470 Granville Street, Suite 630, Vancouver, BC V6C 1V5
Tel: 604-629-9075 | www.pecg.ca

January 6, 2021

A Proven Approach to Mineral Exploration in Thick Surficial Deposits Applied to the CICGR Project Areas, Central British Columbia

Dave Sacco, Palmer, British Columbia (dave.sacco@pecg.ca)
Wayne Jackaman, Noble Exploration Services, Jordan River, British Columbia (wjackaman@shaw.ca)
Cameron Knox, Palmer, British Columbia (cameron.knox@pecg.ca)

Abstract

The integration of surficial geochemical and mineralogical data, bedrock geology and geophysics data has proven effective in identifying economic mineralization. The CICGR project area, located in central British Columbia, has significant mineral potential; however, exploration is hindered by thick drift that obscures bedrock, increasing the reliance on exploration methods that utilize surficial data. Few methods for surficial exploration are consistently successful at providing an accurate understanding of bedrock composition below thick drift. One exception is the use of subglacial till geochemistry and mineralogy contextualized by a detailed understanding of the surficial geology and glacial history.

This project applied a scalable and proven methodology to produce a standardized and comprehensive subglacial till geochemical and mineralogical database, and the glacial framework necessary to collect and interpret these data. In the first year of the project, surficial geology and till sampling suitability were classified for ~12 1:50 000 NTS map sheets. This exploration-focussed mapping provided a basis to understand the genesis of historical surface sediment samples and streamline a regional subglacial till sampling program. Material from 966 archive samples was recovered and analyzed using current analytical methods, and 456 new till samples were collected to supplement the historic data and optimize sample densities throughout the study area. The goal of this project is to provide high-quality, baseline data that promote and support successful mineral exploration in British Columbia and can be leveraged by private-sector exploration programs.

A Proven Approach to Mineral Exploration in Thick Surficial Deposits Applied to the CICGR Project Areas, Central British Columbia

Dave Sacco[1] (dave.sacco@pecg.ca), Wayne Jackaman,[2] and Cameron Knox[1]

[1]Palmer, Vancouver, British Columbia [2]Noble Exploration Services, Jordan River, British Columbia

Central Interior Copper-Gold Research Project

Geoscience BC's **C**entral **I**nterior **C**opper-**G**old **R**esearch (**CICGR**) project is a multi-year initiative investigating the potential for new mineral deposits in the central part of British Columbia's Interior Plateau between Mackenzie and Williams Lake. The project area includes parts of NTS 093A, B, G, J, K and O and covers approximately 9,700 km^2 (Figure 1). The project is designed to provide comparable, high-quality geoscience data that can be used to identify mineral exploration targets buried under Quaternary sediments and to attract investment and inform natural resource decisions. This surficial exploration component of the CICGR project uses refined drift prospecting strategies that have been developed over decades (*e.g.*, Bobrowsky *et al.*, 1995; McClenaghan *et al.*, 2005) and have proven to be powerful tools in identify mineralization under thick surficial cover.

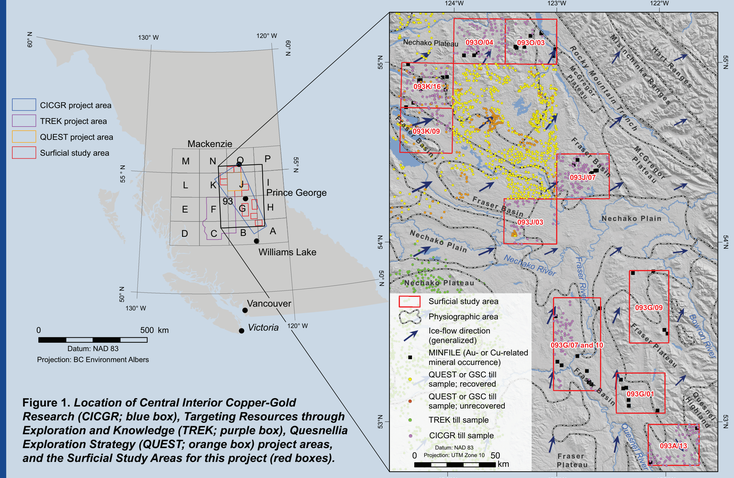


Figure 1. ***Location of Central Interior Copper-Gold Research (CICGR; blue box), Targeting Resources through Exploration and Knowledge (TREK; purple box), Quesnellia Exploration Strategy (QUEST; orange box) project areas, and the Surficial Study Areas for this project (red boxes).***

The CICGR project area has significant mineral potential; however, exploration is hindered by extensive Quaternary sediment units that obscure bedrock. This surficial exploration project is generating high-quality baseline data necessary to promote and support successful mineral exploration in this challenging setting. Employing streamlining mapping and field methodologies developed specifically for central British Columbia during Geoscience BC's QUEST (Ward *et al.,* 2013) and TREK (Jackaman *et al.,* 2015) projects, the results of this project extend the coverage of directly comparable till geochemical and mineralogical data and 1:50 000 scale surficial mapping to a large, nearly continuous portion of central BC.

This surficial exploration program focusses on select regions of the larger CICGR project area that have prospective bedrock geology, are suitable for till sampling and contain limited amounts of private land (*e.g.*, agriculture and development). During the second year of the project, the area of the surficial exploration project was increased from 8,600 km^2 with the addition of a 1,100 km^2 area dominantly covering NTS map sheet 093G/09. The scope of the program defines three main objectives:

1) 1:50 000 scale surficial geology, till sampling suitability and drift thickness mapping. In year one, surficial geology interpretations were used to derive till sampling suitability maps and drift thickness and bedrock occurrence maps to identify and prioritize areas for till sampling and focus bedrock mapping and sampling initiatives.

2) Compilation of historical data and reanalysis of archived till survey samples. Also completed in year one, all historical data were compiled, and aliquots of available archive samples were collected and reanalysed using modern protocols.

3) New and infill till geochemical and mineralogical surveys. Till surveys were started in year one and will be finished in year two. Target sample spacing is roughly two kilometres with material collected at every other site for indicator mineral analysis .

Surficial Geology Interpretations

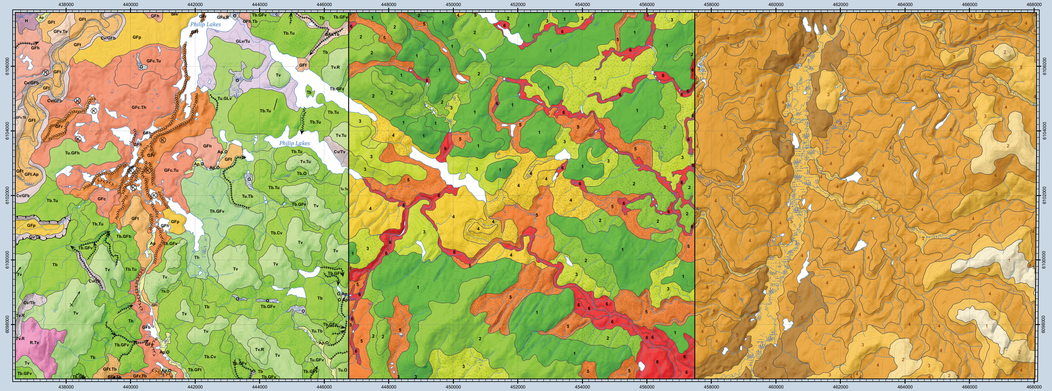
The surficial geology mapping provides an understanding of the drift composition and geomorphological events that formed and actively modify the landscape. This information allows optimal exploration methods to be selected and provides a context in which surficial exploration data can be evaluated to better understand how anomalies are formed and their potential displacement from source. Interpretations of surficial geology were used to derive till sampling suitability and drift thickness maps that are designed to inform the planning and execution of fieldwork.

During the first year of the program, preliminary surficial geology interpretations were completed for the entire study area. This mapping was finalized for NTS map areas 093J/07, 03, 093K/09, 16 and 093O/03, 04 using field observations collected during the till sampling program. The remaining areas will be finalized using field observations collected during the upcoming 2021 sampling program. Till sampling suitability and drift thickness categories were finalized and attributed to the surficial geology polygons. In the CICGR area, till sampling suitability is most heavily influenced by the distribution of glacial lake sediments and ablation till. These glacial lake and stagnating ice deposits are also generally associated with thicker drift as they tend to accumulate in large depressions (*i.e.,* Fraser Basin around Prince George) and within valley fill sequences. As a result, the areas that are poorly suited to surface till sampling due to overlying glaciolacustrine and ablation till deposits are well-suited to subsurface drill-supported sampling. Drill-supported sampling has the potential to provide till and bedrock samples, and stratigraphic information, which can inform the evaluation of surface sediment exploration data and provide additional information about groundwater and sediment aquifer potential.

Surficial geology mapping - 1:50 000-scale surficial interpretations following standardized protocols established by the Geological Survey of Canada with minor refinements to improve applicability to exploration. Polygons are coloured based on the dominant surficial material and patterned overlays are used to emphasise geomorphological processes and ground conditions that affect till sampling programs. Discrete landforms are identified by onsite symbols.

Till sampling suitability mapping - derived from the surficial interpretations to identify areas that are well- and poorly suited to till sampling to inform the planning and execution of till surveys. Each polygon is attributed a suitability based on a multi-class index that is tailored to the results of the surficial mapping. The index considers till facies and geomorphological processes that may have affected the sediments. The suitability rating is ultimately determined according to the proportion of a polygon in which *in-situ* subglacial till occurs at surface.

Drift thickness mapping - Drift thickness attributions are based on the surface expression of the surficial map units and provide a relative estimate of sediment thickness over bedrock. This derivative is designed to help determine effort required to access bedrock for mapping and sampling (*e.g.*, exposed at surface; accessed with hand tools, or requires mechanical assistance). It also informs where deep-sediment sampling techniques, such as drill-supported till sampling, are applicable.



Outcrop
Kettle
Kame
Esker
Streamlined bedform
Meltwater channel
Reworked (major)
Reworked (minor)
Colluvial veneer
Organics
Alluvial plain
Glaciofluvial hummocks
Glaciofluvial ice contact
Glaciofluvial veneer
Glaciofluvial ridge
Glaciofluvial terrace
Glaciofluvial plain
Glaciolacustrine veneer
Till veneer
Till undulating
Till blanket
Till hummocky
Bedrock

Till sampling suitability	Implications for exploration
1	Most surface sediment is composed of till and suitable for sampling; minor amounts of other materials may occur even where not indicated in map unit.
2	Till is the dominant surficial material, or greater than half of the map unit is in situ subglacial till. Most of the map unit is suitable for surface till sampling.
3	In situ subglacial till comprises less than half of the map unit. Focus on high ground and down-ice from bedrock outcrops to increase the probability of finding till suitable for sampling at surface.
4	Suitable till for sampling likely occurs at surface in a small proportion of map unit. Focus on high ground and down-ice from bedrock outcrops to increase the probability of finding till suitable for sampling at surface; machine-supported sampling may be benificial.
5	Map unit dominantly composed of reworked till at surface, which is not suitable for sampling, and other materials. Till suitable for sampling is most likely to occur on high ground, but will be very limited in extent; machine-supported sampling is recommended.
6	Unlikely to locate suitable till for sampling at surface within map unit; machine supported sampling is recommended.

Drift thickness class	Implications for exploration
1	Bedrock occurs at surface or can be accessed with hand tools in most areas; optimal target for bedrock mapping and sampling; till in these units is commonly weathered and may not be suitable for mineral exploration samples.
2	Bedrock is exposed at surface on topographic highs and can be accessed in hand-dug pits in most areas; good target for bedrock mapping and sampling; weathered till is common; composition of in situ till reflective of local bedrock.
3	Bedrock outcrop is limited, but may be accessible with hand tools on topographic highs, along steep slopes, and where meltwater has removed sediment; bedrock likely accessible with an excavator; till composition typically reflects local bedrock.
4	Bedrock outcrop is rare and will likely only occur on topographic highs; bedrock may be accessible using excavator; till composition reflective of more distal bedrock sources.
5	Drill likely needed to access bedrock; underlying till is likely representative of more distal bedrock sources.
6	Drill needed to access bedrock; potential for complex stratigraphy must be considered during drill-supported sediment sampling.

Data Compilation and Reanalysis of Archive Samples

Historical analytical results have been compiled from regional till sampling programs by the Geological Survey of Canada and Geoscience BC's QUEST project. From these, samples with incomplete or outdated analytical information and available archived material are being reanalyzed to elevate the analytical results to current standards (Table 1; Figure 1).

To date, 288 representative 2 g splits of the silt plus clay–sized (<0.063 mm) fraction of archive sample material and 672 original unprocessed character splits were retrieved from the storage. Archive sample material was sent to Bureau Veritas for an ultra-trace analysis by inductively coupled plasma–mass spectrometry for 53 elements following aqua-regia digestion, and major and minor elements by lithium borate fusion inductively coupled plasma–emission spectrometry following lithium metaborate/tetraborate fusion and dilute acid digestion.

Report	Year	Recovered Samples	Pending Samples	Archived Fraction	NTS map area
Geoscience BC Report 2013-15 (Ward *et al.*, 2013)	2013	672	153	Unprocessed	093J/03, 05, 06, 10-14
GSC Open File 2593 (Plouffe and Ballantyne, 1993)	1990, 1991	225	63	0.063 mm	093K/01-08, 10-12, 15, 16; 093N/01, 02, 06-11
GSC Open File 3194 (Plouffe, 1995)	1992, 1993, 1994	53	353	0.063 mm/ unprocessed	093K/01-10, 12, 14-16; 093L/01, 08; 093N/02-12, 14-16; 093O/05,12
GSC Open File 3687 (Plouffe and Williams, 1998)	1997	2	0	0.063 mm	093K/04
Unpublished	1997, 1998	8	2	0.063 mm	093K/09,15; 093N/02, 03, 06, 11

Table 1. ***Sources and status of archive sample compilation for the CICGR surficial exploration project***

New Till Geochemical and Mineralogical Data

The current sampling program aims to improve sample site densities throughout the study area. To date, 456 new till samples have been collected. Adequate sample density has been attained within NTS map sheets 093J/03,07, 093K/09,16 and 093O/03,04. 093A/13 and 093G/07,10 were partially sampled but require additional sampling to attain the ideal sampling density and distribution (Figure 1).

At each sample site, two 1–2 kg subglacial till samples are collected for geochemical analysis and 50 clasts of large pebble- to small cobble-size are collected for lithological analysis. At the lab, an archive is created and clay-sized (0.002 mm) and silt plus clay–sized (<0.063 mm) fractions are prepared. Both fractions are analyzed for minor and trace elements by an ultra-trace aqua-regia digestion ICP-MS package for 53 elements and by INAA for total gold plus 34 elements. Major and minor elements are determined by ICP-ES following a lithium metaborate/tetraborate fusion and dilute acid digestion. This analytical package also includes loss-on-ignition, plus total carbon and sulphur by LECO analysis. Clasts will be grouped into fundamental lithologies to provide insight on the direction and distance of glacial transport. At approximately every other site, a 10–12 kg sample is collected for mineralogical analysis and sent to Overburden Drilling Management Limited where concentrates are produced using a combination of gravity tables and heavy liquids and gold grains and porphyry copper indicator minerals are identified.

Figure 3. ***Typical till sampling site and till and pebble samples.***

Conclusions and Future Work

This project provides a comprehensive dataset that contributes to the province-wide, regional exploration database. Methods conform to strict specifications; data are comprehensive, compatible, and reproducible; and the results inform a wide range of ongoing geoscience initiatives and exploration activities in BC. Project results, combined with data from the TREK and QUEST projects, extend the coverage of comparable surficial geology interpretations and geochemical and mineralogical data to a large portion of central British Columbia, and will promote and support successful exploration in a highly prospective region.

Surficial geology, till sampling suitability and drift thickness maps for 093J/07,03, 093K/09,16 and 093O/03, 04 will be released in Q1 2021. The remaining mapping will be completed following ground truthing in the 2021 field season. The reanalysis of historical samples is also complete. One more attempt will be made to recovery any remaining archived samples proposed for reanalysis. These data will also be released in 2021. The new till samples are currently being analysed at the laboratory. Completion of the till sampling in 093A/13 and 093G/07, 10, and 093G/01,09 is expected to occur during the 2021 field season.

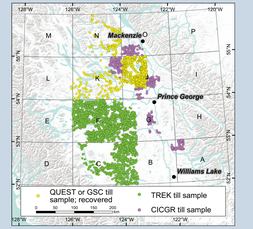


Figure 4. ***Till samples collected or reanalysed through Geoscience BC projects with comparable analytical results in central BC.***

Acknowledgements

This program was funded by Geoscience BC. The authors would like to thank A. Plouffe from the Geological Survey of Canada for his heroic efforts to recover archive samples from storage in Ottawa and his support in the development of this project. Assistance in archive sample recovery was also provided by R. Lett, E. Banner, B. Ward and T. Ferbey. H. Bains, B. Elder, J. Constandinou and B. Janzen provided additional field support and their willingness to dig "just a bit deeper" helped ensure high-quality samples were collected.

References

Bobrowsky, P.T., Sibbick, S.J., Newell, J.M., Matysek, P.F. (Eds.). 1995. Drift Exploration in the Canadian Cordillera. British Columbia Ministry of Energy and Mines and Petroleum Resources. Paper 1995-2. 310 p.

Jackaman, W.; Sacco, D.A. and Lett, R.E. 2015. Regional geochemical and mineralogical data, TREK project – year 2, Interior Plateau, British Columbia; Geoscience BC, Report 2015-12, 13 p., URL

McClenaghan, M.B., Bobrowsky, P.T., Hall, G.E.M., Cook, S.J. (Eds.). 2001. Drift Exploration in Glaciated Terrain. Association of Exploration Geochemistry-Geological Society of London Special Publication 185.

Plouffe, A. 1995. Geochemistry, lithology, mineralogy and visible gold grain content of till in the Manson River and Fort Fraser map areas, central British Columbia (NTS 093K, N); Geological Survey of Canada, Open File 3194, 119 p.

Plouffe, A. and Ballantyne, S.B. 1993. Regional till geochemistry, Manson River and Fort Fraser area, British Columbia (NTS 093K, N), silt plus clay and clay size fractions; Geological Survey of Canada, Open File 2593, 224 p.

Plouffe, A. and Williams, S.P. (1998): Regional till geochemistry of the northern sector of Nechako River map area, British Columbia (NTS 093F); Geological Survey of Canada, Open File 3687, scale 1:400 000.

Ward, B.C., Leybourne, M.I., Sacco, D.A., Lett, R.E. and Struik, L.C. (2013): Drift prospecting for porphyry copper-gold, volcanogenic massive sulphide mineralization and precious and base metal veins within the QUEST project area, central British Columbia (NTS 093J); Geoscience BC, Report 2013-15, 59