

Yukon Geological Survey 2023 overview

Carolyn Relf*
Yukon Geological Survey

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Introduction

This paper provides a high-level overview of the Yukon Geological Survey's (YGS) activities in 2023. Several of the projects described here are presented in more detail in the 2023 Yukon Exploration and Geology technical papers volume. References to these are included where applicable.

The YGS had a challenging year in 2023. Wildfires and landslides punctuated the field season, disrupting field plans for some, and requiring work priorities to be adapted. Additionally, the survey had six staff members leave and two others were on extended absences, which had an impact on operations. Despite a reduced capacity, YGS staff continued to deliver on projects and fill client requests for information. Recruitment efforts are underway and YGS anticipates seeing growth in the coming year.

Looking forward, 2024 marks the start of the survey's next five-year planning cycle. The YGS has started preparing for discussions among staff, research partners and clients about knowledge gaps and emerging needs. Readers are welcome to reach out and share their project ideas or suggest ways to improve on data delivery.

Snapshot of YGS

Staffing

The Minerals Geology and Surficial Geology units were most affected by staff vacancies in 2023. In January, Scott Casselman (Head of Minerals Geology) joined Rackla Metals as VP of exploration; he is now exploring for gold in the Tombstone belt in NWT and Yukon. Warwick Bullen (Mineral Assessment Geologist) joined Abyssinian Metals in February, working on mining projects in Ethiopia and other African countries. Collectively, they have more than 60 years of mineral exploration experience and their departures have left a big gap. In the Surficial Geology unit, Jeff Bond retired in September after more than 25 years working with YGS, mapping surficial geology and geohazards at a variety of scales and providing expert geological advice to placer miners. In March, Kristy Kennedy's secondment to Kluane First Nation was extended to November, and Panya Lipovsky took six months of deferred leave between April and September. As a result of these staff movements, the Surficial Geology unit was thin on capacity in 2023.

Other 2023 departures included Karen MacFarlane, who retired in July after 15 years leading the Technical Services unit and serving as publication editor. Sarah Sternbergh completed her term with the Bedrock Geology unit in March and joined Tetra Tech's Environmental Group in Whitehorse. In October, Julie Minor was offered the position of Finance Manager for Energy, Mines and Resources. Julie has managed YGS finances for the last seven years and her low-key competence has lulled the YGS into a sense of complacency, trusting that things will just get done. To all our ex-YGS staff, we wish you the best of luck in the various next chapters of your lives. We will miss you all.

While several people moved on from YGS, there were some additions as well. Chad Coté joined the survey as a Geomatics specialist, and Amanda O'Connor was hired as an Outreach Geologist. In the fall, Kristy Kennedy and Panya Lipovsky rejoined the Surficial Geology unit, and in December, Diane Skipton returned after a one-year maternity leave.

* carolyn.relf@yukon.ca

For the past two years, YGS has been advancing plans for a minor re-organization. The organizational chart (Fig. 1) reflects these changes, which are anticipated to be finalized early in 2024. The reorganization involves two significant changes. First, a position has been created for a Geoscience Research Manager, to which all three geology units (Bedrock, Surficial and Minerals) will report. This manager will focus on coordinating studies across the three units to enhance collaboration between disciplines. They will also take some of the administrative burden off the unit heads, freeing up more of their time to focus on research. An additional role will be to help identify external sources of funding, which make up a significant portion of YGS' annual

budget. The other structural change is the addition of a second Outreach Geologist position. This position was created to increase YGS' capacity to engage with Yukon First Nations on project plans, and to fill the growing demand for geoscience information by communities and the public. For instance, the recent increase in the number and frequency of landslides around the territory has led to greater awareness of climate change-induced landscape changes and their impacts. Ongoing land-use planning is also creating pressures, not only for the provision of mineral potential maps, but also for the role critical minerals will play as Yukoners work to reduce greenhouse gas emissions.

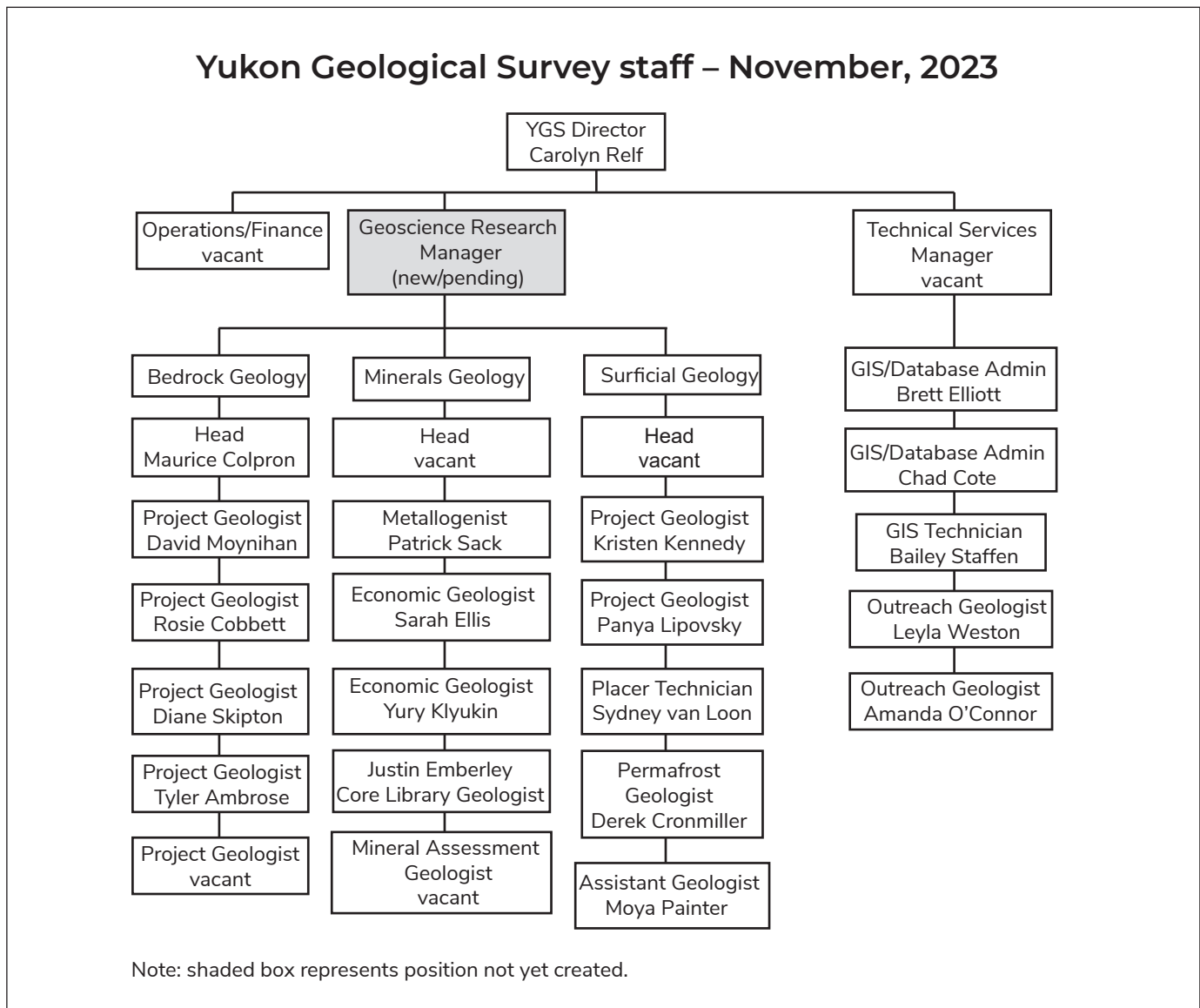


Figure 1. Yukon Geological Survey organizational chart.

Budget for YGS

The YGS' operational budget for 2023–24 was \$4,083,000, broken down as follows:

- \$1,365,000 Operation and Management, which covers core YGS project activities and administrative costs;
- \$425,000 to support geothermal research (\$300K) and geohazard assessments in communities and along highway corridors (\$125K), as part of the Government of Yukon's 'Our Clean Future' initiative;
- \$249,000 from (Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)) to support geohazard studies in the Klondike Region and along the Dempster Highway;
- \$230,000 of federal money committed by CIRNAC for drilling and instrumenting boreholes to enhance permafrost monitoring;
- \$380,000 from the Geological Survey of Canada's Geo-mapping for Energy and Minerals (GEM) program for a regional magnetotelluric survey; and
- \$1,433,000 for the Yukon Mineral Exploration Program (YMEP), of which \$1.4M are allocated for grants under the program.

Details of the activities funded by these sources are presented in the sections that follow.

Bedrock studies

In 2023, fieldwork was carried out on eight bedrock projects (Fig. 2). These included regional bedrock mapping projects (four), stratigraphic studies (two), and projects focused on mineral deposits/metallogeny (two). Highlights of these projects are presented below.

Teslin map area

In 2023, David Moynihan wrapped up three seasons of bedrock mapping that covered the area between the Teslin fault and Quiet Lake. The map area is shown in Figure 2 (location 1); both the entire map area and the area of focus for 2023 fieldwork are outlined. Moynihan's mapping suggests that rocks of the Cassiar terrane are more widespread in this part of Yukon than shown on existing maps.

The central part of Moynihan's map area is underlain by the Quiet Lake batholith, which cores a north-west-striking upright anticlinorium (Fig. 3). The batholith intrudes into a sequence of rocks that is correlated with the Cassiar terrane (Askin and Earn groups). Garnet amphibolite and eclogite are exposed on the southwest (near the Teslin fault) and northeast (St. Cyre klippe) flanks of the anticlinorium, and are interpreted to form part of a thrust sheet that was arched over the batholith. Correlation of these high-grade rocks across the area is based on the ca. 266 Ma ages of metamorphic zircons (Moynihan and Crowley, unpublished data, 2022, 2023; Fallas et al., 1998; Petrie et al., 2016). The southwestern edge of the map area is bounded by the Teslin fault, along which deformed rocks of the Yukon-Tanana terrane are preserved.

Moynihan's observations from the 2023 field season are presented in Moynihan (2024). He will initiate compilation of a Geoscience Map and Bulletin on the entire study area in the spring of 2024.

Rackla River area

Tyler Ambrose completed a fifth and final season mapping in the Rackla River area in 2023 (Fig. 2, location 2) and has initiated work on a final Geoscience Map and Bulletin detailing the results of the project. Following last year's release of a compilation of whole-rock and sulphide isotope datasets (<https://data.geology.gov.yk.ca/Compilations/>), Ambrose and Patrick Sack have initiated a study investigating the lead isotope compositions of carbonate-hosted zinc occurrences in Selwyn basin and Ogilvie Platform.

Ambrose is also working with PhD student Lucy Webb (Stanford University) on a stratigraphic reinterpretation of Proterozoic rocks in the Coal Creek Inlier (Fig. 2, location 3). The rocks here are stratigraphic equivalents to the units he has been mapping near Rackla River. Preliminary results of this work are presented in Webb and Ambrose (2024).

Misty Lake area

Rosie Cobbett initiated a new bedrock-mapping project in the Misty Lake area (Fig. 2, location 4), and her 2023 fieldwork entailed a few weeks of reconnaissance work to familiarize herself with the geology of the area. The project will focus on subdividing rocks of the Hyland Group using stratigraphic subdivisions defined to

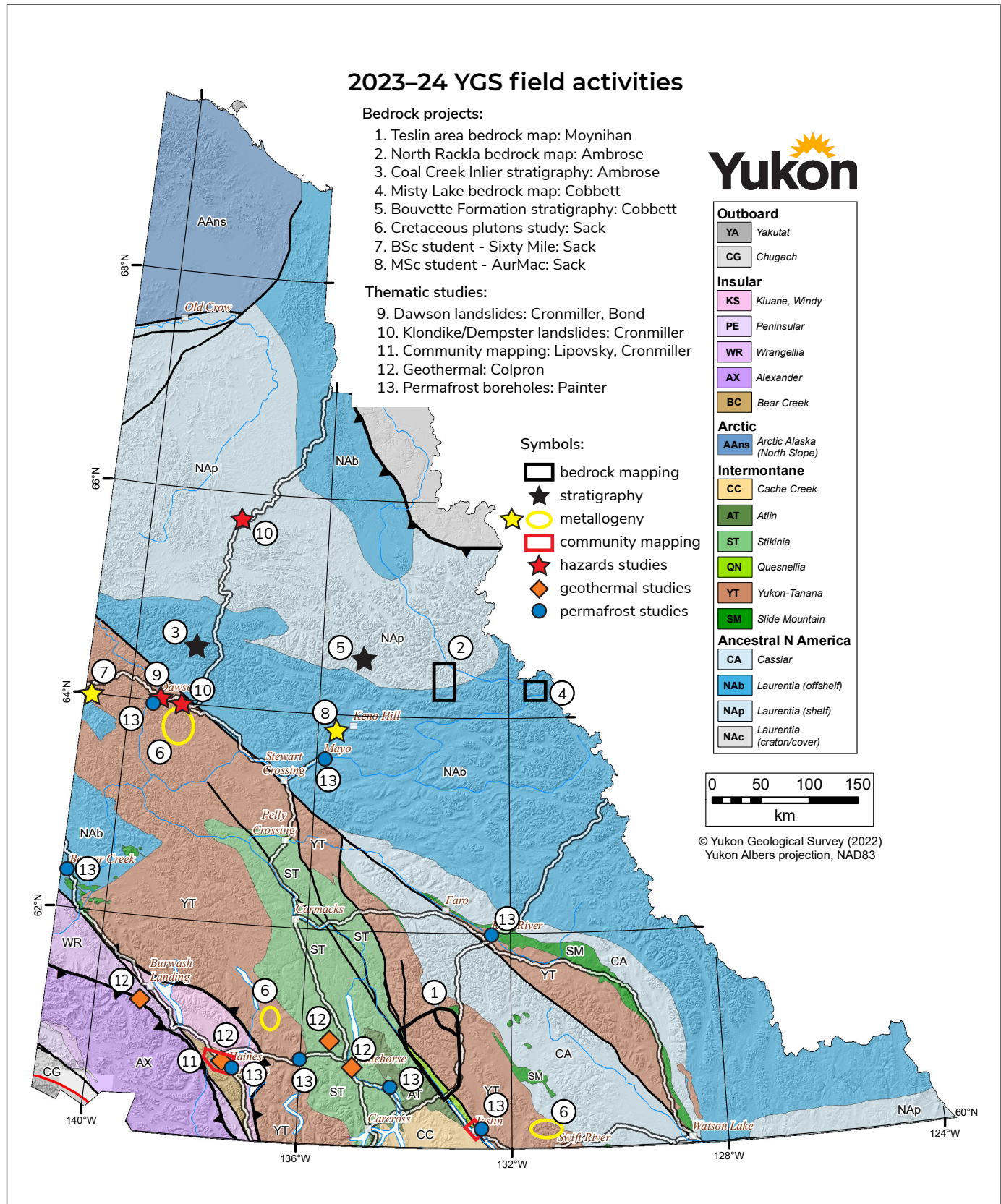


Figure 2. Locations of 2023 YGS field activities. Terrane map from Yukon bedrock geology map (Colpron, 2022).

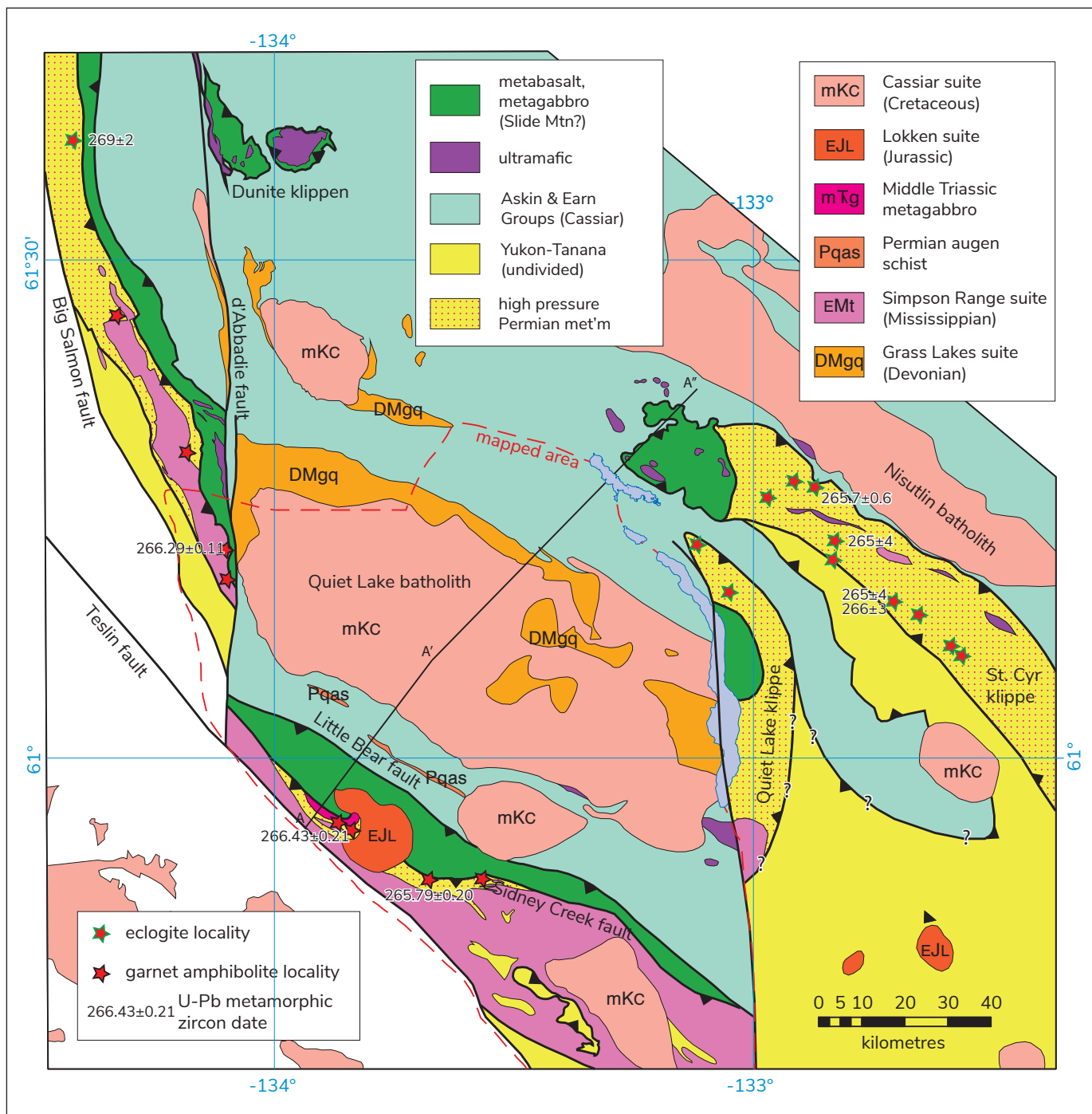


Figure 3. Simplified geology map of the Quiet Lake batholith and surrounding area. Dashed red line indicates area mapped as part of the Teslin mapping project.

the west (Moynihan et al., 2019) and better defining Paleozoic rock units and structures northeast of the Hyland Group.

One of the units of particular interest in the area is the Algae Formation, which preserves fossils from the

Ediacaran-Cambrian boundary. Cobbett collaborated with Reina Harding (Dartmouth College), who collected samples and data for her PhD thesis. A second PhD student (Prescott Vayda, Virginia Tech) participated in the fieldwork and collected fossils to support his research (Fig. 4).

Bouvette Formation

In addition to initiating new mapping at Misty Lake, Cobbett continued collaborating with Justin Strauss (Stanford University) on a study of the Bouvette Formation (Fig. 2, location 5). In 2022, they measured a section through the lower part of the formation. In 2023, they completed measuring the upper part of the formation. This represents the first complete stratigraphic section of the entire Bouvette Formation (approximately 2.5 km); a unit that records carbonate deposition and minor volcanism on the Yukon stable block throughout the Paleozoic (Morrow, 1999).

Late Cretaceous pluton metallogeny

Patrick Sack wrapped up his study of Late Cretaceous magmatism and metallogeny, focusing fieldwork in three areas in 2023: the Klondike, south Aishihik Lake and Rancheria areas (Fig. 2, locations labelled 6). Samples were collected for whole-rock geochemistry, isotope analysis and U-Pb geochronology to characterize this widespread magmatic event and assess the copper porphyry potential of these rocks.

Results of this project will be written up as an Open File atlas of Late Cretaceous plutons once all the analytical work is completed.

Sixty Mile area

Patrick Sack's student Emilia Butty (Queen's University) carried out fieldwork for a BSc thesis in 2023 (Fig. 2, location 7), mapping volcanic rocks in the Sixty Mile district and collecting samples for geochemical and geochronological analyses (Fig. 5). Two preliminary U-Pb ages of 69.8 Ma (J. Crowley, unpublished data, 2023) confirm the correlation of these rocks with Late Cretaceous volcanic rocks of the Carmacks Group. An Open File map of the area is anticipated for release in early 2024; Butty's thesis will be completed shortly thereafter.

AurMac study

Patrick Sack initiated a project with Pilar Lecumberi-Sanchez (University of Alberta) for an MSc thesis study of the gold deposits at AurMac (Fig. 2, location 8). The pair are supervising student Keagan Parry, who started fieldwork in 2023. His first field season focused on logging core from the AurMac deposits and collecting samples for lab work. Preliminary graphite geothermometry shows a temperature gradient across the area, which may indicate the presence of a buried intrusion (heat source) to the north.



Figure 4. Trilobite from the Sekwi Formation near Misty Lake.



Figure 5. Patrick Sack examining Klondike Schist in Emilia Butty's thesis area. Photo taken on lower Bedrock Creek.

Other bedrock projects

Rosie Cobbett continued writing up the results of her PhD thesis research on Paleozoic volcanic rocks that are preserved as part of the continental margin across central Yukon (e.g., Goodfellow et al., 1995). This includes three papers—one of which was recently published (Cobbett et al., 2023), and two of which are in prep (*Cambrian and Late Ordovician magmatism along the Dawson fault*, and *Implications of alkali igneous rocks in southwestern Northwest Territories-southeastern Yukon*). Cobbett anticipates completion of her thesis at Memorial University of Newfoundland in 2024.

David Moynihan continued working on a Bulletin that summarizes results of mapping in the Upper Hyland River area between 2015 and 2018. The project included a comprehensive study of the pressure-temperature history in the central part of the area. Completion of the Bulletin is anticipated in spring 2024.

Justin Emberley and Andrew Schaeffer of the Geological Survey of Canada–Pacific (GSC-Pacific) visited a broadband seismic station at Stokes Point over the summer to perform annual maintenance. The station was installed in 2022 as part of a Canadian network of earthquake-monitoring instruments for the GSC’s Geohazards Program. The YGS has supported the network by providing field assistance during maintenance.

Thematic studies

Dawson landslide monitoring

In fall 2022, YGS installed a series of near-real time monitoring instruments on the Moosehide rock avalanche in Dawson City, and supported an MSc thesis study of a second large rock slide nearby (the Sunnydale slide; Fig. 2, location 9). The latter slide is located just upstream of Dawson City on the west bank (far shore) of the Yukon River. In 2023, YGS contracted BGC Engineering to complete a hazard assessment of the Sunnydale slide. The study modelled landslide runout as well as the magnitude and impact of a slide-generated displacement wave for six scenarios (based on two volumes of debris at low, high and average water levels). The study prompted the installation of near-real time instruments on the slide in spring 2023 (Fig. 6). Currently BGC Engineering is working

with Derek Cronmiller of YGS to monitor these two large slides. Their contract with YGS runs through to March 2025, at which point YGS staff will take over the monitoring.

Cronmiller is also monitoring a number of landslides and permafrost issues in and around Dawson City. These include substantial erosion along creeks in West Dawson and Sunnydale (related to permafrost degradation), and widespread slope instabilities throughout the Klondike Valley. Several slopes that pose a risk to the public were documented and instrumented for long-term monitoring. These sites are being integrated into a permafrost modelling study in collaboration with Dr. Stephan Gruber (Carleton University) to understand how ground temperature change is driving regional instability.

Landslides on the North Klondike and Dempster highways

Landslides along the North Klondike and Dempster highways continued to cause road closures and pose risks to motorists in 2023. Cronmiller installed near-real time tilt meters and ground temperature sensors at sites near Rock Creek and Dempster corner (North Klondike Highway), and worked with colleagues from Yukon’s Department of Highways and Public Works to coordinate road closures.

To help understand how permafrost degradation and landslides are affecting the Dempster Highway,



Figure 6. Panya Lipovsky adjusting a GPS unit installed on the Sunnydale landslide.

Cronmiller initiated an MSc thesis study with Heather Clarke (Simon Fraser University). Clarke is examining slides in areas where recent wildfires have affected permafrost between KM 130 and 370 (Fig. 2, location 10 on the Dempster Highway). Preliminary results of her work are presented in Clarke et al. (2024).

Community geohazards mapping

Upon completion of the Greater Whitehorse Area community geohazards study, Panya Lipovsky resumed work in 2023 on the Haines Junction map (Fig. 2, location labelled 11). The 1:15 000-scale map covers approximately 200 km² and documents surficial geology in and around the community, integrating remotely sensed data (air photos, satellite images and lidar) with field observations. Moya Painter and Derek Cronmiller also contributed to the project by facilitating targeted drilling for long-term permafrost monitoring wells. The map reveals widespread but discontinuous permafrost across the area, including local ground ice, and helps to constrain the limits of Neoglacial Lake Alsek. The final map and accompanying report will be valuable for informing community infrastructure planning and agricultural developments. It will also serve as a tool for identifying aggregate resources and geohazards (e.g., landslides, permafrost). Lipovsky plans to complete the map and report by summer 2024.

In collaboration with Lipovsky and Cronmiller, Jan Dettmer and Jeremy Gosselin (University of Calgary) initiated a novel study using passive seismic data from anthropogenic sources to characterize near-surface ground conditions around Haines Junction and Whitehorse. Specifically, the goal of the study is to identify areas where thawing permafrost may lead to increased seismic risk due to unconsolidated sediments being subject to more intense shaking during an earthquake. Their work is described in more detail in Dettmer and Gosselin (2024).

The YGS has been mapping the surficial geology and associated geohazards for the communities of Teslin and Beaver Creek. The Teslin map builds on work completed by Cronmiller when he was employed by Palmer Environmental and is supplemented with additional mapping and borehole logging by Lipovsky in 2022. In 2023, Cronmiller undertook additional field mapping and plans to release the map in 2024. The map of Beaver Creek is scheduled for release early in 2024; an associated hazards report will follow in the spring/summer of 2024.

Community-based geothermal studies

In 2023, YGS began winding down a series of geothermal studies targeting communities located near major faults (Fig. 2, locations labelled 12). A systematic approach was taken for the studies by collecting geological, geophysical and lidar data, and compiling the information to generate three-dimensional geological models. Modelling focused on identifying sites where fault bends may create local areas of extension (potential pathways for geothermal fluids) and near-surface anomalies characterized by high conductivity values (potential brines). The intent of these studies was to locate geothermal targets near these communities that could be tested with temperature gradient wells. To date, work around Watson Lake (Witter, 2022) and Teslin (Witter, 2023) has been completed. At Haines Junction, gravity and magnetotelluric data have been collected, and work will begin this winter to compile and interpret these data.

Near Burwash Landing, geothermal research has been ongoing since 2018. Geological modelling of the type described above was completed in 2020 (Witter, 2020) and a drill target was identified along the Duke River, 10 km west of the community. Since then, work has focused on refining the geophysical model with additional datasets: more detailed magnetotelluric data (Tshirhart et al., 2022a, b), drone lidar surveys (Finley et al., 2022), and fracture analysis (Chapman et al., 2023). More recently, there has been seismic data analysis (Han et al., 2024; Berumen-Borrego et al., 2024), and data collection from shallow temperature loggers (S. Grasby, unpublished data, 2022). Han et al.'s (2024) study reveals that the Denali fault near the Duke River drill site is not active; instead, displacement is occurring on nearby faults that parallel the Denali fault. The authors suggest that seismicity along these structures may enhance permeability and have implications for geothermal potential. Modelling of broadband seismic data by Berumen-Borrego et al. (2024) enabled estimates of the thickness of surficial sediment cover in the area. Such information is valuable for the design of temperature gradient and/or production wells, if there is interest for additional wells in the future.

The first phase of a temperature gradient well at the Duke River site was drilled to a depth of 220 m in fall 2022. The well was instrumented with a fibre-optic cable capable of measuring both temperature and seismic signals. In 2023, PhD student Fiona Chapman

(Institut national de la recherche scientifique – INRS) measured the temperature gradient and conducted a heat injection test to determine the downhole thermal conductivity and calculate heat flow at the Duke River site. She also collected temperature gradient data and conducted a heat injection test from a 384 m deep well in surficial sediments within the community of Burwash Landing. The community well was drilled by Kluane First Nation. Temperature gradients from the two wells are shown in Figure 7.

A new geothermal study was initiated late in 2023 in collaboration with the Business Transformation Branch (BTB) at Highways and Public Works. Under Yukon’s ‘Our Clean Future’ initiative, BTB has been tasked with identifying ways to reduce greenhouse gas emissions generated by heating public buildings. In 2022, they commissioned a study to assess the feasibility of geothermal heating opportunities in and around Whitehorse, focusing on areas around Yukon University, Whistlebend and Riverdale. The geology around the university campus is particularly appealing because it has many parallels with the geology surrounding the Takhini Hot Springs; specifically, a number of warm springs occur at the contact between Upper Triassic limestone and sandstone units in the Porter Creek and Crestview neighbourhoods. These rocks are intruded by the Haeckel granite pluton, which is inferred to be similar to the radiogenic Eocene granite found to the west of Takhini Hot Springs (Fraser et al., 2019). In October, YGS partnered with BTB to collect gravity data as a first step in assessing the area’s potential. Data collection was completed in 2023 and processing of the data is expected to be completed by spring 2024.

Although not specifically within a community, YGS supported a geothermal research project in the Takhini Hot Springs area, led by Xavier Léveillé-Dallaire of INRS. The study (Léveillé-Dallaire and Raymond, 2024) generated a hydrothermal model of the area surrounding the Takhini Hot Springs, using temperature and petrophysical data from a well drilled by YGS in 2017 near the spring (Fraser et al., 2019). The model, which attempts to simulate the observed water temperatures at the hot spring and in the well, suggests that basal heat flux, surface recharge, thermal conductivity and permeability of the rocks are all key factors in the observed conditions.

Maurice Colpron will coordinate the synthesis of the results from the above geothermal studies. Publication of the results is anticipated in 2024.

Regional geothermal investigations

In addition to geothermal studies at the community scale, YGS contracted a regional magnetotelluric (MT) survey across southern Yukon in 2022 and 2023 (Fig. 8). This contract was funded by the GSC through their GEM-GeoNorth program. The survey followed highway corridors, infilling areas that were not covered by the Slave Northern Cordilleran Lithosphere Experiment (SNORCLE) transect under the LITHOPROBE program of the 1990s. Data were also collected by helicopter

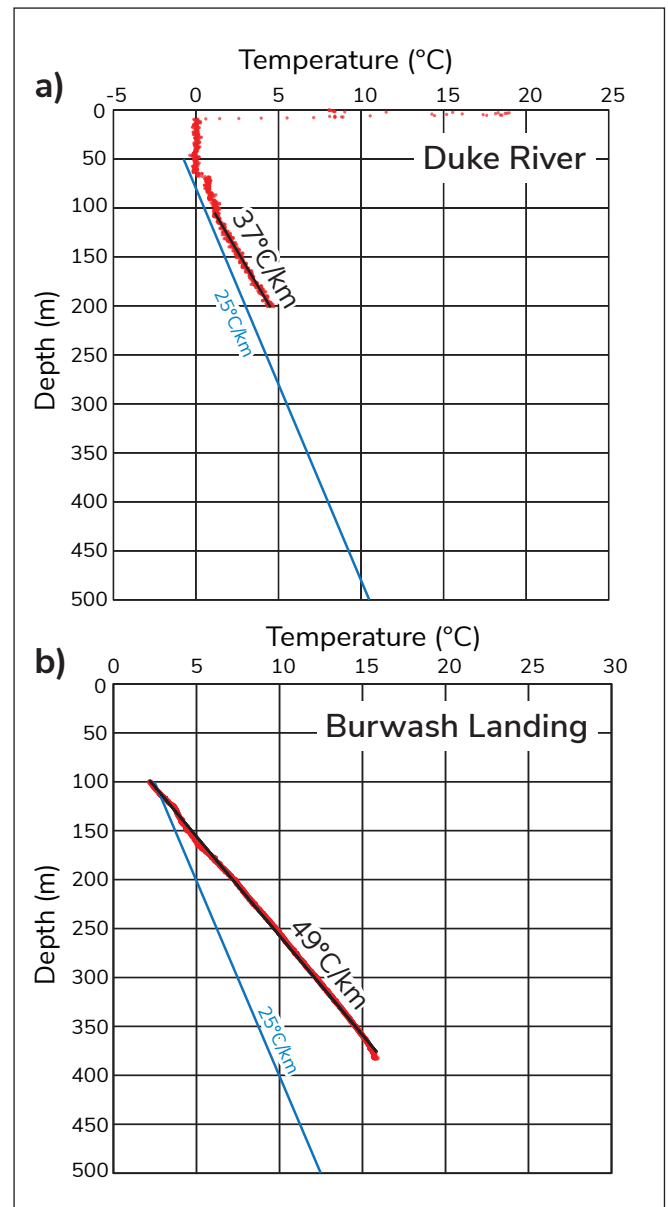


Figure 7. Temperature gradient data: **a)** the Duke River well (10 km west of Burwash Landing), and **b)** the Burwash Landing well in the community.

along a remote transect to fill a gap between data acquired in the Klondike area and the Kluane Lake region.

The intent of this survey is to characterize regional crustal-scale magnetic and conductive features that may reflect the presence of large-scale structures in order to target areas for future geothermal assessment.

Permafrost monitoring

Moya Painter took the lead role in permafrost monitoring for YGS in 2023, overseeing drilling of 19 new boreholes in targeted locations (Fig. 2, locations labelled 13). These include boreholes in Haines Junction and Teslin (two per community), and single boreholes in Mendenhall, Marsh Lake, Dawson City, Ross River and Beaver Creek. These boreholes range in depth from

7 to 10 m and are instrumented with thermistors. The boreholes in Dawson City, Ross River and Beaver Creek were located next to new water wells. In addition to these, 10 deep boreholes (ranging in depth from 15 to 30 m) were drilled in 5 communities in the fall (Dawson City, Mayo, Ross River, Beaver Creek and Haines Junction; Fig. 9). These boreholes were designed to enable monitoring of temperature changes at the base of permafrost. Thermistors will be installed in these wells in 2024.

The 19 boreholes drilled in 2023 brings the total number of YGS permafrost monitoring wells to 47. Temperature data were downloaded from the wells this summer, and Painter will upload the new data to the permafrost database (<https://service.yukon.ca/permafrost/>) over the winter. More details on the borehole project are presented in Painter et al. (2024).

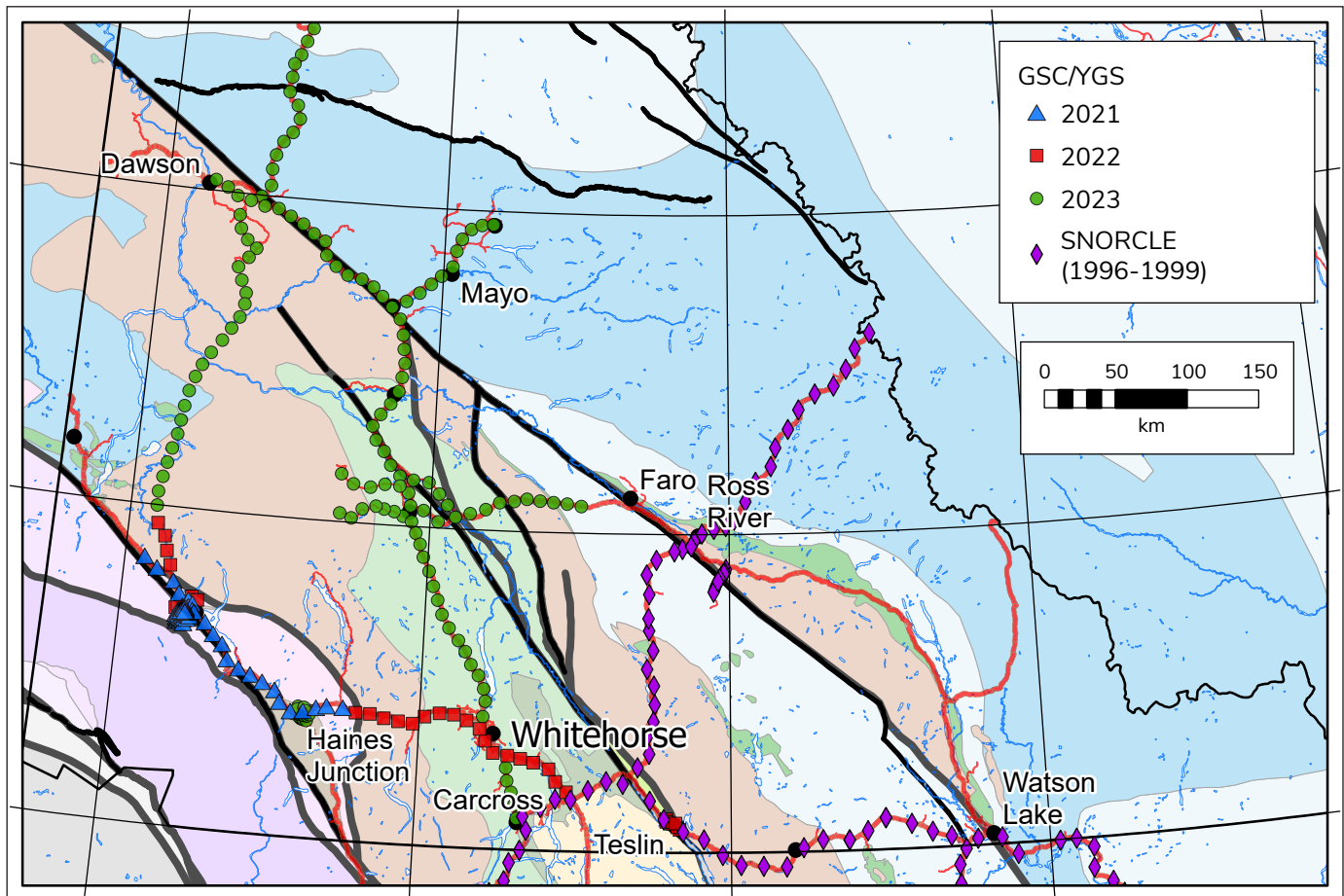


Figure 8. Map illustrating magnetotelluric (MT) station locations. Green dots indicate sites where data were collected in 2023.

Mineral industry services

Hardrock industry liaison

Staff carried out visits to 30 exploration properties in 2023. Sarah Ellis led the team, visiting 28 properties and capturing data from colleagues on properties she did not see in person. These visits provide staff an opportunity to familiarize themselves with property-scale geology, document preliminary exploration results, and collect data on exploration spending. One of the highlights of the 2023 exploration season was the keen interest in exploration for reduced intrusion-related gold systems, triggered by the discovery of the Valley gold occurrence by Snowline Gold Corp. in 2022.

Preliminary exploration, development and production results from 2023 are presented in Ellis and Sack (2024). Exploration data for 2023 will continue to be tracked into 2024 and will be presented by Ellis at the 2024 Mineral Exploration Roundup in Vancouver.



Figure 9. Ice-rich core from a permafrost-monitoring borehole in Ross River.

The YGS' Core Library facility was used for 17 days by 8 different clients in 2023; usage consisted mainly of core logging. During the summer, Justin Emberly continued to oversee the move of drill core from the old core storage facility on Range Road to the H.S. Bostock Core Library on the Alaska Highway. Two students were hired to assist with the move; they moved, catalogued and photographed more than 1600 boxes (15 properties) in 2023. The YGS anticipates that all remaining core will be removed from the old facility by the end of 2024.

Placer industry liaison

Sydney van Loon and Jeff Bond visited 70 placer operations in 2023, collecting data that will be compiled in the next Placer Industry Report and liaising with researchers working in the Klondike (Fig. 10). Both geologists attended the annual Gold Show in May, where they promoted YGS' historical placer database and recent publications related to the placer industry (e.g., van Loon and Bond, 2021, Steinke et al., 2023), and planned 2023 field visits. They also attended the Klondike Placer Miners Association's annual barbeque in August, where members honoured Bond's career and his contributions to the sector.

As Bond wrapped up YGS commitments in advance of his retirement, van Loon stepped in to manage placer-related activities for YGS. In July, she spent a week in the Sixty Mile area with Patrick Sack, investigating links between hardrock mineral occurrences and placer activities to help assess placer potential. In late August, she led a field trip for Vancouver Island University students who were studying placer geology.

November marked the 13th anniversary of the annual Placer Forum that takes place during the Yukon Geoscience Forum. The 2023 Forum featured presentations ranging from wetlands research and the implementation of the Yukon Wetland Policy to a discussion on drone use in the placer industry. It also included an exhibition from the Klondike Placer Miners Association celebrating 125 years of gold mining. Of particular interest to the audience were presentations by staff from the Department of Environment, who shared information on the Government of Yukon's wetland inventory framework. This was a very relevant topic due to the upcoming regulations regarding wetland disturbance and reclamation.

Highlights from the 2023 field season are summarized in van Loon (this volume).

Yukon Mineral Exploration Program (YMEP)

At the time of writing, 44 proponents had completed work on YMEP-supported exploration projects, which included 27 hardrock and 17 placer projects. Spending commitments from these proponents total more than \$3.7M, representing a leveraging ratio (total spend versus total grants) of 2.6:1, based on the \$1.4M in available funding.

The YGS recently started collecting data from YMEP recipients on their expenditures. These data, collected each January as part of the final reporting requirements, are intended to provide indicators on the economic impact of the program. Data from 2022 recipients showed that 83% of funds spent on YMEP projects stayed in the territory. Of this, 41% was spent on local contracts (drilling, air charters, camp services, etc.), 25% went to wages, and 17% was spent on supplies (groceries, fuel, lumber, etc.). Statistics on 2023 spending will be submitted in January 2024, and will be reported in next year's overview.

More details on YMEP activities are presented in Ellis and Sack (this volume).

Compilation of geochemical data from assessment reports

In 2022, Yury Klyukin initiated the compilation of geochemical data from assessment reports. These data are expected to be released in early 2024 via GeoYukon (<https://data.geology.gov.yk.ca/Compilations>), and through YGS' web map application. Included in the compilation are geochemical data from more than 300 000 soil, rock, stream sediment, and vegetation samples from more than 300 assessment reports. Klyukin has been working on a tool to simplify data extraction from new assessment reports and streamline its capture in the database going forward. The project is described in more detail in Klyukin (2024).

Drill core update

In 2022, Calgary-based GeologicAI was funded through Canada's Innovation Supercluster to develop algorithms to aid in logging drill core. As part of the project, they scanned 82 drillholes from YGS' core collection (60 from the Tom & Jason deposits; 12 from Minto; 7 Kudz Ze Kayah, and 1 each from Klaza, Rusk and Cyprus). The company generated high-resolution photos, X-ray fluorescence (XRF) analyses, lidar and

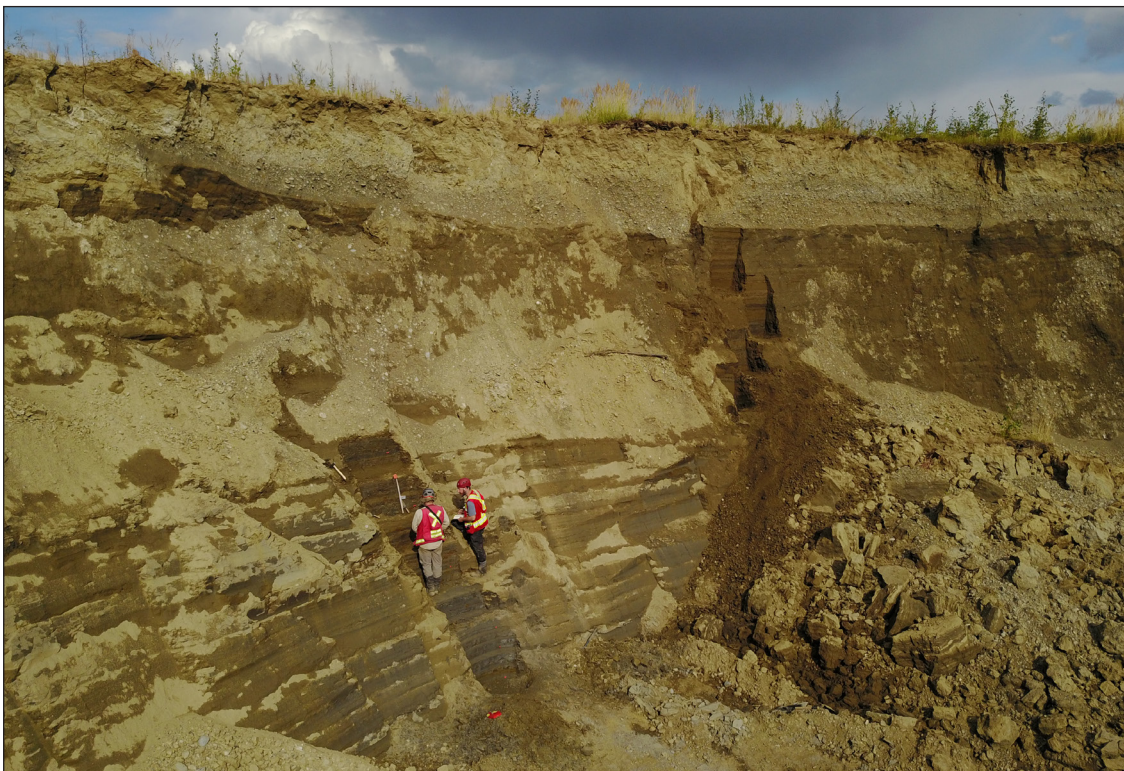


Figure 10. Brent Ward (Simon Fraser University) examining a section of Klondike outwash gravel at Lovett Hill with one of his graduate students.

hyperspectral images from the cores. These logs are now available to view via YGS' website: <https://yukon.maps.arcgis.com/home/item.html?id=87457fac7009430189f95d909cba55a6>

MINFILE

In 2023, YGS' Technical Services staff worked with colleagues from the Geological Survey of Canada and other provincial and territorial surveys to develop a single portal through which all mineral occurrence data in Canada could be queried and viewed. The intent of this project is to remove provincial and territorial borders from online searches for mineral occurrence data and present a unified national view. A prototype has been developed with data from seven of twelve jurisdictions, including data from the Yukon. It is anticipated that the portal will soon be publicly accessible.

In the meantime, YGS has initiated discussions for ways to improve MINFILE, which currently has a number of issues, including location inaccuracies, inconsistencies in how data are captured, and errors inherited from the original data files. The national online mineral occurrence project is serving as a catalyst for YGS to upgrade MINFILE.

Updates to online data

In collaboration with various YGS geologists, Chad Coté updated several online data layers available on GeoYukon (<https://data.geology.gov.yk.ca/Compilations/>). These include the bedrock and surficial geology layers, litho-geochemistry, geochronology, and the sulphur and lead isotope datasets. Additionally, a new compilation of the geothermal dataset is being finalized and is expected to be released early in 2024.

Outreach activities

Requests for classroom visits continued to grow in 2023. With Amanda O'Connor joining YGS in August, the survey's capacity for outreach and engagement has doubled, enabling the YGS to respond to more requests (Fig. 11). In Whitehorse, Leyla Weston and O'Connor organized in-class workshops and led tours of the Whitehorse Copper Belt for 14 classes. Whitehorse students also had

an opportunity to participate in Mining Week activities. Beyond Whitehorse, O'Connor and Weston visited classes in Carmacks, Mayo and Haines Junction. While in Haines Junction, they organized outreach activities at the Dakwākāda Mountain Festival, and Weston presented an overview of the territory's geothermal energy potential.

To the broader public, YGS hosted Weekend on the Rocks (involving interpretive hikes and public lectures at Tombstone Park), organized geology hikes in Kluane Park, and ran tours of the Whitehorse Copper Belt.

In addition to educational activities, YGS participated in three targeted events to engage with Yukon citizens on geoscience-related work. The first was a workshop organized by Yukon's Water Resources Branch. The intent of the workshop was to share information on a flood-mapping initiative and prioritize communities for mapping based on their level of risk. Staff from YGS participated in the event, presenting information on some of its geohazards work. Discussions focused on hazards that are associated with flooding, such as bank erosion and precipitation-induced landslides. The second event was an open house in Dawson City to share results of a recent hazard assessment that was undertaken by BGC Engineering on the Sunnyside slide. This work is part of a broader initiative by Yukon government, Dawson City and Tr'ondëk Hwëch'in First Nation government to raise awareness of landslide hazards in the community and develop a system to warn residents if a slide appears likely to occur. The third event was a workshop attended by 26 representatives



Figure 11. Amanda O'Connor (back left) and Leyla Weston (back right) demonstrate YGS' augmented reality sandbox to students.

from Yukon First Nation and municipal governments to share results of YGS' geothermal research program. Until this year, YGS had been engaging in geothermal studies on a community-by-community basis, providing information on the proposed activities and results. This was the first opportunity to provide an overview of the emerging picture of Yukon's geothermal potential to all communities.

Engagement with Yukon First Nations on YGS' research activities continues to be a priority for YGS. Weston led the bulk of this work in 2023, reaching out to First Nations to seek input on their geoscience needs and request feedback on YGS project plans.

Weston and O'Connor (this volume) present a more detailed summary of 2023 geoscience outreach activities.

Summary

In 2023, fieldwork on a number of multi-year projects wrapped up; final reports and maps from these projects are planned for release in 2024/25. Despite several staff vacancies, YMEP grants were issued in a timely manner, and staff still managed to spend a significant amount of time carrying out property visits to hardrock and placer projects.

Efforts are currently underway to fill YGS staff vacancies. Looking forward, we hope that most positions will be staffed by the 2024 field season. With YGS' five-year planning cycle approaching in spring 2024, the survey has begun work to organize a series of thematic workshops in the winter and early spring. Information on the timing and themes of these workshops will be posted on social media (<https://www.facebook.com/YukonGeologicalSurvey/>); please reach out if you are interested in participating.

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