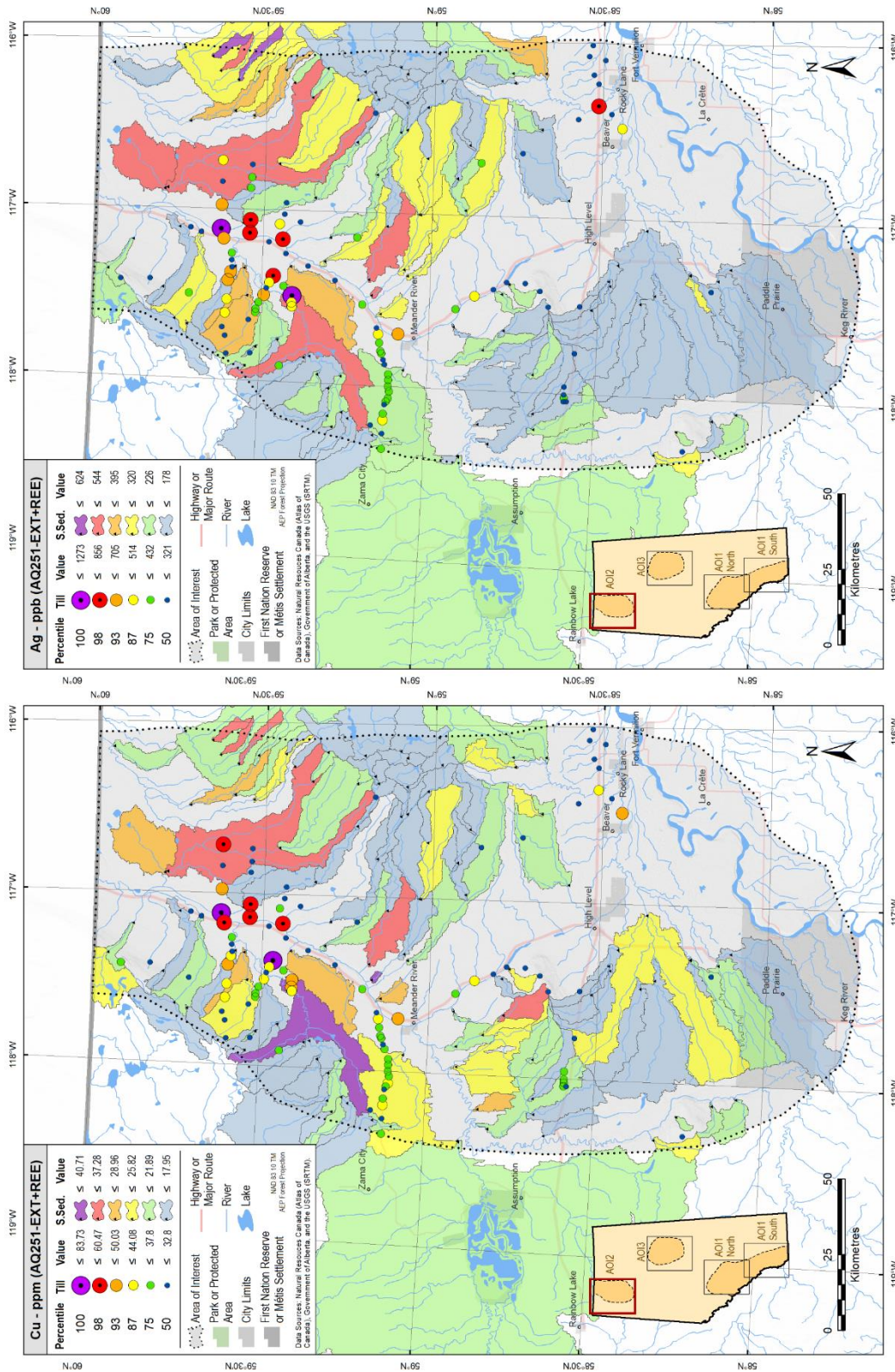


Figure 2. Coincident Cu and Ag anomalies in till and stream sediment samples (symbolized by catchments) in AOI-2 resulting from the regional geochemical survey.