



Yukon

Exploration & Geology Overview

2022

- Yukon Geological Survey Activities
- Placer Mining Development & Exploration
- Hard Rock Mining, Development & Exploration
- Yukon Mineral Exploration Program
- YGS Publications



Yukon Geological Survey staff

Left to right: Rosie Cobbett, Scott Casselman, Brett Elliot, Yury Klyukin, David Moynihan, Sarah Ellis, Warwick Bullen, Tyler Ambrose, Jeff Bond, Bailey Staffen, Maurice Colpron, Derek Cronmiller, Chad Cote, Diane Skipton, Justin Emberley, Karen MacFarlane, Panya Lipovsky, Sydney van Loon, Carolyn Relf, Moya Painter and Julie Minor.

Missing from photo: Leyla Weston, Patrick Sack and Sarah Sternbergh.



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& Geology
Overview
2022

Edited by
K.E. MacFarlane

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Front cover photograph: Boudinaged vein containing large tourmaline crystals, hosted in metatonalite of the Simpson Range suite.

Back cover photograph: Field notes from the Teslin area.

Preface

Yukon Exploration and Geology (YEG) papers and the Yukon Exploration and Geology Overview are two of the main publications of the Yukon Geological Survey (Energy, Mines and Resources, Government of Yukon). Individual YEG papers, with colour images, are available in digital format and can be downloaded from our website. The YEG Overview is available in digital format and in a limited colour print run.

YEG 2022 contains up-to-date information on mining and mineral exploration activity, studies by industry, and results of recent geological field studies. Information in this volume comes from prospectors, exploration and government geologists, mining companies, and students, all of whom are willing to contribute to public geoscience for the benefit of the scientific community, general public and mineral industries of Yukon. Their work is appreciated.

As another calendar year comes to an end, I wonder, where did it go? Luckily, I get an early crack at reading the papers submitted to our YEG volumes and, at least in terms of work, get a recap to remind me of what went on. Once again, I thank my colleagues at the Yukon Geological Survey for their continued efforts in providing geoscience information and support to clients, and then writing about it for YEG. You know you have as much fun with it as I do...

Input or suggestions that you may have to improve future YEG publications are welcomed. Please contact us at (867) 667-8519, or by email at geology@yukon.ca.



Karen MacFarlane

Yukon Exploration and Geology Overview 2022

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Yukon Geological Survey 2022 overview

Carolyn Relf
Yukon Geological Survey

Relf, C., 2023. Yukon Geological Survey 2022 overview. In: Yukon Exploration and Geology Overview 2022, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 1–19.

Introduction

Yukon Geological Survey (YGS) had a busy year in 2022. Travel restrictions related to the pandemic were gradually lifted, enabling staff to attend conferences and allowing southern-based researchers to return to Yukon for fieldwork. While COVID did not hinder field activities, wildfires and flooding did affect access to some parts of the territory. The Yukon saw an unusual number of landslides over the spring and summer, and YGS invested significant resources assessing the slides and documenting the factors that caused them. This focus on geohazards is expected to continue into future years and be a “growth area” for the Survey.

This overview provides a summary of research highlights for 2022. Many of the projects described here are presented in more detail in the Yukon Exploration and Geology technical papers that are released with this Overview volume. Two highlights from 2022 are worth noting this year. First, 2022 marks the 30th anniversary of YGS. Since its creation, the Survey has grown and evolved into a multi-disciplinary organization that provides expertise across a range of disciplines (bedrock geology, regional tectonics, glacial history, geohazards and metallogeny) and excels at geoscience education and information management. The second noteworthy event to point out was the discovery of a mummified baby woolly mammoth (Nun Cho Ga) in June on Upper Eureka Creek. Two Survey staff had the privilege of assisting with the recovery of the mammoth and participating in the Tr’ondëk Hwëch’in First Nation ceremony that marked this scientifically and culturally important discovery. Jeff Bond subsequently mapped the discovery site in detail, documenting the conditions that led to the remarkable preservation of Nun Cho Ga.

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YGS budget

YGS's operational budget for 2022–23 totalled \$4 430 000, broken down as follows:

- \$1 365 000 O&M, to cover office/administrative costs and project activities;
- \$320 000 of federal money committed by Canada to support climate change initiatives in Yukon. This is to support mitigation of landslide hazards in Dawson City (see below);
- \$270 000 from Yukon government to support “Our Clean Future” initiatives led by YGS: specifically, geothermal studies, permafrost hazards assessments in communities and along highways, and documenting changes in glaciers;
- \$955 000 from NRCan's Emerging Renewable Power Program to support geothermal studies;
- \$87 000 from Crown-Indigenous Relations and Northern Affairs Canada to install permafrost monitoring boreholes; and
- \$1 433 000 for the Yukon Mineral Exploration Program (of which \$1.4M are allocated to fund projects under the program).

In addition to the funds noted above, the Geological Survey of Canada (GSC) has committed \$500 000 over two years to support a regional magnetotelluric survey along Yukon's highway corridors, as part of the geothermal research program (described below). The funding is part of their Geo-Mapping for Energy and Minerals (GEM) – GeoNorth Program.

Bedrock studies

YGS carried out three regional bedrock mapping projects and three thematic bedrock studies in 2022. Project highlights are summarized below and locations are shown in Figure 2. A fourth thematic project (at Volcano Mountain) is described below in the Outreach section of this paper.

Teslin map area

David Moynihan continued mapping Yukon-Tanana terrane rocks in the northwestern Teslin area, extending previous coverage southeastward to the South Canol Road (Fig. 2). 2022 marked his third year on this project. Fieldwork revealed that Mississippian metatonalite

of the Simpson Range suite underlies much of the Mount Grant area. The metatonalite has been thrust over a package of rocks that includes metachert and siliceous argillite (lowest exposed interval), quartzite and chlorite/muscovite schist (intermediate interval), and marble/calc-silicate rocks (upper interval; Fig. 3). Moynihan (2023) has proposed the term Evelyn Creek succession for this package of rocks.

A distinctive mauve-coloured metachert unit was identified northeast of the Mount Grant area. The unit, which has not been previously documented in this area, is tentatively correlated with the Old Highway Metachert found near the British Columbia–Yukon border. The metachert defines a distinct time-stratigraphic marker and may provide evidence for VMS-type hydrothermal activity.

The eastern-most part of the map area preserves low pressure/high temperature metamorphic assemblages in deformed country rock, intruded by mid(?)–Cretaceous plutons. The plutons are both foliated and crosscut foliation, suggesting their emplacement overlapped with metamorphism and deformation. For details of this summer's mapping, see Moynihan (2023).

Study of Paleozoic volcanic rocks

Rosie Cobbett completed a final year mapping and correlating volcanic rocks across lower Paleozoic continental margin strata in central Yukon and western NWT. Fieldwork focused on resolving outstanding questions from previous seasons' work. Based on field relationships, Cobbett has subdivided the Bouvette Formation into lower (interpreted as Cambrian to late Ordovician strata) and upper (Silurian to Devonian) members separated by volcanic and clastic rocks in the Castle Mountain area. Microfossil analysis is underway to refine the inferred age limits of the new members. In the Hart River area, a facies change was observed between “typical” upper Bouvette Formation (thick-bedded dolostone) and a recessive silty limestone and rudstone unit. The unit, previously mapped as Gossage Formation, contains shelly fossils not previously recognized in this part of the Cordillera (Blodgett, unpublished data).

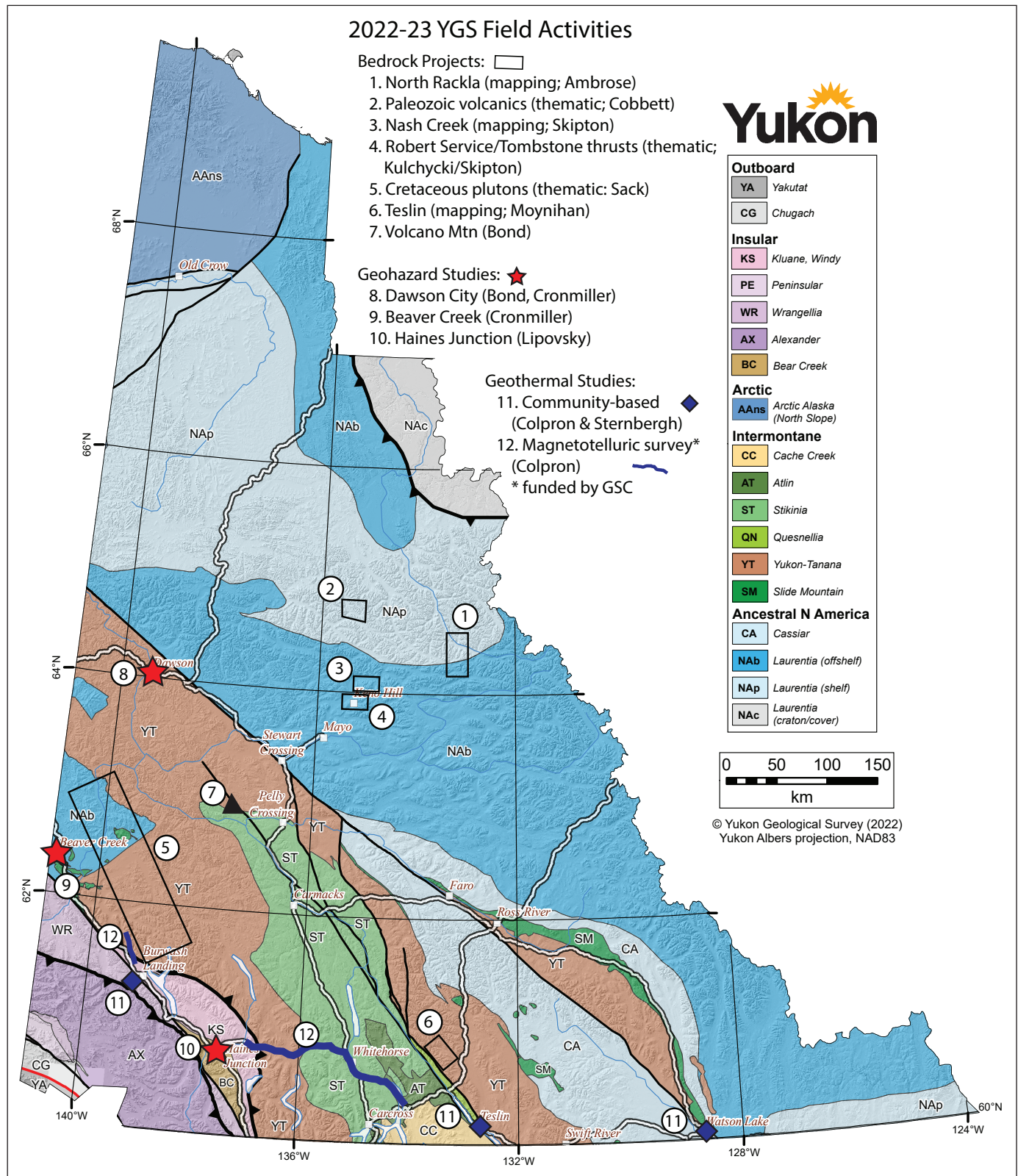


Figure 2. Map showing locations of YGS' 2022 field activities.

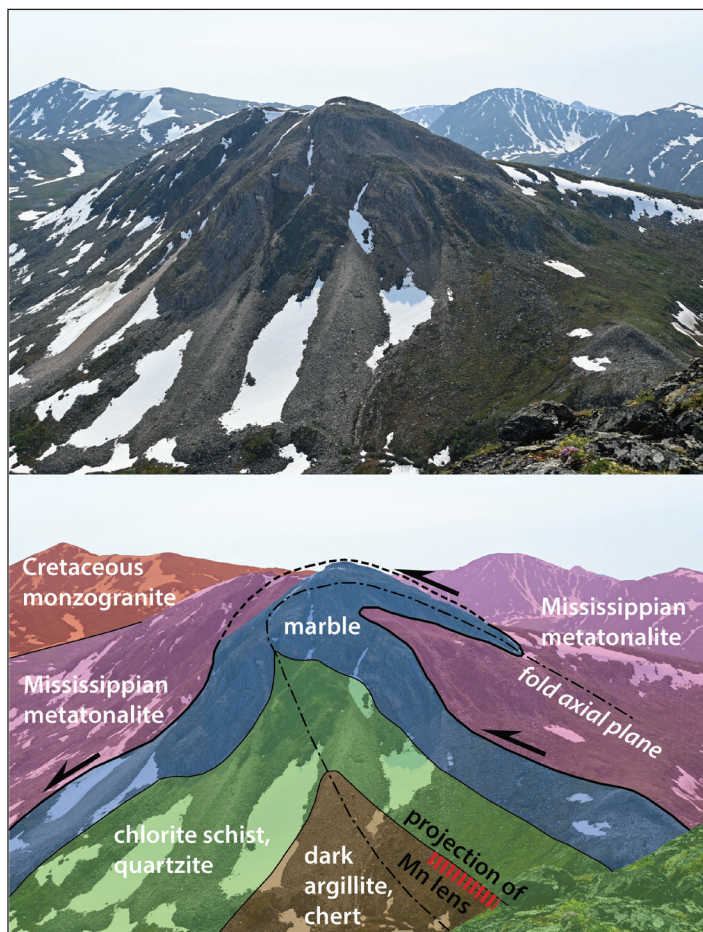


Figure 3. View looking south at folded thrust fault near Evelyn Creek. Rocks of the Evelyn Creek succession are exposed in the footwall; hanging wall rocks are Mississippian metatonalite of the Simpson Range suite. All units are cut by Cretaceous granite (distant part of photo).

Cobbett also documented a change in structural style across the study region, from flat-lying, openly-folded strata near Castle Mountain to tightly upright-folded rocks north of Hart River. More information on the geology of the Castle Mountain and McKay Hill areas is available in a recently-released Open File (Cobbett, 2022).

Late Cretaceous pluton metallogeny

Patrick Sack continued studies of late Cretaceous pluton metallogeny, though he had a shortened field season in 2022. He collected about a dozen samples along a transect in western Yukon north of Beaver

Creek (Fig. 2), and has submitted them for whole-rock, isotope and geochronological analyses. This project links to the porphyry predictive mapping work done by Warwick Bullen (Bullen, 2021a), testing the veracity of the modelled prospectivity of plutons and providing further geochemical data to constrain the model.

Nash Creek map area

Diane Skipton continued investigations into the tectonic evolution of the southern Nash Creek area. This multi-disciplinary study integrates field mapping with geochronology and thermochronology. Collaborators include Alfredo Camacho (University of Manitoba), Jim Crowley (Boise State University), Kyle Larson (University of British Columbia-Okanagan) and Dawn Kellett (GSC). Unfortunately, extensive forest fires prevented access to the map area in July; however, Skipton did manage to get into the field area for two weeks in August, where she was able to advance mapping in the Davidson Range north of Keno (Fig. 2). As noted above, Skipton began maternity leave in December; she will be resuming work on this project in January 2024.

Robert Service and Tombstone thrusts

Skipton also spent time in the field with her graduate student Anya Kulchycki, whose MSc thesis focuses on documenting kinematics and timing of displacement of the Robert Service and Tombstone thrust faults in the Keno mining district. The project, co-supervised by Skipton and Larson, will integrate field data with microstructural and thermochronological methods to constrain the timing of ductile deformation.

North Rackla map area

Tyler Ambrose's field plan for 2022 was to wrap up his North Rackla project by extending map coverage to the base of the Windermere Supergroup. However, like Skipton, Ambrose's field season was shortened by factors beyond his control. Over the summer, he was able to complete three fly camps before he returned to Whitehorse (Fig. 2). In spite of a shortened season, he mapped a significant area, and he anticipates being able to complete map coverage with a week's fieldwork in 2023. Ambrose will focus on compiling his map and begin drafting the accompanying report over the winter.

Geothermal studies

YGS continued studies to characterize geothermal potential along the Denali, Tintina and Teslin faults in 2022. The study areas are located close to nearby communities (Burwash Landing, Watson Lake, Teslin and Haines Junction) and the affected First Nations are partnering on the projects. In addition to work near communities, regional geophysical data collection continued; this work is intended to image crustal features at a regional scale.

Funding for the geothermal studies described here was sourced primarily from NRCan (Emerging Renewable Power Program) and Yukon government (Our Clean Future). Additional contributions to individual projects are noted below. A number of contractors and researchers from universities and the Geological Survey of Canada are involved in different aspects of the geothermal studies described below. Their contributions are also noted below.

Burwash Landing

A number of field studies were carried out on the Denali fault system in the Burwash Landing area over the summer; collectively, they will support a better understanding of deformation and fault kinematics. Building on data collected in 2021 (Finley *et al.*, 2022), researchers from the University of Victoria continued acquisition of drone lidar data across the fault and collected kinematic information from outcrops. The group from Institut national de la recherche scientifique (INRS) collected outcrop data on fractures in the Duke River area that will provide a regional framework for analysis of fractures in core from drilling planned for 2023 (Chapman *et al.*, 2023). The fracture data from outcrop and core will help to characterize permeability in the region. Colpron joined colleagues from the United States Geological Survey (USGS) to examine exposures of the Denali fault and collect structural data to complement the kinematic analysis documented in an upcoming paper by J.S. Caine and colleagues. Colpron also visited outcrops north of Kluane Lake to collect samples of Kluane schist for physical rock property analysis; these data will help to better constrain interpretations of subsurface geology northeast of the Denali fault in geophysical models. Finally, YGS and

GSC geologists installed shallow temperature loggers at more than 100 sites in the Duke River area. These instruments will collect near-surface temperature data for a year and will be retrieved in 2023.

Plans to drill a deep temperature gradient well near Duke River starting in spring 2022 were thwarted when YGS failed to find a qualified bidder to do the drilling. Over the summer, Colpron and Sarah Sternbergh amended the drill plan, splitting it into two phases. Phase 1 called for an eight-inch diameter well cased into bedrock, and Phase 2 called for a diamond drill to start at the bottom of the cased well and recover core to whatever depth could be achieved with available funds. Notional depths of 300 m for Phase 1 (based on an estimate of 200 m of overburden) and ~800 m for Phase 2 were targeted, recognizing that depth to bedrock was poorly constrained, and escalating fuel costs would significantly influence the final depth of the well.

Phase 1 drilling was completed in the fall, with Phase 2 planning and implementation to follow in 2023. Midnight Sun Drilling carried out the Phase 1 drilling using an RC rig, and Kluane Community Development Limited Partnership was contracted to provide drilling support services (e.g., provision of fuel, accommodation, road maintenance, etc.) The drill encountered bedrock at 49 m depth, and drilled a further 172 m into bedrock before casing and cementing the well to a depth of 221 m. A distributed temperature sensing fibre optic cable has been installed and temperature data will be collected at some point in 2023. Planning for Phase 2 will get underway shortly.

At the same time that work was underway to initiate drilling, geophysical data sets were interpreted to help characterize subsurface geology in the drill target area. Colpron worked with GSC colleagues Victoria Tschirhart and Jim Craven to interpret the magnetotelluric and EM data sets that were collected in 2020 and 2021 around the Duke River site (Tschirhart *et al.*, 2022). Their model confirmed the releasing bend previously interpreted along the Denali fault (Witter, 2020) and an associated conductor that could reflect a fluid pathway.

To complement the broadband seismographs deployed in 2020 in the Duke River area, two arrays of geophones

were deployed for a month along Duke River and Burwash Creek by researchers at the University of Calgary in fall 2022 (Fig. 4). Following retrieval of the geophones, a distributed acoustic sensing fiber optic cable was laid out across the Denali fault at Burwash Creek and connected to a seismic interrogator that will be collecting data until spring 2023. The intent

of both the geophone arrays and the fibre optic cable is to collect data that could provide more detailed information about near-surface structures around the Denali fault and in the geothermal drill target area. Initial data from the broadband stations and geophones are being processed this winter.

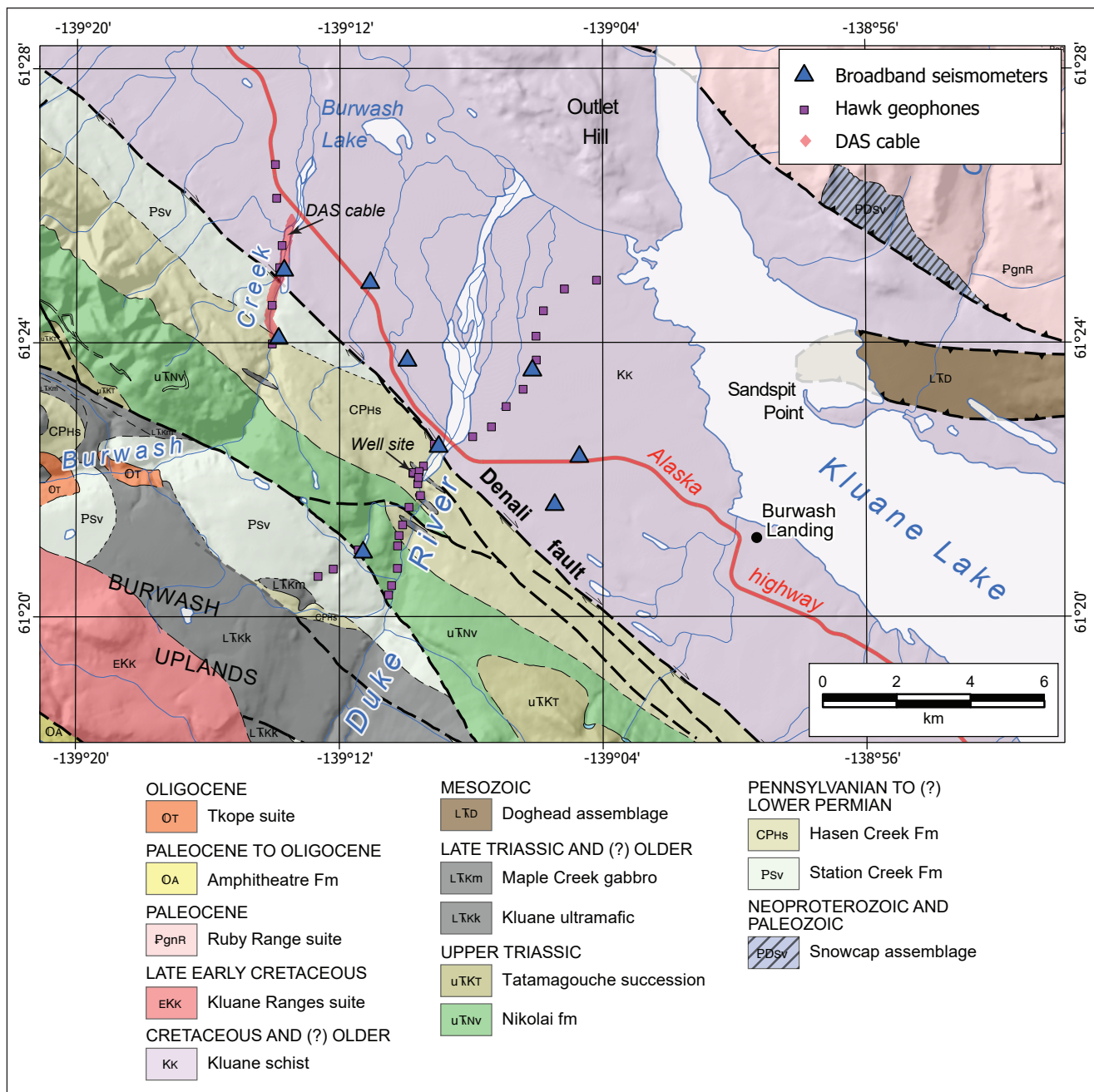


Figure 4. Geological map of the Duke River area showing locations of seismic instruments (broadband seismometers, geophones and distributed acoustic sensing fiber optic cable) deployed by University of Calgary researchers. Location of the temperature gradient well site along the Duke River is also shown. Geology extracted from Yukon Geological Survey (2022a).

Watson Lake

In the Watson Lake area, new gravity (Aurora Geosciences Ltd.), magnetotelluric (University of Alberta) and lidar (University of Victoria) data were integrated with geology and magnetics by Innovate Geothermal to generate a model of the subsurface geology across the study area. Collaborators on the Watson Lake project (YGS, GSC, University of Alberta, and Liard First Nation representatives) met in Edmonton in September to discuss the results of the project and consider next steps. The final report, (Witter, 2022) presents a model of the shallow crustal structure across the Tintina fault zone and highlights testable uncertainties about the geothermal potential of the area. At the time of writing, Liard First Nation is considering whether to pursue funds for a drill program to directly measure temperature gradient and test the geological model.

YGS and Liard First Nation (represented by Barkley Project Group) co-managed the Watson Lake geothermal study. The magnetotelluric survey was jointly funded by Crown Indigenous Relations and Northern Affairs Canada (through a Northern REACHE grant to Liard First Nation), the University of Alberta and YGS. Acquisition of lidar data that supported the interpretation of gravity and geologic data was covered by Northern REACHE funding.

Teslin

In the Teslin area, gravity data and detailed bathymetry of the lake in the study area were acquired in 2022 (Aurora Geosciences). In addition, data from a few audio-magnetotelluric sites were acquired (Quantec Geoscience) in September. Currently, Innovate Geothermal is integrating these data with existing magnetics and geology, to generate a 3D geological model of the Teslin fault that will guide future steps in the study. Plans for 2023 include the potential acquisition of an airborne EM survey (by GSC) to enhance the ground data.

The Quantec Geoscience contract was funded by GSC through their GEM-GeoNorth program.

Haines Junction

With the Watson Lake study completed and work wrapping up in Teslin next year, YGS has initiated a study in the Haines Junction area, applying the same suite of tools. In mid-November, Aurora Geosciences was contracted to start collecting gravity data. The bulk of the survey is expected to be completed over the winter, with the remainder of the area covered in summer 2023 when the ground is snow-free.

Regional geothermal investigations

In addition to site-specific studies near communities, the geothermal research program includes some regional-scale geophysical data collection to help characterize crustal structure. A series of 21 broadband seismometers were deployed in 2020 by University of Calgary researchers across southern Yukon from west of Burwash Landing to south of Watson Lake (Fig. 5). These instruments will be collecting earthquake data for a period of 3–4 years.

GSC is providing funds to complete magnetotelluric surveys along Yukon's major highway corridors (Fig. 5). Coverage will include those sections of highway that were not surveyed during Lithoprobe's SNORCLE transect. Data at sites along the Alaska Highway were acquired in 2021 and 2022; acquisition of data at the remaining proposed sites is planned for 2023. The contract for the magnetotelluric survey was managed by YGS and funded by the GSC through their GEM-GeoNorth program.

Seismic monitoring

In addition to collecting new seismic data to support geothermal studies, researchers from the University of Calgary have re-evaluated existing earthquake information from regional seismograph networks, including the USArray Transportable Array that was recently deployed across Alaska, Yukon and northern British Columbia. Using the USGS earthquake catalogue, Biegel et al. (2023) have relocated >5500 seismic events of magnitude >1.5 and greatly enhanced event clustering and depth of hypocentres. Their study has delineated a number of cryptic faults

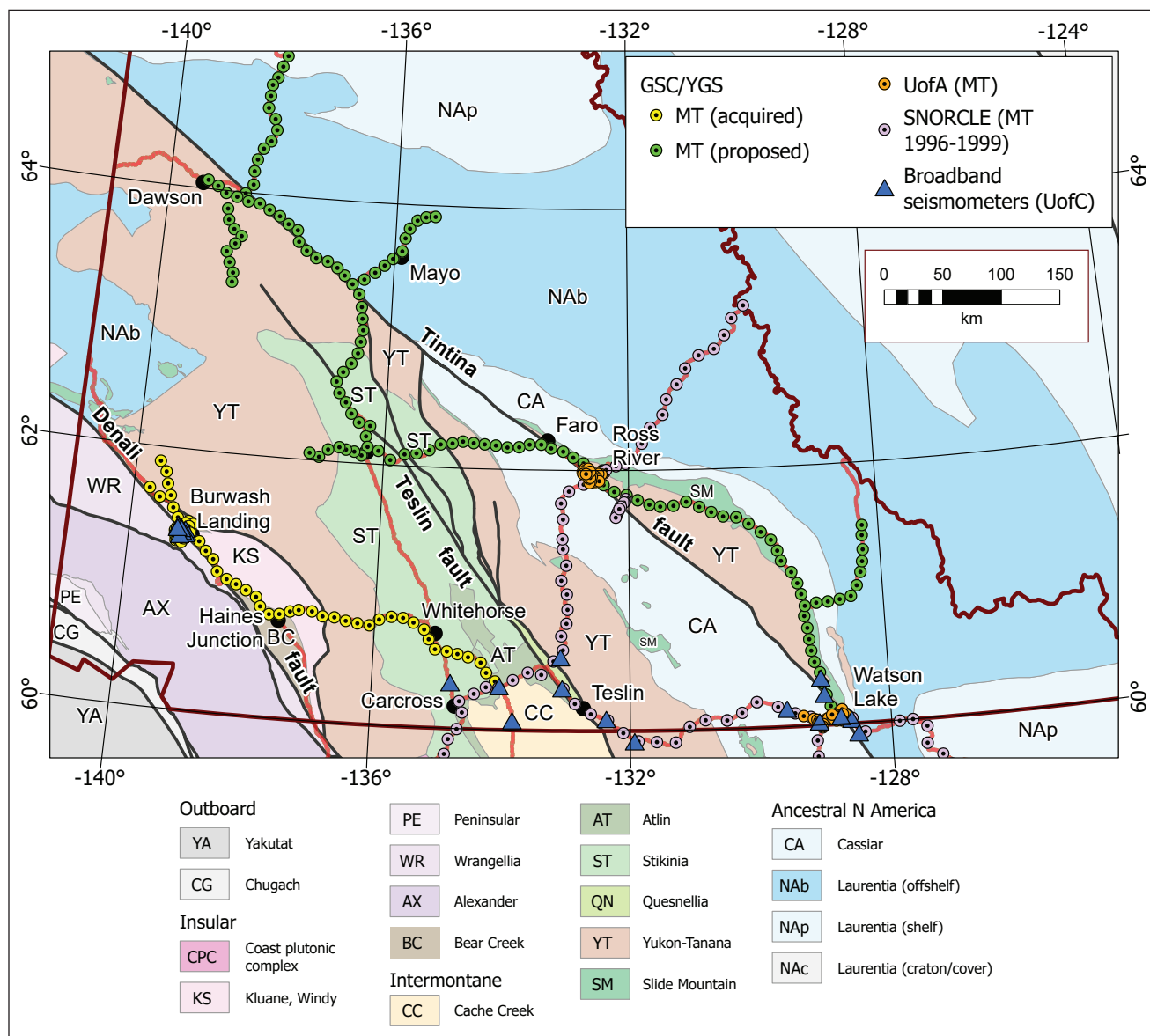


Figure 5. Regional magnetotelluric transects and broadband seismometer network supporting geothermal research in southern Yukon. Terrane map extracted from Yukon Geological Survey (2022b).

in the St. Elias Mountains that are related to the Denali fault system. A parallel study by Gosselin et al. (2023) provides an improved earthquake focal mechanisms catalogue that will inform further analysis of crustal stresses in southwestern Yukon. Both of these studies are presented in the accompanying Yukon Exploration and Geology volume.

Justin EMBERLEY worked with Andrew Schaeffer (GSC-Pacific) to install a broadband seismic station on Yukon’s

North Slope at the Stokes Point DEW Line site. The station is a redeployment of a YGS-owned instrument that was moved from southeastern Yukon. This station, in conjunction with others located across northern Yukon and NWT, will help to better characterize seismicity in the Richardson Mountains and Beaufort Sea. It is part of a broader Canadian network of instruments deployed to monitor earthquakes and determine epicentre locations as part of GSC’s Geohazards Program.

Surficial geology studies

Landslide monitoring

Landslide monitoring and research occupied a significant amount of YGS' Surficial Geologists' time in 2022, as numerous landslides impacted infrastructure. Higher-than-normal groundwater levels triggered slides in Whitehorse in late April and May, closing a major access route to the city for several weeks and resulting in the evacuation of some residents (Fig. 6). A remote YGS camera captured the flow of one of the Whitehorse landslides across Jeckell Street (www.facebook.com/YukonGeologicalSurvey/videos/). Over the summer, a landslide closed the Robert Campbell Highway near Little Salmon Lake, and in September, several active layer detachment slides caused by heavy rain closed the North Klondike Highway and stranded motorists. Jeff Bond, Panya Lipovsky and Derek Cronmiller worked with City of Whitehorse engineers and staff from Yukon's department of Highways and Public Works to assess slope stability and provide advice on when it was safe to clear debris. Such slides are expected to become increasingly more frequent as weather patterns change, and YGS anticipates that more of its resources will be dedicated to helping to monitor and predict such events.



Figure 6. View looking south along Robert Service Way (Whitehorse) at debris from an April 30th 2022 landslide that closed the road for several weeks.

In Dawson City, two potentially significant rock avalanches were the focus of attention by Cronmiller and Bond. A study commissioned by YGS in 2021 indicated the Moosehide Slide posed a level of risk that would be considered unacceptable in British Columbia (Yukon does not have a defined risk tolerance threshold for landslides). Consequently, YGS worked with contractors from BGC Engineering and installed a suite of near real-time instruments to monitor the head scarp (Fig. 7). The purpose of the array is to collect ground movement data over a period of two or more years to establish a baseline for movement rates and enable seasonal variations to be distinguished from movement rates that could indicate pending failure. Bond, Cronmiller and Lipovsky will work with BGC staff to monitor data as they are collected.



Figure 7. BGC Engineering staff installing an extensometer on the Moosehide Slide in September, 2022.

At the Sunnydale Slide, Cronmiller is co-supervising a student (Jackson Bodtker) who is studying the slide as part of an MSc thesis (Bodtker et al., 2023). Lidar change detection analysis indicates the rock mass is moving, although the oldest lidar image is fairly recent, making it difficult to assess whether movement is accelerating. Bodtker is using older imagery (air photos, satellite images) to project movement rates back in time and he has collected samples for cosmogenic nuclide dating to quantify movement rate based on timing of exposure on the footwall. BGC has been contracted to model runout and associated wave displacement for Sunnydale, as flooding is considered the most significant hazard posed by this slide. In the meantime, reports of shallow failures on the cliff face above Yukon River have triggered plans by YGS to install some GPS instruments on the slide surface in the spring, to enable near-real time monitoring of movement.

The Dawson landslide working group, chaired by YGS, continues to share information with residents and liaise with municipal officials as they develop an emergency response plan.

Community mapping

YGS staff carried out community-based geohazard mapping and associated studies in three communities in 2022.

In Haines Junction, Lipovsky, Cronmiller and Moya Painter collaborated on a project to map and document geohazards and permafrost in and around the community. Lipovsky completed lidar analysis, then spent two weeks in the field with Painter mapping surficial geology. A final map is being prepared for release by spring 2023 (Lipovsky and Cronmiller, in prep.). Cronmiller drilled and installed thermistors in three new boreholes in 2022 to complement a borehole drilled in 2021 (Fig. 8). The borehole temperature data will be uploaded to YGS' permafrost database (<https://service.yukon.ca/permafrost/>) when data are downloaded from the loggers next summer. A final report for this project is planned for spring 2024, and will integrate mapping results, borehole data and profiles from an electrical resistivity tomography survey carried out in 2021 by Kryotek Arctic Innovation Inc.



Figure 8. Derek Cronmiller installing a thermistor in a borehole. This one of four instrumented boreholes established in the Haines Junction area to monitor permafrost.

Before joining YGS, Cronmiller mapped surficial geology in Teslin for Palmer Environmental. Palmer has granted YGS permission to include these data in a YGS geohazards map for Teslin. In 2022, Lipovsky and Painter carried out some fieldwork to expand the map area. Surficial geology information has been supplemented by a water well drilled by Yukon government's Water Resources Branch (as part of an aquifer mapping project). The well was logged by Lipovsky and the subsurface data will help inform geologic interpretations. Cronmiller plans further mapping in 2023, after which a final map will be prepared for release. As part of this project, Cronmiller installed an instrumented borehole; the temperature data will be uploaded to the permafrost database in 2023.

A surficial geology/geohazards mapping project initiated at Beaver Creek in 2021 was completed this year. In addition to mapping, three new boreholes were drilled and instrumented. The maps are currently undergoing review (Cronmiller, *in press*), and a final report is planned for spring 2023 (Cronmiller, *in prep.*).

In addition to the above projects, Panya Lipovsky worked to finalize the write-up of a four-year surficial mapping project in the greater Whitehorse area. Project outputs will include a digital Open File map (GIS product) of surficial geology with landslide and permafrost features embedded and an accompanying Open File Report (both *in prep.*). The report will include

a derivative aggregate potential map that will help to address the city's shortage of aggregate resources.

Permafrost and glacier monitoring

Beyond the instrumented boreholes installed to support community mapping, Cronmiller drilled and installed thermistors in boreholes along the Alaska Highway, Dempster Highway, in the Eagle Plains area and by the Nordenskiöld River near Carmacks. Temperature data from these boreholes will be added to the permafrost database in the new year. Plans are also underway to drill and instrument six deep (~10 m) boreholes later this winter in Mendenhall (1), Marsh Lake (1), Haines Junction (2) and Teslin (2), to further expand YGS' long-term permafrost monitoring network.

The Nordenskiöld River borehole(s) supported the BSc research of Carolyn Hatton (Laurentian University), whose study is examining how degrading permafrost affects bank erosion and channel migration (Hatton et al., 2023).

Over the summer, Painter and Cronmiller collected data from the Tweedsmuir glacier and Wheaton River valley glaciers, as part of a study to monitor the impact of receding glaciers on local watersheds (Fig. 9). The study involves both fieldwork and satellite image interpretation of about 20 glaciers in southern Yukon/northern British Columbia, recording retreat rates between 1986 and present. Details of the study are presented in the accompanying volume (Painter and Cronmiller, 2023).



Figure 9. Derek Cronmiller documenting retreat of a glacier in the Wheaton Valley.

Minerals-related activities

Industry Liaison

YGS Minerals Geology staff (Scott Casselman, Warwick Bullen, Yury Klyukin) visited ten exploration properties over the summer to view the local geology, learn about exploration results and engage with company geologists. Property visits included Sitka Gold's RC project, Snowline Gold's Rogue Project, and CMC Metal's Silver Hart property (Fig. 10). In addition to field visits, Casselman tracked news releases and contacted companies directly for updates on their activities. At the time of writing, exploration expenditures reported by companies working in the territory were just over \$124M; up slightly from 2021 (just under \$124M). Exploration and development highlights from all projects active in 2022 are presented in this volume (Casselman, 2023).



Figure 10. Scott Casselman examining Manto-style Ag-Pb-Zn mineralization with company geologist at CMC Metals Ltd.'s Silver Hart property.

The Core Library saw 51 days of use by 19 different users in 2022. While this is not a record for number of days of use, it is the largest number of users documented to date. Users included junior mining companies, prospectors, university researchers, colleagues from other geological surveys and a geothermal exploration company.

Following YGS's move to the H.S. Bostock Core Library in 2012, the survey spent two years moving the bulk of the drill core collection from the old core storage facility to the new core library. Core was catalogued and photographed so it could be captured in the Drill Core database (<https://data.geology.gov.yk.ca/Drillholes/>). A portion of the collection was left at the old facility, as space the Core Library is limited. In the spring, YGS received notice that the old facility would be torn down in the next few years, so Emberley began moving the remaining core over the summer. Just over 2500 boxes of core were moved, catalogued and photographed in 2022 (220 holes from 18 properties); roughly the same number of boxes remain to be moved in 2023.

Data compilation projects

Isotope data

As an offshoot to his Cretaceous porphyry study (described above), Sack has begun compiling whole-rock (Nd, Hf, Sr, Pb and O) and feldspar (Pb) isotope data, as well as S and Pb isotope data from sulphide deposits. Most of the data are sourced from geologic literature, with some new data generated from YGS samples. He is collaborating on this work with Ambrose.

Sack et al. (2022) used Pb isotope data to distinguish Late Cretaceous porphyry and epithermal systems in the Mount Nansen area; such studies have potential implications for exploration. Ambrose has been applying the isotope data to mineral occurrences in his North Rackla study area to constrain the timing of mineralization and potential metal sources. Silver-lead-zinc mineralization at the North Rackla, Val and Vera occurrences are interpreted to be Paleozoic in age, with the metals scavenged from the host stratigraphic units (Ambrose, pers. comm., 2022).

The compiled isotope data were recently released by YGS and can be downloaded in a variety of formats (<https://data.geology.gov.yk.ca/Compilation/37#InfoTab>). Further applications of these data will continue to be explored.

Geochemical data from assessment reports

In the spring of 2022, Yury Klyukin initiated work on a new data compilation project. The project, modelled after British Columbia Geological Survey's Assessment Reports with digitized surface sediment geochemical data (http://webmap.em.gov.bc.ca/arssg/arssg_home_map.asp), involves extracting and compiling spatial and geochemical data from rock, soil, stream sediment, water and vegetation samples collected by mineral explorers and filed for assessment credit.

To date, Klyukin has extracted data from almost 300 publicly available assessment reports, including geochemical data for more than 225 000 soil, 74 000 rock, and 2200 stream sediment samples, primarily from the area around the Casino deposit. Many of the files required the use of optical character recognition software on scanned tables and .pdf files; however, more recent assessment reports include tabular data in digital form. Since joining YGS, Sarah Ellis has been assisting with data capture, focusing on new reports as they are submitted.

The next step in the project will be to build a spatial database to house the data.

Drill core scanning

Last winter, Fireweed Metals contacted YGS regarding plans to have their drill core scanned by a Calgary-based company (GeologicAI). The company had successfully applied for a grant under the federal government's Innovation Supercluster Initiative (<https://www.scaleai.ca>) to develop artificial intelligence to aid in the logging and interpretation of drill core. While the focus of the project was Fireweed's drill core at Macmillan Pass, GeologicAI was interested in scanning additional Yukon drill core and "training" it for other deposit types.

While this project wasn't something that was originally in YGS' work plan, the survey's Technical Advisory Committee had previously flagged core scanning technology as a potentially powerful tool for automated core logging. As a pilot project, this would provide high-resolution photos, XRF analyses, and lidar and

hyperspectral images of the core and allow YGS to assess the benefits against the cost, should scanning be considered in the future. Emberley is lead on coordinating this project.

In spring 2022, GeologicAI scanned 2200 m of YGS core from 60 holes drilled on the Tom and Jason deposits. They focused on core from the Macmillan Pass area at the start of the field season in order to calibrate their instruments when they scanned Fireweed's core. In the fall, they returned to Whitehorse and scanned 3000 m of YGS core from the following deposits: Minto (12 holes), Kudz Ze Kayah (7 holes), Klaza (1 hole), Rusk (1 hole) and Cyprus (1 hole). At the time of writing GeologicAI was focused on processing Fireweed's core, but they anticipate by summer of 2023 they will have scanned files of YGS' core available for viewing. Access will likely be via a link on YGS' Drill Core database, with the files stored by GeologicAI.

MINFILE

With staff turnover and efforts focused on drill core scanning and moving, Minerals staff had less time than usual to work on the MINFILE database. Over the year, 400 occurrences were updated and 150 new occurrences were created (some are new occurrences; others were created by splitting out individual occurrences on a single property).

Thematic studies

Building on his previous work modelling porphyry potential in Yukon using weights of evidence (Bullen, 2021a), Warwick Bullen initiated a study using the random forest algorithm to assess the potential for Cu, Au, Mo and Ag porphyry systems. The algorithm is a supervised machine learning method which generates a prediction model using decision trees, with the predictions from each tree averaged to produce a final predictive model. The models were trained on known porphyry-style mineral occurrences ("present" points) and randomly generated "porphyry-absent" points. The density of absent points was determined from weights of evidence analyses.

Eleven “training layers” were used to predict prospective areas. Bullen used a lithology-based analysis developed by YGS (described in Bullen, 2022) to identify anomalous Au, Ag, Cu and Mo in catchment basins from stream sediment geochemical data. Geophysical layers (gravity, magnetics) and bedrock geology features (lithology, age, contacts, faults) were also used to train the data.

Prophyry-style mineralization was predicted to fishnets of differing cell sizes to allow for the generation of decreasing zones of prospectivity away from core areas (i.e., areas of highest porphyry potential).

Preliminary results of his work were presented at the Geoscience Forum in November. As expected (and required), the model accurately predicted locations of known deposits and past producers; more significantly, it highlighted a number of areas with significant potential for previously undocumented porphyry mineralization. The latter make interesting exploration targets, as they have seen little or no exploration to date.

Bullen’s random forest machine learning classification study will be written up over the course of the next year.

Land use planning

In June 2022, the Dawson Land Use Planning Commission released their Recommended Plan to the public. In September, Yukon and Tr’ondëk Hwëch’in governments launched public engagement on the plan. The engagement period closed in December.

Over the summer and fall, Bullen evaluated the recommended land management units against his assessment of mineral potential (Bullen, 2021b), and provided input to Yukon government’s response. He examined the impact of the plan on highly to significantly prospective areas across the region: on mineral occurrences generally, and on critical minerals in particular. Bullen also determined the opportunity

cost of permanent and interim land withdrawals as contemplated by the plan, and quantified the degree of value destruction, from a mineral exploration perspective, of the withdrawals.

The response to the recommended plan is expected to be released by spring, 2023.

Yukon Mineral Exploration Program

In 2022, YGS received 63 applications for funding under the Yukon Mineral Exploration Program (YMEP). This is the lowest number of applications seen in a decade. Applications were received for all four modules: Grassroots (6), Focused Regional (10), Target Evaluation (23) and Placer (24). Following the initial review, 45 applicants were offered funding. Wildfires and challenging market conditions caused a number of proponents to cancel their exploration plans in 2022, so funds were redistributed to projects that were not initially awarded grants. Ultimately, 42 projects were supported in 2022.

At the time of writing, it is anticipated that the Program will invest roughly \$1.3M, and the total investment in exploration (i.e., YMEP plus private funding) on YMEP-supported projects is forecast to be \$3.8M.

In 2021, YGS added a questionnaire to the final reporting requirements for YMEP, asking recipients for data on where their exploration funds were being spent. The purpose of the questionnaire is to help track local economic impacts of the program. Results from the 2021 survey indicated that roughly 79% of YMEP project expenditures, which totalled \$4.04M last year, stayed in the Yukon. Just over \$2M was spent on local contractors for services such as drilling, air charters, camp support; almost \$770K was spent on wages for Yukoners; and \$323K was spent in the territory on supplies (e.g., groceries, fuel, hardware, etc.).

Highlights of 2022 YMEP-supported projects are presented in this volume (Ellis and Casselman, 2023).

Placer geology activities

During the 2022 field season, Sydney van Loon and Jeff Bond visited 85 placer operations (Fig. 11). Data collected on these visits will be compiled into the next placer activity report (2021–2023 Placer Industry Report), planned for release in spring 2024.

In May, van Loon and Bond attended the Gold Show in Dawson City, where they organized a series of presentations (in lieu of the cancelled 2021 Placer Forum) and distributed copies of the 2018–2020 Placer Industry Report. In November, van Loon organized the 10th annual Placer Forum. The one-day event included talks on 2022 industry activities and production statistics, wetlands classification and the application of drones to placer exploration and mine planning, among others. The 2022 Placer Forum was attended by more than 100 delegates.



Figure 11. Jeff Bond visiting a placer operator on Scroggie Creek.

Highlights of the 2022 placer season are presented in this volume (van Loon and Bond, 2023).

Thematic studies

Bond completed fieldwork on his study of placer potential in the Clear Creek district (Big and Josephine creeks area), where multiple glaciations have complicated placer exploration, but also locally reconcentrated gold. The study will be written up and released in 2023.

Outreach

As COVID-related restrictions on gatherings continued to lift in 2022, YGS outreach and public education activities ramped up. Leyla Weston organized or participated in numerous geoscience education events in 2022; two in particular are highlighted here as they are unique relative to the types of activities that she usually leads.

The first involved a field-based study of Volcano Mountain that involved representatives from Selkirk First Nation (SFN), YGS and Simon Fraser University (Fig. 12). Volcano Mountain is a basaltic cinder cone that was active periodically during the Holocene. It has not been directly dated, however, lava flows locally caused damming, and organic material recovered from the resulting ponds have yielded ages as young as 4200 BCE (Jackson and Stevens, 1992). The intent of



Figure 12. Jeff Bond discussing Volcano Mountain geology with Selkirk First Nation Elder Roger Alfred (centre) and Lands & Resources Director Ellie Marcotte (right).

this study is to determine the age of the most recent eruption by sampling a flow that overlies the youngest-dated flow and submitting it for cosmogenic nuclide dating. The project's appeal as an outreach activity is that the volcano has been active within the timeframe of SFN's oral history, and presented an opportunity to merge Traditional Knowledge with western science. SFN participants included Elder Roger Alfred, the Director of Lands and Resources Ellie Marcotte, and youth Keyshawn Sawyer.

The second event of note was the Great Yukon Shake-Out; an earthquake-awareness event organized by Yukon's Emergency Measures Organization (EMO). Held at Selkirk Elementary School, the event featured information on earthquake safety and involved students, staff and local media. Students had an opportunity to practice the "drop, cover and hold on" safety drill (Fig. 13) at the event, and Weston debuted YGS' new Raspberry Shake portable geophone. She ran an interactive demonstration that involved kids enthusiastically jumping in the gym and viewing the seismic response in real time on a graph projected on a screen.

Beyond these two unique events, Weston organized the usual array of interpretive hikes and school visits, and contributed to outreach activities at the Yukon Geoscience Forum. Over 400 students participated in the Discovery Day Camp during Mining Week 2022, and 600+ students attended the school tours during the Yukon Geoscience Forum. The Family Day event at the Forum reached over 300 people. Weston helped teachers enhance their geoscience curriculum with classroom visits and field trips for local schools, and she organized the annual Weekend on the Rocks at Tombstone Park, involving interpretive hikes and lectures.

In addition to educational events, Weston coordinated information-sharing with First Nation governments on YGS' program activities, inviting feedback on proposed studies and seeking input on their geoscience information needs. Recent flooding and the landslides that occurred in 2022 have raised awareness of landslide hazards in many communities, and growing interest in renewable energy has fueled discussions with a number of First Nation governments.



Figure 13. Students at Selkirk Elementary School in Whitehorse practice an earthquake safety drill during the Great Yukon Shake-Out event.

In July, Weston was invited to participate in Champagne and Aishihik First Nation's (CAFN) General Assembly. This was a great opportunity for her to connect in-person with many CAFN citizens and their government representatives and highlight YGS program activities within their Traditional Territory. Weston also brought some of her most popular activities that are engaging for both children and adults alike.

Summary

Although 2022 posed many challenges that impacted YGS' activities (e.g., wildfires, landslides, floods), staff were able to advance field projects and deliver services to industry, Yukon communities, and First Nation governments. New maps and reports resulting from the activities described above will be released in 2023. Publications can be found online at <https://data.geology.gov.yk.ca> and downloaded free of charge.

Looking forward, YGS will continue providing geoscience information to the public, and welcomes feedback on how its data are delivered. Staff are always happy to engage in discussions on project ideas or to visit sites of interest to clients.

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Yukon placer mining 2022 development and exploration overview

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Introduction

Placer mining in the Yukon remains a strong and innovative industry, and has the potential for a modern record-high reporting this season. The number of active operations is similar to previous years and 147 of them reported sluicing activity. Of the active operations, 72% are in the Dawson area, 20% are in central Yukon (South McQuesten, Mayo, Keno, Canadian, Big and Nansen) and 8% are in southern Yukon (Kluane, Livingstone, Whitehorse South, Nisutlin). For the sixth consecutive year, reported placer gold production exceeds 70,000 crude ounces. Crude ounces represent an unrefined measure. Placer gold can contain inclusions of quartz or other matrix material or impurities such as silver and copper. These impurities, on average, account for 20% of the mass.

Climate for mining

Yukon weather and snowpack conditions were similar in all districts with above-normal precipitation blanketing most of the territory throughout the winter and continuing into March. In Dawson, cumulative precipitation was well above median on April 1, and 463% of the climate normal for the winter period. This delayed mobilization and access for operations to commence their spring stripping programs. The average low temperature for Dawson in April was -11°C . Cooler temperatures and delayed thawing hindered sluicing in most districts and many operations commenced sluicing in early June. Tributaries of the Yukon River all reported high flows throughout the summer, with heavy precipitation events in July, August and September across the Yukon. This culminated in landslide-related road closures affecting the Klondike Highway, disrupting the supply chain. A mild fall that extended well into October, with a mean average temperature of -2.6°C in Dawson, resulted in favorable conditions for sluicing until the end of the month.

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Gold production summary

Yukon placer gold production, for the reporting period of April 1 to November 8, 2022, was 80,165 crude ounces. The average gold price per ounce this season was CDN\$2335, which amounts to CDN\$149.8 million in production revenue (Fig. 1). The production revenue for 2022 is the second highest value reported from the Yukon placer industry: in 2020, the reported value was CDN\$173.4 million.

There are ten placer mining areas in Yukon and the majority of reported production is from those located in west-central Yukon (Klondike River, Indian River, Lower Stewart and West Yukon). Of these areas, the majority of placer production is reported from the Indian River area which includes the Indian River proper, Dominion Creek, Sulphur Creek and Quartz Creek. The distribution of placer gold production is derived from the royalty reporting collected by the Yukon Mining Recorder as of November 8, 2022 (Fig. 2).

Development highlights

Indian River area

The Indian River district has the highest concentration of large-scale operators (20+ employees) in the Yukon, which contributes to the district consistently generating the highest gold production. In 2022, placer gold produced from the Indian River area amounted to 36,787 crude ounces or 47% of the total Yukon production. This is the highest reported production from this area since 2018. Within the district, Indian River proper reported the highest production with 14,749 crude ounces, followed by Eureka Creek (6570 crude ounces), Dominion Creek (5665 crude ounces) and Quartz Creek (5066 crude ounces).

One of the largest operations in the Yukon is Fine Gold Resources Ltd., who targeted a deep left limit bench and right limit side pay on Eureka Creek this season. A transition of ownership to the La Prairie Group from Alberta was initiated; Fine Gold Resources Ltd. remained the operator for the season.

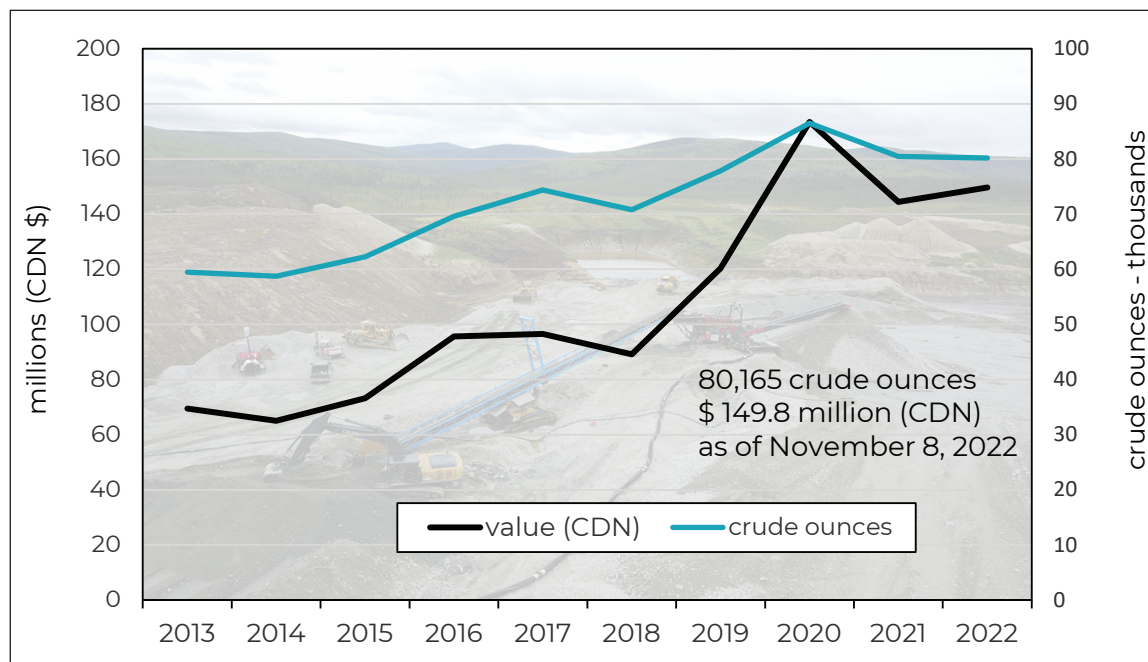


Figure 1. Total placer gold production in crude ounces and its value in Canadian dollars for the past ten years.

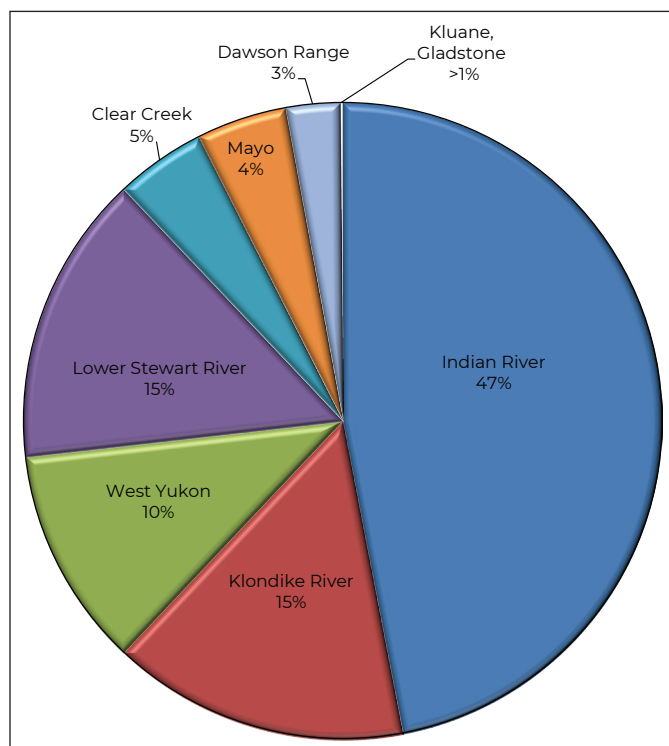


Figure 2. Placer gold production distribution according to district in 2022.

They completed a left limit bench cut measuring 91 by 91 m (300 × 300 ft) and averaging 20 m (65 ft) deep, and sluiced a total of 25,000 yards of material. An additional six claims on the right limit were worked. Next season the new owners will continue mining and exploring the deep left limit bench with a goal of developing the most efficient method of stripping the deposit.

Treadstone Gold conducted their fourth season of mining on upper Eureka Creek where they have optioned ground from Fine Gold Resources Ltd. Mining predominately occurred on the right fork of Eureka Creek, at the mouth of a small unnamed tributary (Fig. 3). Paleo Eureka Creek gravel buried under an alluvial fan sequence derived from the small tributary is targeted as pay. On June 21, operator Travis Delawski unearthed a mummified calf mammoth (named Nun cho ga meaning “big animal baby”). Treadstone Gold is acknowledged for their significant contribution to palaeontological research.



Figure 3. Upper Eureka Creek where Treadstone Gold mined in 2022. The view is looking downstream towards the Indian River valley.

Little Flake Mine ULC processed 3.8 million ft² (353 000 m²) of material from the Indian River valley this season. The thirty-person crew employed two sluice plants 24/7, which collectively processed 400 yd³ (306 m³)/hr. Material targeted by the operator was situated in the middle of the Indian River valley and consists of a cobble-pebble gravel up to 3 m (10 ft) thick. A 200-acre (809 371 m²) section on the Indian River valley bottom was reclaimed by contouring overburden and top coating the area. The Robert E. Leckie award for excellence in environmental stewardship was awarded to Little Flake Mine ULC this year, as they are recognized for their progressive reclamation.

A new operation on Green Gulch, a tributary to Sulphur Creek, commenced sluicing in the Indian River district. Lucky Dog Mining leased claims from DK Gold Inc. and with a crew of six people completed a 40 m (130 ft) wide by 70 m (230 ft) long cut (Fig. 4). They progressively mined up the drainage and sluiced 10,000 yd³ (7645 m³). A noticeable gutter in the bedrock was targeted for sluicing, along with all rounded material and up to 0.9 m (3 ft) of bedrock. Activity on Green Gulch occurred from 1979 to 2005; it then remained dormant until 2021 when DK Gold Inc. purchased the property.



Figure 4. Drone image looking up Green Gulch, with Lucky Dog Mining's active cut in the foreground.

Yukon Heliski had a significant discovery this season on Sulphur Creek, in an area heavily worked by dredging in the 1940s and 1950s. For several seasons, the drainage has been investigated for economic pay remaining under dredge tailings. This season Yukon Heliski found an area with up to 1.5 m (5.0 ft) of virgin Sulphur Creek gravel, which was thicker and more extensive than expected (Fig. 5). Coarse gold was found associated with the pay gravel.



Figure 5. P. Wright, with Yukon Heliski, investigating the virgin Sulphur Creek gravel in the 2022 cut.

Klondike River area

The Klondike River is the second highest gold producing area, accounting for 15% of the Yukon's total placer gold. Production from the Klondike River drainages dropped by 28% in 2022, reporting 11,832 crude ounces. This decrease is primarily due to a drop in production from Paradise Hill, Klondike River proper and Last Chance Creek. The largest contributors in the Klondike River area are Lovett Hill (2734 crude ounces), Paradise Hill (2303 crude ounces) and Hunker Creek (2118 crude ounces).

Lovett Hill Corp. took over mining from Northern Shovel Resources Ltd. on Lovett and Jackson hills. Lovett Hill Corp. aggressively approached the hills this season, moving overburden both mechanically and hydraulically (Fig. 6). They used hydraulics on the north-facing side (Jackson Hill side) of the property to thaw and liberate Klondike outwash gravel. Stripping the uppermost layers of the high terrace exposed a previously unidentified lake sediment. This deposit may be the first physical evidence for Glacial Lake Yukon, the 2.5 million year old glacial lake that formed when the Yukon River reversal occurred. Gold production focused on the Lovett Hill side of the deposit where a portion of the pay streak was targeted. Thrusted bedrock blocks were encountered suggesting that relatively young tectonic activity has disrupted the pay gravel.



Figure 6. Lovett Hill Corp. stripping Lovett Hill mid-season of 2022.

In fall 2021, on Bonanza Creek, A. Hollis acquired American Hill and Fox Gulch claims from D. Jackson. In 2022, A. Hollis and an assistant processed material they were able to liberate from the historic ditches or 'races' that were created by hydraulic operations in the early 1900s. They also worked a high-level bench on the property early in the season. They began efficiently stripping the deposit by employing a custom fabricated track-mounted conveyor.

Since the Gold Rush, this area has been heavily worked, and in order to target remnant pay gravel A. Hollis has been extensively compiling and interpreting historic data. The historic data include photos from the Dawson City Museum, air photos of various vintages, dredge data, and historic drilling information from the 1950s.

Tatra Ventures Ltd. acquired Upper Gauvin Gulch on Bonanza Creek this year, allowing them to consolidate the upper claims with their pre-existing lower claim block. With a three-person crew they initiated mining on the upper reaches of the drainages, focusing on the left limit, Pliocene bench (Fig. 7). Bulk testing was completed on different areas of the bench to gain a better understanding of the pay extent. Towards the end of the season, they identified a higher-grade channel within the bench, which will remain an important focus in 2023. With the addition of the bench deposit to the unmined valley bottom, a large amount of minable ground is remaining in this Upper Bonanza Creek tributary.



Figure 7. Aerial view looking up Gauvin Gulch at Tatra Ventures Ltd. operation, mining on the left limit.

K.T. Mining excavated a section of virgin Hunker Creek gravel on the left limit of the drainage. Their operation is located immediately downstream from Little Gem Gulch and employs a two person crew. The cut measured 30 ft (9 m) in width and happened to expose a section of buried Hunker Creek side pay, overlain by colluvium and massive ice. The side pay likely escaped dredging due to the narrow valley-bottom setting and thick cover of frozen silt, visible in Figure 8. This discovery proves that even in prominent Klondike drainages side pay still exists, which is encouraging for the historic district.



Figure 8. K.T. Mining's operation active on the left limit of Hunker Creek, immediately below Little Gem Gulch.

Favron Enterprises Ltd. was sluicing on Dago Hill this season, dividing efforts between Hunker Creek and their Sulphur Creek property. A 100,000 ft² (9290 m²) cut that was 21 m (70 ft) deep was prepared for sluicing, and half of the cut material was processed this season. Frozen gravel was encountered in the lowermost 4.5 m (15 ft) of the cut, which decreased production this season. On Bremner Hill, a tributary of Last Chance Creek an additional 30,000 yd of material that was excavated and stockpiled in 2018 was sluiced. Activity also included a large stripping program and reclamation on 300,000 ft² (27 870 m²) of previously mined ground. Favron Enterprises Ltd. is the recipient of a Robert E. Leckie Award this year, recognized for their responsible and innovative exploration and mining practices.

West Yukon area

In West Yukon, production increased by 15%, with the most noticeable production derived from the Sixty Mile River (5710 crude ounces). This season 8722 crude ounces were reported, the highest reported production from the placer area since 2008 (13,416 crude ounces). In the Fortymile drainage, production from Bruin Creek increased by 59% (399 crude ounces) and by 207% from Browns Creek (415 crude ounces). In the past few years activity in the Browns Creek area has been progressively increasing, and this season 4 operations reported production. Aside from Sixty Mile River, the next highest producing creeks in West Yukon are Bedrock Creek (644 crude ounces) in the Sixty Mile River drainage and Kenyon Creek (562 crude ounces) in the Moosehorn Range.

Bruin Creek is a large, right limit tributary of the Fortymile River, with headwaters located immediately off the Top of the World Highway. Sandro Frizzi, with support from the Yukon Mineral Exploration Program (YMEP), has been exploring in the drainage. Mechanized mining was initiated in the drainage in 2020, and it has been an active drainage in the West Yukon area since then. Chrysos Mining moved into the lower portion of the drainage in 2019 and this season they acquired the claims in the upper reaches of the drainage, to be the sole claim holder on Bruin Creek. Mining these upper claims this season, Chrysos Mining is targeting a low-level, discontinuous bench deposit on the right limit (Fig. 9).



Figure 9. Chrysos Mining processing a low-level, right limit bench deposit on Bruin Creek.

M2 Gold Mines Limited mined two different placer settings on the Sixty Mile River this season. The first was on the floodplain and the second was a mid and high-level bench on the right limit, with the upper bench located 24 m (80 ft) above the floodplain. Evaluating the bench potential has occurred for several seasons, with sluicing on both levels initiated this year. Preservation of the mid-level bench is discontinuous, whereas on the high-level bench the width of pay is more extensive than thought. Each plant sluiced for 2000 hours, and an 18-person crew was employed at the mine. A large reclamation program was also completed on previously mined areas upstream from camp.

With a crew of five personnel, No Name Resources Inc. spent the season mining two locations in the Ten Mile Creek drainage (Fig. 10). They focused on mining a prominent high-level White Channel bench on the left limit of the drainage. Two cuts were completed, each consisting of a 10 m (33 ft) section of gravel. With a 1.5 m (5 ft) diameter trommel, they were processing 120 yd³ (92 m³)/hr when in silty gravel and 180 yd³ (138 m³)/hr in sandier material. The pay streak remained on the rim of the bench as they mined and is defined by an increase of white silt within the gravel and coarse gold grains.



Figure 10. No Name Resources Inc. operation on a high-level bench in the Ten Mile Creek drainage.

Lower Stewart area

The Lower Stewart area is the third largest gold producer in the Yukon, reporting 11,560 crude ounces. Production from Lower Stewart remained consistent this year, dominated by production from the Henderson Creek drainage (6067 crude ounces). Kirkman Creek is the second largest contributor, reporting 9% (1037 crude ounces) of the reported production from the Lower Stewart area. The third largest contributor is Scroggie Creek producing 8% or 921 crude ounces.

Henderson Creek, the top producing drainage in the Lower Stewart area has two active operations in the drainage. The larger of the two, H.C. Mining Ltd., sluiced 1.5 million ft² (139 355 m²), predominately from the valley bottom of the lower portion of the drainage. Employing up to 4 wash plants operating 24/7, the 30-person crew completed several large cuts throughout the season. In Figure 11, three Macon wash plants operating in unison are responsible for the operation processing a large volume of pay. An extensive sonic drilling program to evaluate the lowermost 2 km of the drainage was completed in the spring.



Figure 11. Three wash plants being fed by a Hitachi 470 excavator at H.C. Mining Ltd. operation on Henderson Creek.

Fellhawk Enterprises Ltd. completed their fourth season on North Henderson Creek, leasing claims from H.C. Mining Ltd. The creek gradient decreased as they moved upstream throughout the season, concluding the year by sluicing material from a 49 by 271 m (160 × 890 ft) cut. An increase of gold was observed as they mined into the reach with a lower gradient. A YMEP-funded project was also completed on an unnamed left limit tributary of upper Henderson Creek. Using Northern Sonic to complete twenty-seven 6” diameter sonic drill holes, they identified the presence of side pay and a thick section of economic gravel in the valley bottom.

Aquila Mining and Exploration Ltd. optioned Mariposa Creek, a tributary of Scroggie Creek from Z. Bidrman. Operating with six people, they focused on processing historic tailings from the drainage. While excavating into the far right limit of the modern valley, they uncovered a bench deposit, shown in Figure 12. The bench deposit consists of 3.5 m (11.5 ft) of colluvium overlying an oxidized, cobble-pebble gravel of unknown thickness. Further exploration will determine the extent and economics of this deposit.



Figure 12. Aquila Mining and Exploration Ltd. operation on Mariposa Creek. The bench deposit is visible on the right side of the drainage.

New production is reported from Larsen Creek, a right limit tributary of Black Hills Creek. In the fall of 2021 2074098 Alberta Ltd. staked the drainage and stripping commenced in the spring of 2022. With a three-person crew, they spent a month sluicing material from a 30 by 165 m (100 × 540 ft) cut at the mouth of the drainage (Fig. 13). A boulder-cobble gravel up to 0.6 m (2 ft) thick is situated on the undulating bedrock contact. The operation also completed a cut on Dome Creek and concluded their season reprocessing historic cat-mining tailings from the 1980s.



Figure 13. 2074098 Alberta Ltd. cut at the mouth of Larsen Creek. The view is looking up Larsen Creek.

Mayo, Keno and Clear Creek area

Mayo district production decreased by 49% (reporting 3578 crude ounces), largely due to a reduction of operations in Granite Creek. Production is reported from Keystone Creek, which is the first year of mechanized mining in the drainage. Consistent production is reported from the Clear Creek area accounting for 5% of the overall production with 3601 crude ounces of gold reported. Production is distributed among a number of drainages in the Clear Creek area including Clear Creek (1824 crude ounces), Josephine Creek (1043 crude ounces) and Big Creek (659 crude ounces).

Wally Creek is a locally named left limit tributary of Clear Creek. M. Hollingsworth and J. Colosimo have been exploring the drainage since they purchased the claims from K. Wilson in 2014. Mining was initiated in the valley bottom of the drainage, and in the last two seasons focus has shifted to a high-level right limit bench (Fig. 14). An increase in coarse gold was noted from the valley bottom immediately downstream from a right limit tributary that intersects the bench deposit, encouraging the operators to explore farther upslope where they discovered a deposit.



Figure 14. A view looking up Wally Creek where a high-level bench has been exposed near the mouth of the drainage.

K. Wilson, a long-time operator in the Mayo and Clear Creek area, recently shifted operations to Bennett Creek. An eight-person crew completed sluicing material from a cut 30 m (100 ft) wide by 457 m (1500 ft) long on the middle reaches of the drainage. Pay consists of up to 1.2 m (4.0 ft) of a poorly sorted, cobble-pebble gravel situated on till that acts as a false bedrock. The overall stripping ratio is favorable as overburden ranges in thickness from 0.9 to 3.0 m (3–10 ft).

Bardusan Placers Ltd. reinitiated mining on Thunder Gulch, opening a cut 30 m (100 ft) wide by 91 m (300 ft) long by 24 m (80 ft) deep, approximately 1.5 km upstream from its confluence with Lightning Creek. For the past five years, the three-person operation has focused mining at the confluence of Thunder Gulch and Lightning Creek. An enriched trough or gutter 18 m (60 ft) wide is cut into the bedrock surface, and has no distinguishable texture from the overlying

reworked till. The Derocker wash plant processed up to 75 yd³ (57 m³)/hr, and water is supplied to the plant using a gravity-feed system. Gold is becoming more crystalline as the operator progresses upstream.

Dulac Mining reported production from Keystone Creek, a tributary of Mayo Lake, where they focused extraction on the apex of a fan delta landform (Fig. 15). This was the first year of mechanized mining in the drainage. Glaciers that once flowed westward in the Mayo Lake valley have influenced the ground. As Dulac Mining progressed upstream into the confines of the drainage, the stratigraphy became more predictable and less influenced by the ice sheet. Interglacial gravel was present and the bedrock channel was not reached on the right limit. Near surface deposits consist of a very high-energy boulder gravel up to 4 m (13 ft) thick, deposited during a deglacial reworking (flush) event.



Figure 15. A view looking upstream on Keystone Creek of Dulac Mining's operation.

A new operator, leasing claims from J. Davies, was active in the Granite Creek drainage this season. MDB Northern Mining and Exploration Inc. from Belgium arrived on the creek in late July, and by mid-September completed sluicing material from their second cut. Mining was initiated immediately downstream from the discovery production cut of 2013. The pay unit consists of brown oxidized till on bedrock measuring 13 m (43 ft) thick that is overlain by 7 m (23 ft) of grey gravel.

Dawson Range, Kluane and Whitehorse South areas

Reported production from the Dawson Range remained consistent this season; 2142 crude ounces were reported, which accounted for 3% of the total Yukon production in 2022. Canadian Creek and Nansen Creek contributed the majority of the production with 1103 and 682 crude ounces reported respectively.

Two operations were active in the Freegold area, one of which was D. Dodge on Seymour Creek. A variety of targets were evaluated using a sonic drill rig and by conducting 400 yd bulk samples. The drilling program identified a buried valley on the left limit of Seymour Creek, and tested the terraces present on lower Seymour Creek. D. Dodge and his crew of three

completed five weeks of sluicing on Big Creek, immediately upstream from his camp location. They processed right limit side pay and unmined bedrock in a previous cut.

Webber Creek is a right limit tributary of lower Nansen Creek that was prospected and held by Eugene Curley from 1994 to 2020. E. Curley sold the claims to Capital Gold Mining Corp. in late 2020. Capital Gold Mining Corp. completed their second season in the drainage this year; the first half of the season consisted of stripping, testing and construction of settling ponds. By the end of July, the two-person operation identified a pay streak and commenced mining (Fig. 16). The pay gravel consists of an angular, orange, silty gravel with manganese staining.

Collectively, the Kluane and Gladstone areas reported 103 crude ounces as of November 8, 2022, with the majority of production reported from Ruby Creek (94 crude ounces). Additional reporting is noted in Fourth of July Creek (6 crude ounces) and Burwash Creek. Whitehorse South placer area has no reporting, but two small-scale operations were active in the Moose Brook Creek drainage.



Figure 16. Aerial view looking upstream Webber Creek at Capital Gold Mining Corp.'s operation this season.

Yukon Mineral Exploration Program 2022 update

Sarah Ellis and Scott G. Casselman
Yukon Geological Survey

Ellis, S. and Casselman, S.G., 2023. Yukon Mineral Exploration Program 2022 update. In: Yukon Exploration and Geology Overview 2022, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 33–42.

Program overview

The Yukon Mineral Exploration Program (YMEP) is a Government of Yukon funding program designed to support individual prospectors, partnerships and companies. The funding supports placer and hard rock exploration projects by reimbursing a percentage of approved exploration expenditures. The program comprises four different modules of varying reimbursement rates and maximum funding limits: grassroots, target evaluation and focused regional for hard rock, and placer.

Information about the program, the project modules, eligibility and levels of funding, and the YMEP guidebooks can be found at <https://yukon.ca/en/mineral-exploration-funding>.

Applications for funding and submission of project proposals are due by March 31st of each year.

YMEP 2022

The total amount of YMEP funding available for the 2022–23 season was \$1.4M.

The program was oversubscribed: 63 applications sought in excess of \$2.2M of funding with a proposed total budget of \$5.9M. Application breakdown and the number of projects in each module that received funding are provided in Table 1.

Forty-two YMEP projects received funding in 2022 (Fig. 1; Appendix I). Gold continues to be the primary commodity targeted in the hard rock module and 69% of the applications targeted the precious metal. Twenty-four percent of the hard rock applications targeted copper as the primary commodity; 2% targeted nickel-copper-cobalt-PGE; and 2% targeted rare earth elements. All placer applications targeted gold.

Table 1. YMEP 2022 application and funded project numbers.

Module	Total Applicants	Total Funding Received
Grassroots	6	2
Focused regional	10	6
Target evaluation	23	17
Placer	24	17
TOTAL	63	42

* ymep@yukon.ca

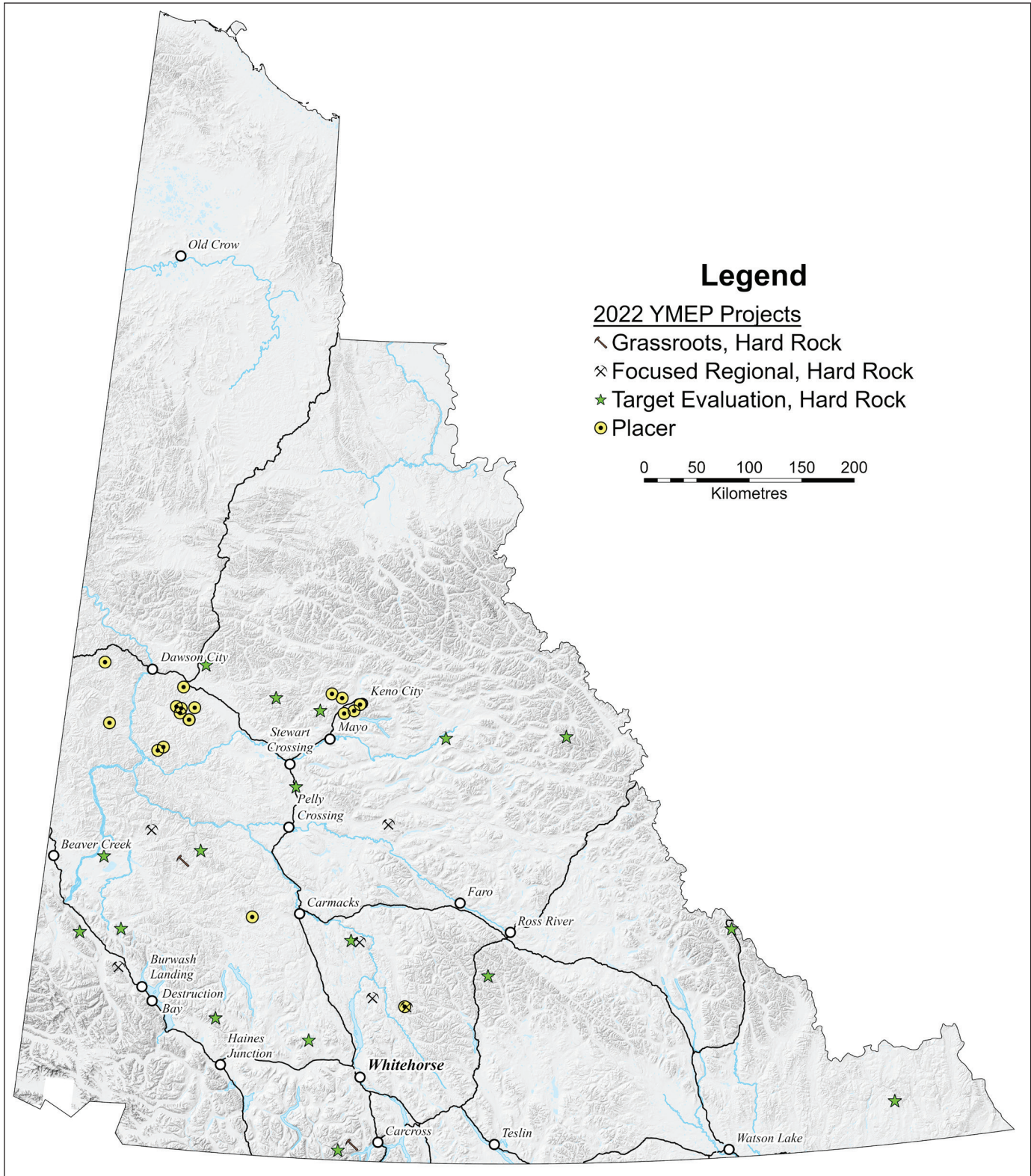


Figure 1. Location summary of 42 YMEP-funded projects in Yukon.

Economic benefits of YMEP

The intent of the YMEP program is to support early-stage projects and stimulate new mineral discoveries in Yukon. A number of indicators are used to measure the success of the program, such as economic benefits, dollars leveraged, new discoveries made and option agreements entered (Table 2). The economic benefits of the program not only include

the potential for same-year discoveries and long-term investment, but also provide short-term local economic impacts within Yukon.

Local economic benefits

YMEP funding recipients are asked to complete a survey on the economic impact and employment related to their program and submit it with their final report. The feedback received from YMEP-supported

Table 2. Examples of successful YMEP projects from 2000 to 2022.

YMEP#	Property Name	Total YMEP Contribution(s)	Optioned by	Total Exploration investment to date
04-041; 07-043	Coffee	\$35 000	Newmont/Gold Corp./Kaminak	~\$400.9M
03-079; 03-082	White Gold	\$25 000	White Gold Corp./Kinross Gold	~\$86.0M
10-118; 14-010	3 Aces	\$93 130	Northern Tiger / Golden Predator/Seabridge Gold	~\$46.8M
05-058	Andrew	\$14 400	Overland Resources	~\$36.9M
01-011; 15-030	Ice/Red Mountain	\$52 500	St James Gold	~\$15.8M
00-069; 06-005; 06-006; 15-014	Mariposa	\$76 000	Pacific Ridge	~\$7.3M
04-072; 05-043	Blende	\$30 000	Blende Silver Corp.	~\$7.1M
07-056; 08-012; 09-112	Toni/Sixty Mile	\$33 000	Radius Gold Corp.	~\$4.9M
03-023; 06-033; 09-137	Scheelite/Gold Dome	\$75 000	Golden Predator Canada Corp.	~\$4.4M
09-015	Clear Creek (Rhosgobel)	\$81 550	Victoria Gold Corp.	~\$4.2M
09-158	Prospector Mountain	\$30 750	Silverquest Resources Ltd.	~\$3.8M
10-132; 20-012	Clear Creek (Eiger)	\$54 950	Sitka Gold Corp.	~\$3.7M
09-046; 09-062; 10-008; 11-019; 12-049; 22-028	Golden Culvert	\$167 000	Stratabound Minerals Corp.	~\$3.8M
19-095; 20-073; 21-043; 22-023	Pike-Warden	\$114 790	Transition Metals Corp.	~\$0.3M
20-108; 21-041; 22-027	Catch	\$115 000	Atac Resources Ltd.	~\$0.3M

programs in 2021–22 indicates that 79% of total project expenditures stayed in Yukon. Of that 79%, 52% went to Yukon-based contractors, 19% went towards wages for Yukoners and 8% went towards Yukon-based suppliers (Fig. 2). In addition, 71% of the workers on 2021–22 YMEP-supported projects were Yukon residents. The results from the 2022–23 survey are unknown until the end of January when final reports and surveys are due.

2022 project spotlights and discoveries

Projects that result in new discoveries or significant advancement of a lesser understood prior discovery

have potential to lead to further investment in mineral exploration in Yukon. Every year a number of YMEP-funded projects stand out and demonstrate exceptional initial results. Some projects are able to raise additional funding on equity markets to conduct additional work in the same field season; others are able to enter into property option agreements. New discoveries commonly fuel property and district-scale exploration and some progress to advanced stages of exploration.

Hard rock spotlight

Sands of Time project

Jack Milton received focused regional funding for the third year in a row to conduct fieldwork on his solely owned Sands of Time project. The property is located

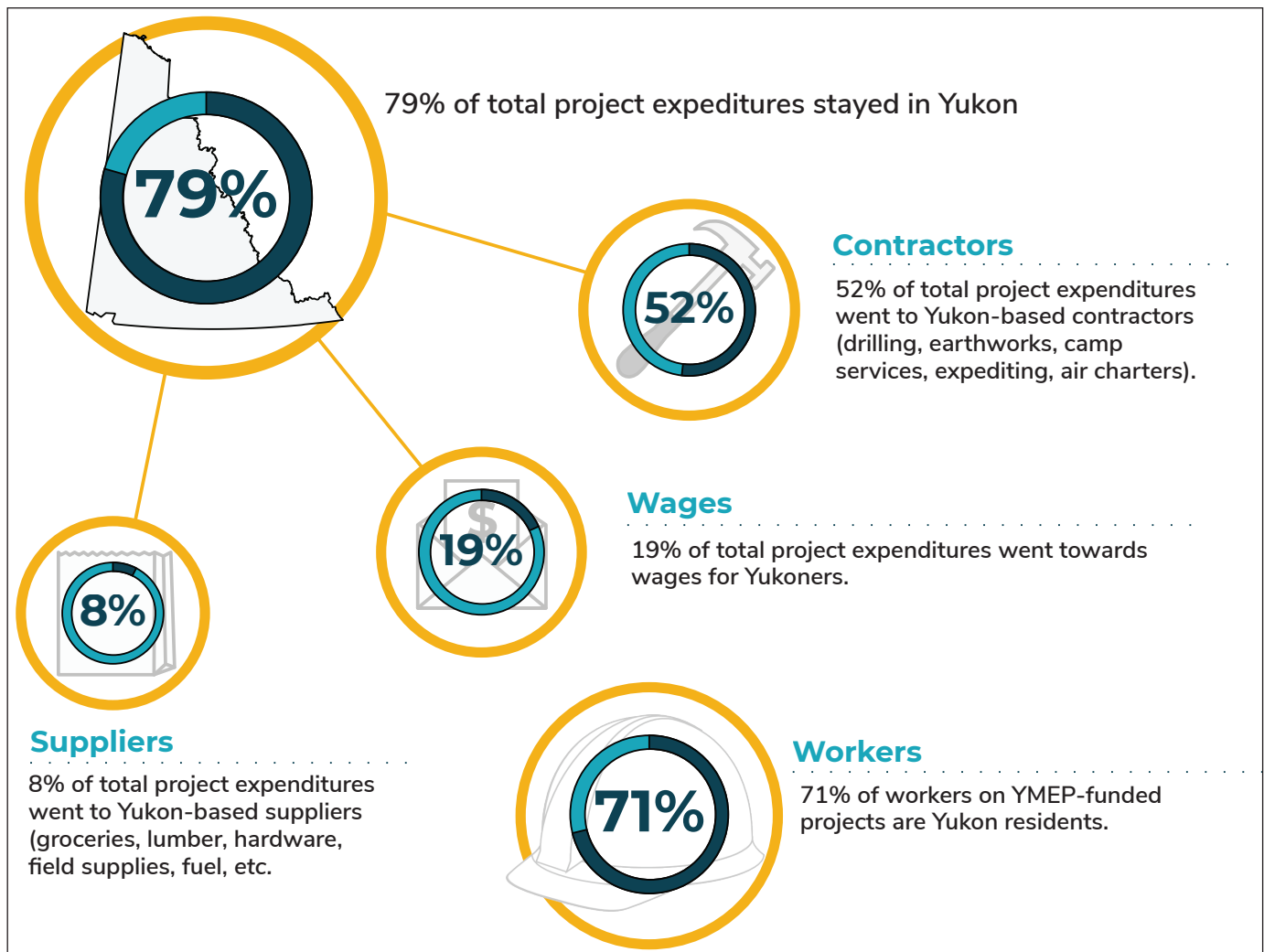


Figure 2. Statistical breakdown of how the YMEP program supports the Yukon economy.

in the Dawson Range approximately 12 km southwest of the Casino deposit. The project is assessing the exploration potential of drainages for hosting early-Late Cretaceous porphyry Cu-Au-Mo-Ag mineralization associated with the ~78–72 Ma Casino suite intrusive rocks. Prior fieldwork (2020–21) consisted of U-Pb geochronology of detrital zircon in stream sediments, zircon trace element geochemistry, porphyry indicator mineralogy of stream sediments, fine-fraction stream sediment geochemical sampling and soil sampling. Encouraging results from these programs identified several anomalous drainages, prompted staking of 123 claims and recommended further follow up.

In 2022, Jack staked an additional 150 claims and planned a field program comprising four days of soil sampling. Two days were spent following up on a Cu-Mo soil anomaly with a 100 × 100 m soil grid within a drainage shedding Casino suite zircons and gold grains. Another two days were spent soil sampling at the POL claims around the head of a drainage containing anomalous Casino suite age zircons and gold grains (Fig. 3). Results of the 2022 program have defined a copper-in-soil anomaly approximately 800 × 200 m within a drainage with stream sediments yielding anomalous, Casino suite zircons and gold grains.

Catch project

ATAC Resources Ltd. received target evaluation funding for their newly optioned (January 2022) Catch project located in south-central Yukon, 56 km southeast of Carmacks. The property lies within an underexplored region in the Stikine terrane that is prospective for Cu-Au ± Mo porphyry deposits. The 2022 program builds upon prior successful YMEP-supported target evaluation fieldwork in 2020–2021 completed by prospector Ryan Burke who identified Cu-Au porphyry-style alteration and mineralization that returned significant assay results on the property.

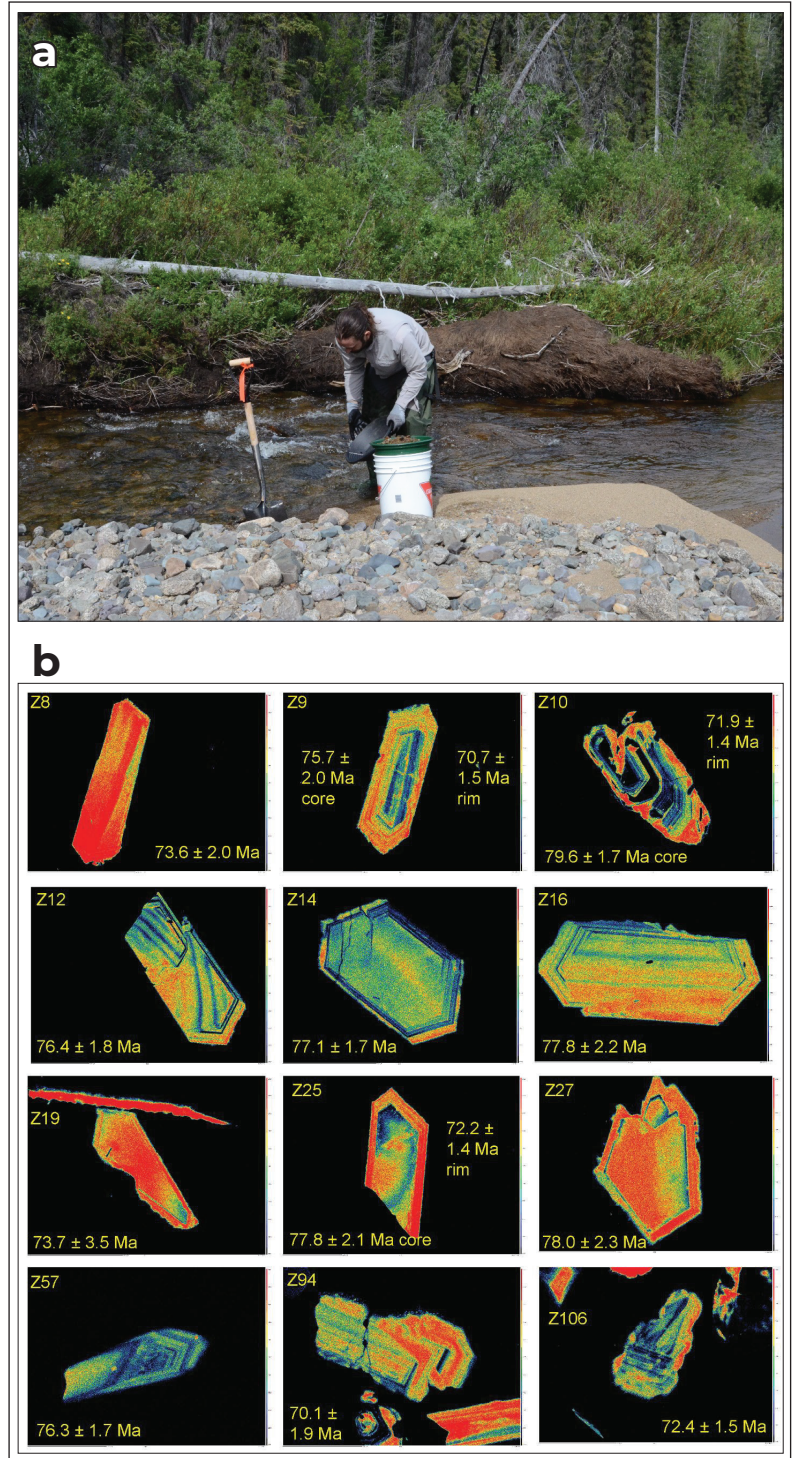


Figure 3. (a) Jack Milton collecting stream sediment sample and **(b)** U-Pb age dates from detrital zircon grains.

The 2022 YMEP-supported exploration program completed by ATAC consisted of prospecting, soil sampling and geophysical surveys (Induced Polarization (IP), ground magnetics and VLF-EM). Highlights of this program include the extension of the main Cu-in-soil anomaly to 5 km × 500 m, and widespread copper mineralization observed in trench and grab samples returning values of 7.45 g/t Au with 1.57% Cu (Fig. 4), 1.05 g/t Au with 1.60% Cu and 1.03 g/t Au with 1.01% Cu. In addition, multiple new target areas were discovered on the property, and IP surveys identified a 1000 × 600 × 400 m chargeability and resistivity high coincident with high-grade surface samples.

Promising results from the field program prompted ATAC to initiate a maiden RC drill program consisting of 6 holes, totalling 474 m. Results from this phase of the program are pending.



Figure 4. Grab sample from Catch Property containing 7.45 g/t Au and 1.57% Cu.

Pike-Warden property

Transition Metals Corp. received target evaluation funding for their newly optioned (June 2022) Pike-Warden property located in southern Yukon, 70 km south-southwest of Whitehorse. The property is approximately 10 km south of Whitehorse Gold's Skukum Gold project, which includes past-producing Mt. Skukum gold mine and advanced stage projects Skukum Creek and Goddell Gully. The property lies within the Intermontane belt along the northern margin of the Bennett Lake volcanic complex in an area that is prospective for structurally controlled, epithermal gold and polymetallic vein-hosted mineralization. The 2022 program builds on previous YMEP-funded programs (2019–20, 2020–21 and 2021–22) that consisted of geologic mapping, rock and till sampling, ground and airborne geophysical surveys and drone imagery, and resulted in the discovery of a number of mineralized showings.

The 2022 program involved prospecting, mapping, hand trenching and reverse-circulation (RC) drilling (3 holes, totalling 204 m). Results from the 2022 program are pending.

Nitra project

In 2019, Banyan Gold Corp. staked the Nitra property 5 km west of their AurMac property, within the Mayo mining district. Nitra is an early-stage intrusion-related gold target that exhibits similar potential to that seen at AurMac. In 2020–21, Banyan received a target evaluation grant that allowed them to infill and expand ridge and spur soil sampling programs. In 2021–22, they received another target evaluation grant that allowed them to collect more than 6000 soil samples. At each step along the exploration path, the company was able to further define and expand on soil geochemical anomalies that returned encouraging gold and pathfinder results. These results prompted another YMEP-supported target evaluation program in 2022 comprising an additional 5500 soil samples, lidar and airborne geophysical surveying. Results of their 2022 exploration program are pending.

Placer spotlight

Duncan Creek

Duncan Creek Goldbusters Ltd. received YMEP funding for their placer operation on Lightning and Duncan creeks located south of Keno. Their initial program consisted of geophysical (resistivity) surveys in order to identify the overall depth to bedrock and the presence of distinct channels within the bedrock profiles (Fig. 5a). Based on results of the survey, the company conducted a bulk-sampling program (Fig. 5b) testing surface gravels and they reported finding 0.007–0.017 oz of gold per cubic yard contained within gravels located 0 to 12 ft below the surface. The company subsequently signed an option to lease agreement with a third party.



Figure 5. (a) IP survey and (b) bulk sampling on Lightning Creek.

California Creek

Metallic Minerals Corp. received YMEP funding for their placer operation on California Creek. An 11-day program comprising property-wide lidar data and digital orthophoto collection, shafting 19 feet to bedrock, hand trenching, staking bench leases, as well as trail upgrading and maintenance was completed (Fig. 6). Panning of material collected from shafting returned gold at the gravel-bedrock interface.

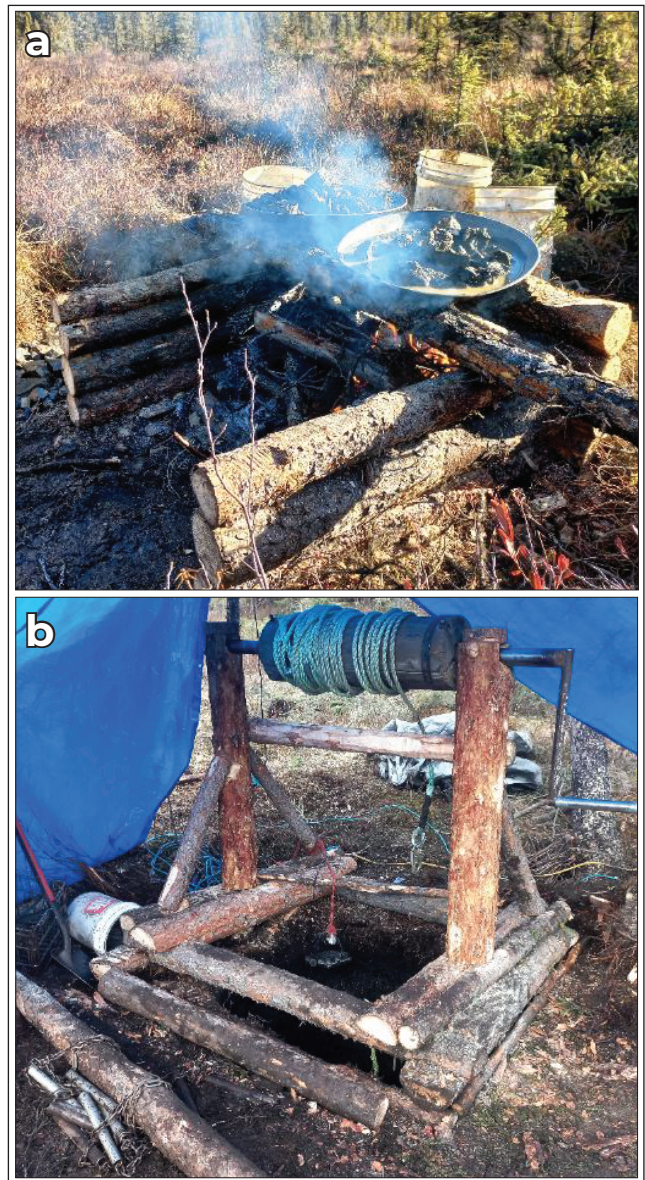


Figure 6. (a) Thawing frozen muck and (b) shafting on California Creek.

Summary

The YMEP program continues to be well received by the Yukon exploration sector and has demonstrated significant benefits to the local economy over the years. The 2022–23 program funded 42 programs and the \$1.4M government investment is expected to leverage an additional \$3.0M in clients funds for a

total contribution of \$4.4M to the Yukon economy. In addition to this immediate-term benefit, a number of projects yielded new discoveries that are likely to spur additional claim staking and exploration, and generate economic benefits well into the future.

Appendix 1. YMEP projects that received funding in 2022–23.

YMEP #	Project Name	Applicant	Module
Hard rock projects			
22-007	Nitra	Banyan Gold Corp.	Target Evaluation
22-010	Mil	Burke, Ryan	Focused Regional
22-013	Kryptos	Richards, Gordon	Target Evaluation
22-014	CDL	Mann, William (Bill)	Focused Regional
22-018	Wels Project	K2 Gold Corp.	Target Evaluation
22-021	Treble	Trifecta Gold Ltd.	Target Evaluation
22-022	Goldorak	Hulstein, Roger	Focused Regional
22-023	Pike-Warden	Transition Metals Corp.	Target Evaluation
22-024	Stevenson Ridge	Arsenault, Chris	Grassroots
22-025	Koi	Strategic Metals Ltd.	Target Evaluation
22-026	Allover	Burke, Mike	Grassroots
22-027	Catch	ATAC Resources Ltd.	Target Evaluation
22-028	Golden Culvert/Little Hyland/Rubus	Stratabound Minerals Corp.	Target Evaluation
22-029	Sands of Time	Milton, Jack	Focused Regional
22-031	Tosh	Senoa Gold Corp.	Target Evaluation
22-032	Rainbow	Senoa Gold Corp.	Target Evaluation
22-033	Cliff	Senoa Gold Corp.	Target Evaluation
22-034	Groundhog	Honey Badger Silver Inc.	Target Evaluation
22-037	Misty	Coates, James	Target Evaluation
22-038	Gold Strike	1079170 BC Ltd.	Target Evaluation
22-039	FLR claims	Florin Resources Inc.	Target Evaluation
22-042	Bandito	Endurance Gold Corporation	Target Evaluation
22-044	Catalyst	Stillwater Critical Minerals Corp.	Focused Regional
22-055	Ogi	Sitka Gold Corp.	Target Evaluation
22-062	Livingstone Creek	Golden Ram Inc.	Focused Regional

Appendix 1 continued. YMEP projects that received funding in 2022–23.

YMEP #	Project Name	Applicant	Module
Placer Projects			
22-003	Veronica and Eagle Benches	Gimlex Enterprises Ltd.	Placer
22-006	Henderson Creek	Fellhawk Enterprises Ltd.	Placer
22-011	Nansen	Hood, William C.	Placer
22-012	Sulphur Creek	Klippert, Dan	Placer
22-015	TMG	Brown, Derek	Placer
22-016	Fire	Bailie, Montana	Placer
22-020	Otto Creek	Star Mountain Resources Ltd.	Placer
22-035	Shanghai Creek	Sans Peur Exploration Services Inc.	Placer
22-041	Duncan Creek	FTG Exploration Ltd.	Placer
22-043	Dominion Ck Dredge tailings	NBC Contracting	Placer
22-048	Sulphur Ck Placer	Yukon Alpine Heliski Ltd.	Placer
22-051	Twenty Mile	GroundTruth Exploration Inc.	Placer
22-052	Lightning-Duncan Creek	Duncan Creek Goldbusters Ltd.	Placer
22-057	Haggart Creek	Taylor, Frank	Placer
22-058	Henderson creek area	Ryan, Shawn	Placer
22-059	Corkery Mayo River Placer	Wildwood Exploration Inc.	Placer
22-061	California Creek Placer	Metallic Minerals Corp.	Placer

Yukon hard rock mining, development and exploration overview 2022

Scott G. Casselman
Yukon Geological Survey

Casselmann, S.G., 2023. Yukon hard rock mining, development and exploration overview 2022. In: Yukon Exploration and Geology Overview 2022, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 43–59.

Introduction

Yukon mineral exploration activity in 2022 normalized, somewhat, as the restrictions related to the COVID-19 pandemic abated. However, headwinds remained for explorers in Yukon: continued worker shortages, rising labour costs, high fuel prices, supply chain issues, and difficult financial markets. A surprising number of companies were not able to raise the funds necessary to execute exploration programs in 2022.

The good news is that precious and base metal prices were generally strong, however, they did soften slightly towards the end of the summer. Expectations are that year-end exploration expenditures will be approximately \$124 million (\$123 million in 2021). Development expenditures for the year are expected to be \$105 million, up from \$86 million in 2021. These estimates are compiled by the Yukon Geological Survey from data posted on company websites and conversations with explorers. The expected value of year-end hard rock metal production for 2022 is approximately \$543 million (\$525 million in 2021; Fig. 1).

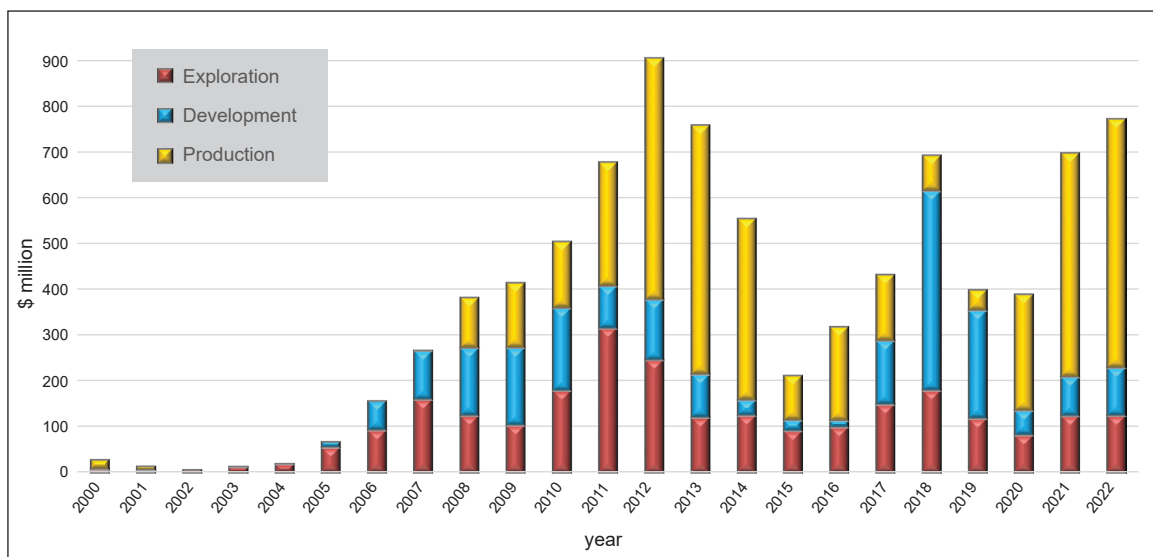


Figure 1. Estimated exploration and development expenditures on hard rock projects, and mine production values, 2000–2022.

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The number of active exploration projects in Yukon has been declining since 2017 (with a pandemic-affected low in 2020; Fig. 2). As of writing, there are 78 projects on the books for 2022 (Fig. 3, Appendix 1), compared to 91 projects at this time last season. Twenty-five of the 78 projects spent more than \$1 million, while 49 projects spent less than \$500 000. Fifty-eight percent of the smaller hard rock projects received Yukon Mineral Exploration Program (YMEP) funding. YMEP funds were distributed to 25 hard rock and 17 placer exploration projects (see Ellis and Casselman, this volume). In terms of exploration focus and expenditures (Fig. 4), gold continues to be the most sought-after commodity, and 61.5% of the projects targeted the precious metal.

The remainder of projects focused on exploring for copper (14.9%), lead-zinc (13.6%), silver (8.1%), nickel-PGEs (1.7%), and tungsten and rare earths (0.2%).

As of November 24, 2022, 6232 claims had been staked, almost double that of 2021. The majority of claim staking occurred within the Mayo district, (73%; Fig. 5). The number of claims in good standing at this time is 164 924, down from the all-time high of 252 902 in 2012 (Fig. 6).

Diamond drilling, reverse circulation and rotary air-blast drilling increased in 2022; 223 099 m of drilling (936 holes) on 32 projects in 2022, as compared to 200 955 m (863 holes) on 41 projects in 2021 (Fig. 7).

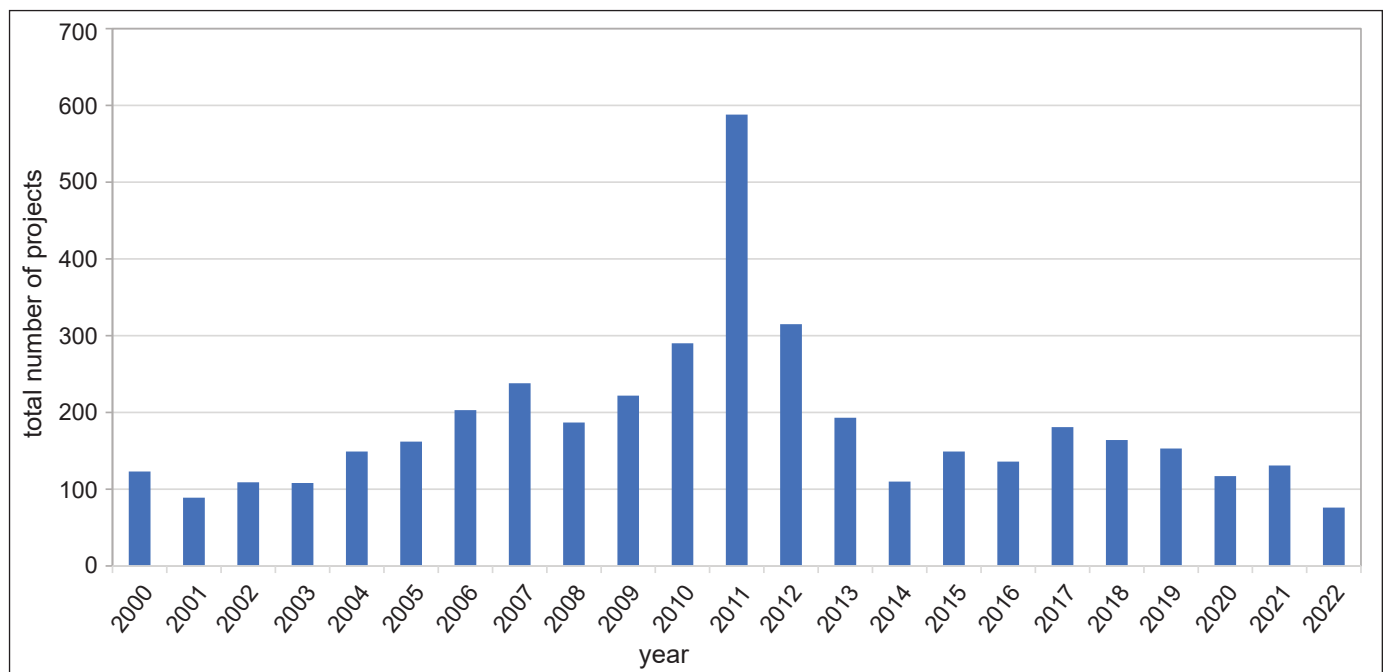


Figure 2. Annual number of active exploration projects.

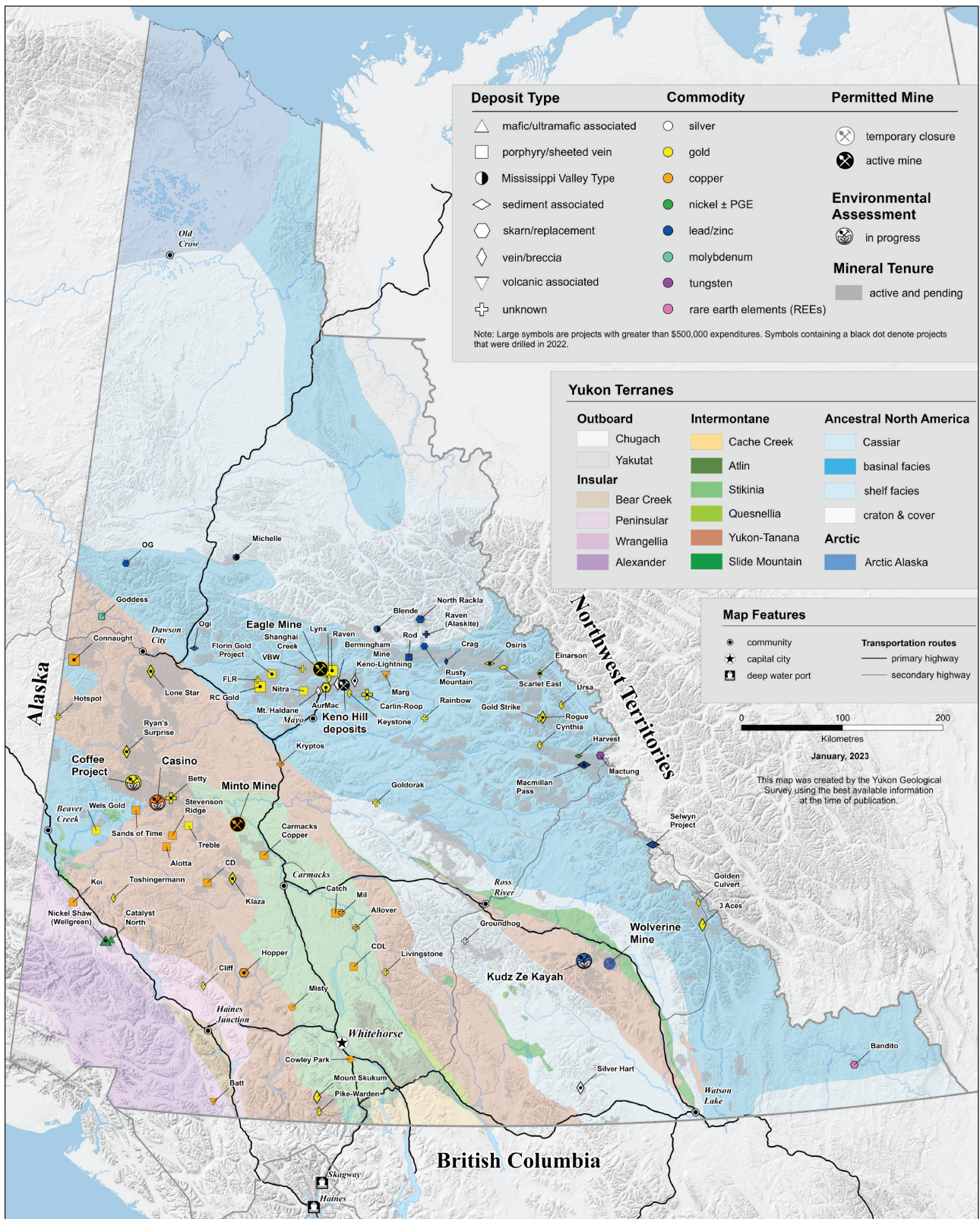


Figure 3. Exploration and mining projects active in Yukon during 2022.

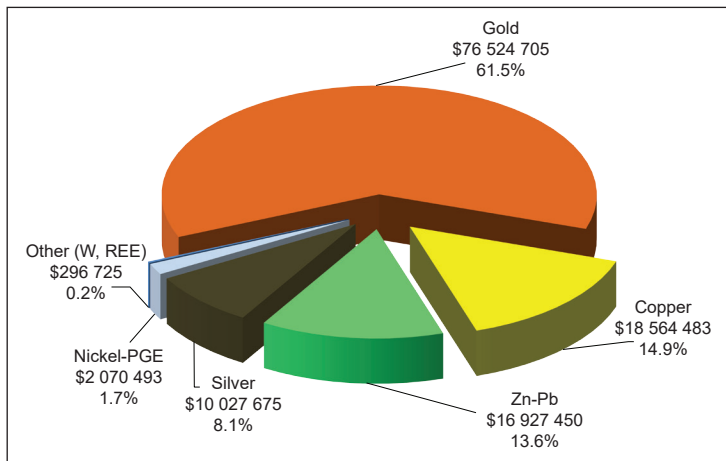


Figure 4. 2022 Distribution of exploration expenditures by primary commodity of interest.

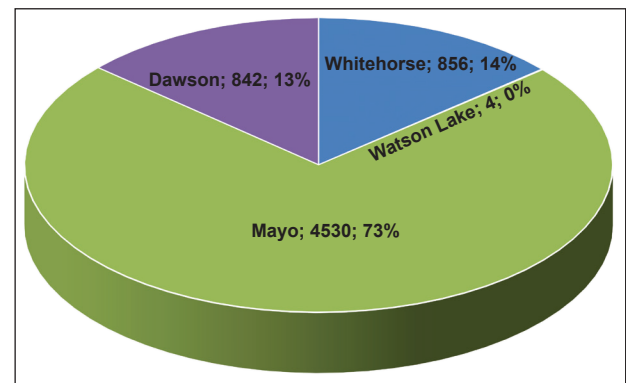


Figure 5. Distribution of claim staking by mining district.

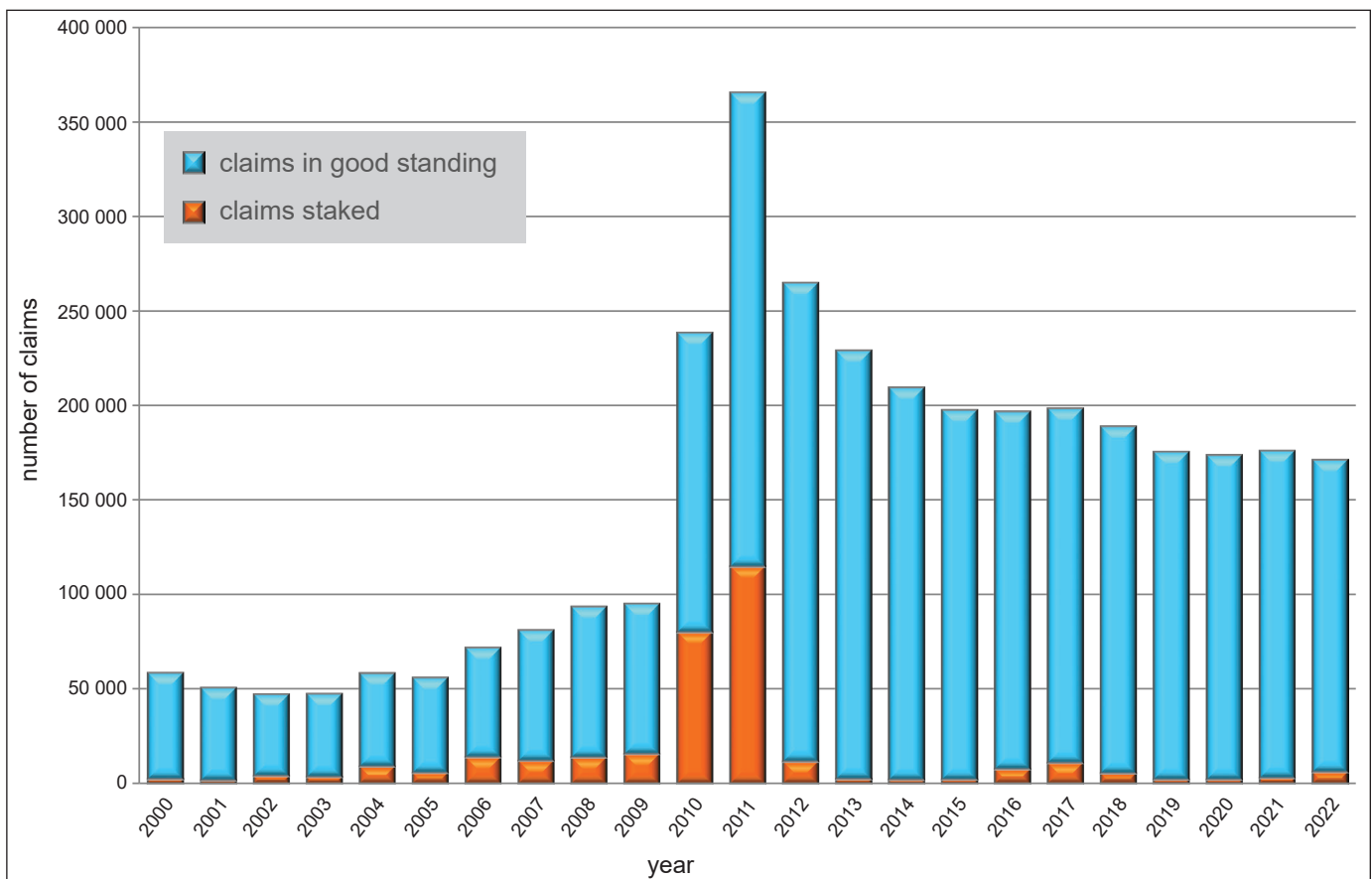


Figure 6. Quartz claims staked and in good standing, 2000–2022.

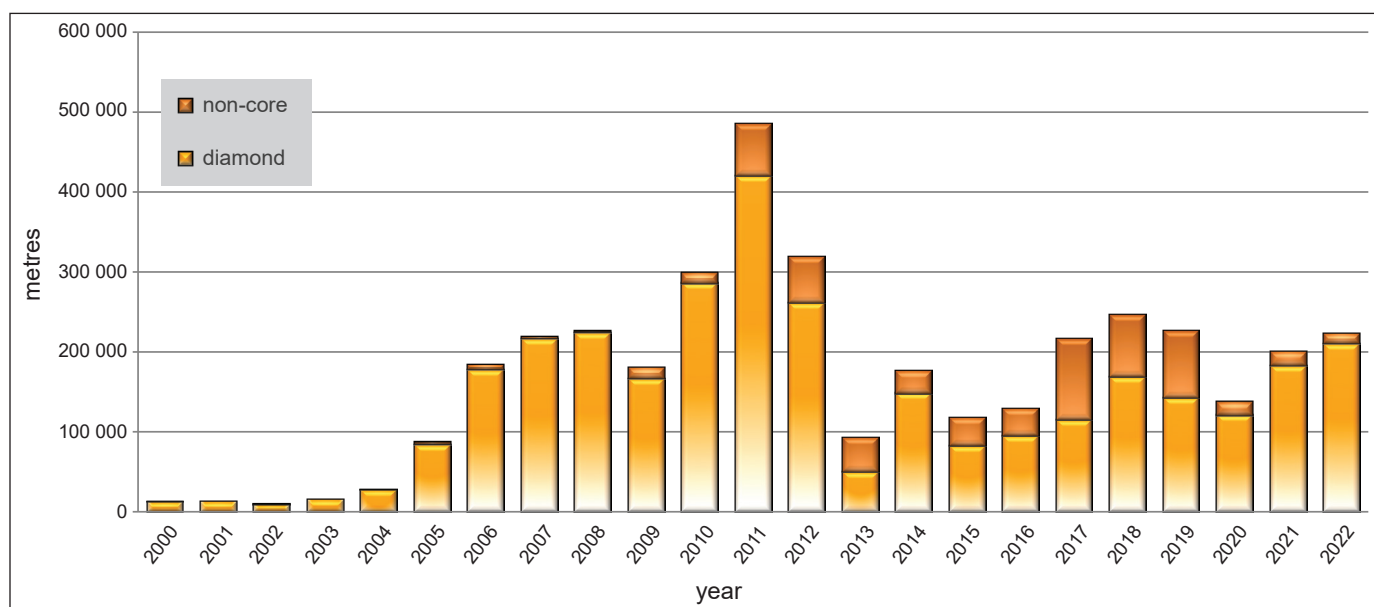


Figure 7. Diamond drilling and reverse circulation or rotary air blast drilling, 2000–2022.

Mining activity

Victoria Gold Corp. began commercial production at the Eagle Gold mine on its Dublin Gulch property on July 1, 2020. The deposit is a reduced intrusion-related gold system (RIRGS). Gold production for the first three quarters of 2022 was 106,441 oz and guidance for year-end 2022 was that the mine will produce approximately 165,000 oz of gold, comparable to 2021 production. A third quarter drop in production occurred due to a conveyor splice failure; repairs to the conveyor took approximately two weeks. The company also carried out an exploration program at Eagle, drilling 23 deep diamond drill holes totalling 10 342 m. Each hole averaged 450 m in depth; the program added approximately 500 m of mineralized strike length to the deposit.

Victoria Gold also drilled at their Raven and Lynx occurrences. In September, the company announced a maiden resource estimate for Raven: 20 Mtonnes at a grade of 1.67 g/t gold for a total gold content of 1,070,239 oz.

The Minto copper-gold-silver mine north of Carmacks is operated by Minto Metals Corp. The company continued to ramp up production in 2022, producing

22.4 Mlbs copper (30% more than in 2021), 8972 oz gold (26% more than in 2021) and 103,116 oz silver (18% more than in 2021). The company conducted a significant drill program at the site, drilling 63 holes (totalling 28 438 m). They targeted four sites: Minto North, Ridgetop, Copper Keel South and a new discovery east of the mine complex. Highlights from the program include 2.2% Cu over 20 m at Minto North, 1.30% Cu over 4.41 m at Ridgetop, and 2.11% Cu over 12.16 m at Copper Keel South.

At the Keno mine site, Alexco Resource Corp. depleted the resource at the Bellekeno mine and switched to producing from the Birmingham mine in early 2022. However, in June the company announced the temporary suspension of production and milling to allow them to get a sufficient number of development headings to supply the mill at 400 tonnes per day. Prior to suspending production the operation had produced 190,930 oz of silver, 312,778 lbs of lead and 532,200 lbs of zinc.

In July, Hecla Mining Corporation announced it had reached an agreement with Alexco to acquire the company. The acquisition was completed on September 7. Hecla intends to restart production some time in 2023.

Permitting and mine development

The Yukon and Canadian governments issued a positive decision on June 20, 2022, accepting the recommendation of the Yukon Environmental and Socio-economic Assessment Board (YESAB) for development of the Kudz Ze Kayah mine. However, the Kaska Nation has applied for a judicial review of the decision. The project is owned by BMC Minerals Ltd. and has a Measured, Indicated and Inferred mineral resource (M, I & I) of 19.1 million tonnes grading 6.35% zinc, 1.9% lead, 0.93% copper, 148 g/t silver, 1.39 g/t gold (CSA Global, 2017). The company did minor work on the site in 2022.

Newmont Corporation’s Coffee gold mine project received signoff from the Yukon and Canadian governments on the YESAB recommendation for the project to proceed. Newmont has not yet announced a timeline for development. The resource at Coffee (M, I & I) is 58.1 Mt grading 1.43 g/t gold for a total of 2.67 Moz of gold (Newmont, 2021). Newmont conducted exploration on its extensive land package focusing predominantly on targets outside the known resource area. The company completed 3456 m of diamond drilling and 6820 m of reverse circulation drilling (RC).

Western Copper and Gold Corp. continues to advance its Casino porphyry copper-gold-molybdenum project in western Yukon. The company filed an updated Feasibility Study in August and they have engaged with YESAB to restart the Panel Review process for the project. YESAB is revising the Environmental and Socio-Economic Statement Guidelines for the project in preparation for the Panel Review. In 2022, the company continued geotechnical and environmental studies for the project.

2022 exploration activities

The swath of land between Mayo–Keno–Clear Creek–Rackla to North Canol was the most active area for exploration and mining in 2022. Forty percent of the active projects and 73% of the exploration and

development spending occurred in this area. The Eagle Gold mine and the Keno silver mines are in this region, hence gold and silver are the focus, but there are also projects exploring for copper, lead, zinc and tungsten.

Banyan Gold Corp. conducted one of the larger exploration programs in Yukon in 2022 at the AurMac property west of Keno. AurMac is an intrusion-related gold occurrence located at the junction of the Eagle Mine access road and North Klondike Highway. The company completed 221 diamond drill holes (more than 50 000 m) on the Powerline and Aurex Hill targets. Highlights of drilling include 1.80 g/t gold over 31.8 m in hole AX-22-258 at Powerline and 1.13 g/t gold over 84.4 m in hole AX22-320 at Aurex Hill. In May, the company released an updated NI 43-101 resource estimate for the project that included an inferred resource for each of the three zones (Fig. 8; Table 1).

Banyan also conducted a program of soil sampling, lidar and airborne geophysics on its Nitra project, 20 km west of AurMac. Results from this program are pending.

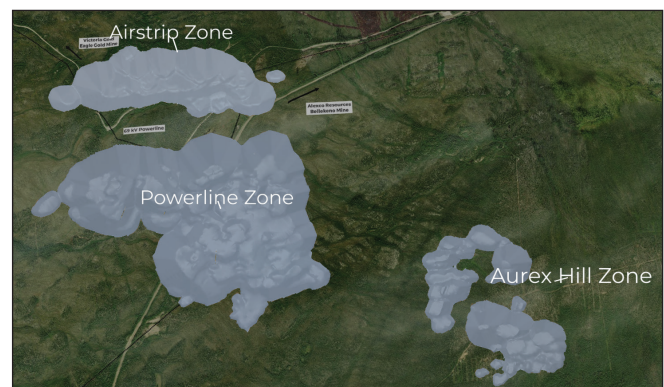


Figure 8. AurMac project resource zones (Banyan Gold, 2022).

Table 1. Inferred resource for AurMac property (Banyan Gold Corp., 2022).

Zone	Tonnes	Gold Grade (g/t)	contained oz
Airstrip	42 500 000	0.64	874,000
Powerline	152 000 000	0.59	2,898,000
Aurex Hill	12 000 000	0.53	215,000
Total oz =			3,990,000

The maiden drill program (2021) on Snowline Gold Corp.'s Rogue property was very successful. In 2022, Snowline did follow-up work and completed 32 drill holes (15 500 m) at the Valley (Fig. 9) and Gracie targets. The company is encouraged by the discovery at Valley, which has potential to be a significant RIRGS (Fig. 10). Highlights from the drilling at Valley include 1.89 g/t gold over 410.0 m in hole V-22-007, 2.55 g/t gold over 318.8 m in hole V-22-010, and 1.45 g/t gold over 285.2 m in hole V-22-014. The company expects more results in the winter months.

Snowline was also active at their Einarson, Ursa, Cynthia, Cliff, Tosh and Rainbow properties conducting a variety of surveys, including drone imagery, IP, ground-base gravity, airborne magnetics and radiometrics, ground VLF-EM, as well as mapping and prospecting. Results from this work are pending.



Figure 9. Snowline Gold's Valley target.



Figure 10. Sheeted gold-bearing quartz veins at in drill core from Snowline Gold's Valley target.

ATAC Resources Ltd. conducted a small drill program at their Carlin-type Osiris gold deposit on the Rackla Gold property. They drilled 5 holes (1551 m): 3 holes on the Osiris zone and one at each of the Sunrise and Conrad zones. Highlights from drilling the Osiris zone include 5.07 g/t gold over 4.0 m in hole OS-22-282, 2.63 g/t gold over 33.20 m in hole OS-22-283, and 3.69 g/t gold over 10.80 m in hole OS-22-285. In July, ATAC released an updated NI 43-101 resource estimate for the Osiris deposit (Table 2).

Table 2. Osiris deposit resource estimate (ATAC Resources, 2022).

Category	Tonnes	Gold Grade (g/t)	Contained oz
Indicated	5 528 400	4.12	732,000
Inferred	9 360 000	3.47	1,044,000
Total oz =			1,776,000

Sitka Gold Corp. conducted 6493 m of diamond drilling (20 holes) at its RC Gold project in the Clear Creek area (Fig. 11), 88 km west of Keno. The RC Gold property is an RIRGS. Highlights from the program include 0.90 g/t gold over 146.6 m in hole DDRCCC 22-030, 0.65 g/t gold over 116.0 m in hole DDRCCC-22-029, and 0.51 g/t gold over 69.0 m in hole DDRCCC-22-031.



Figure 11. Drill platforms at Sitka Gold Corp.'s Blackjack zone, RC Gold property.

In the Dawson area, Klondike Gold Corp. continued to explore its Klondike District Gold property a short distance south of Dawson. Diamond drilling in 2022 focused on the Stander Zone, Gay Gulch showing and regional targets (47 holes, 6000 m). Results from the 2022 drilling have not been released. In November, the company released a maiden NI43-101 resource estimate for the project that does not include the 2022 drilling (Table 3).

Table 3. Resource estimate for the Klondike District property (www.klondike Goldcorp.com).

Category	Deposit	Tonnes	Gold Grade (g/t)	Contained oz
Indicated	Lonestar	19 535 528	0.643	403,857
Indicated	Stander	2 049 741	0.987	65,004
Inferred	Lonestar	6 156 522	0.503	99,562
Inferred	Stander	304 821	1.265	12,397
Total (I & I) =				580,860

White Gold Corp. was active again this year on their extensive claim holdings south of Dawson, working several targets from their Thistle Creek camp. The company completed 9 diamond drill holes (2685 m) and 12 RC holes (919 m) at their Ulli's Ridge and Ryan's Surprise targets. The company also completed 15 diamond drill holes (2182 m) and 18 RC holes (1595 m) on the Betty property (Fig. 12).

Results released to date include 1.14 g/t gold over 27.43 m in hole BETMAS22RC005 and 4.13 g/t gold over 7.62 m in hole BETMAS22RC004 both of which are from the Mascot Target on the Betty property.



Figure 12. Gold-bearing breccia in drill core from White Gold Corp.'s Betty property.

Rockhaven Resources Ltd. completed an extensive diamond drilling program at its epithermal gold-silver Klaza property west of Carmacks (69 holes, 12 042 m). Fifty-three holes were drilled to further define the resource, eight holes were drilled to test for expanding the resource potential, two holes tested outside targets and 16 holes were drilled for geotechnical studies in the propose pit area and infrastructure sites. Results are pending.

In Wheaton River area near Carcross, Whitehorse Gold Corp. announce an update NI 43-101 resource estimate for their Skukum Gold project (Table 4). They did not conduct any fieldwork in 2022.

Table 4. Updated resource estimate for the Skukum Gold project using a 2.0 g/t AuEq cut-off grade (Whitehorse Gold Corp. news release Nov. 2, 2022).

Deposit	Category	kTonnes	Gold (g/t)	Silver (g/t)	Contained koz	
					Gold	Silver
Skukum Creek	Indicated	1048	5.79	170.5	195	5742
	Inferred	1680	4.49	101.3	242	5471
Goddell	Indicated	273	7.52	2.7	66	24
	Inferred	1134	4.61	3.1	168	112
Mt. Skukum	Indicated	273	9.88	11.6	87	102
	Inferred	201	6.05	7.3	39	47
Total					797	11,498

Seabridge Gold Inc. received a Class 4 exploration permit in September for their 3 Aces project in southeastern Yukon and embarked on an 1800 m drill program in the fall. The project is an orogenic gold occurrence with high-grade gold in quartz veins. The results from this work are pending.

Base metal exploration programs

Thirty-two exploration projects targeted copper, lead, zinc, nickel and cobalt in the Yukon in 2022. The copper projects are predominantly in the Dawson Range area, northwest of Carmacks, but there are a few scattered projects in the northern Kluane Ranges and the Whitehorse area. Lead and zinc projects are spread throughout the Selwyn basin, from north of Dawson City arcing north and eastward to the Howards Pass area. Nickel and cobalt projects occur in the Kluane ultramafic belt in southwestern Yukon (see Fig. 3).

Granite Creek Copper Ltd. announced an updated resource estimate (Table 5) on its Carmacks Copper project in the spring of 2022 and conducted a small exploration program. The program consisted of a high-resolution, deep penetrating IP survey. The goal of the program was to look for chargeability anomalies in the gaps between known copper-bearing zones, in the hopes that it might represent additional, deeper copper sulphide mineralization. The survey targeted an

extension of Zone 1 northwards, the gap between Zone 4 and Zone 2000S, and the southern extension of zones 12 and 13. A number of chargeability anomalies were identified and the company plans to drill test them in the future to determine the cause.

West of Dawson, near the Yukon–Alaska border, ATAC Resources Ltd. conducted an RC drill program on the Connaught property. A small-scale open-pit mine operated on the Connaught property in the late 1960s, producing 22.7 tonnes of gold-silver-lead-zinc ore from galena-sphalerite veins. ATAC has re-envisioned the project as a porphyry copper-gold-molybdenum target based on extensive soil copper-molybdenum anomalies and trenching that has encountered abundant copper-oxide mineralization. In 2022, the company drilled eight RC holes (2164 m). Results from the drill program are pending.

ATAC also worked their newly acquired Catch property located 51 km east of Carmacks. Catch is an early-stage project that has interesting gold and copper values from surface sampling. The initial small program consisted of soil sampling, prospecting and an IP survey. The program identified a copper-in-soil anomaly that measures 5 km × 500 m. Grab samples returned up to 1.57% copper, 1.01% copper with 1.03 g/t gold, and 0.70% copper with 2.82 g/t gold.

Table 5. Updated resource estimate for Granite Creek Copper’s Carmacks Copper project using a 0.30% Cu cut-off grade (Granite Creek Copper Ltd., 2022).

Category	Tonnes	Grade			Contained Metal		
		Cu (%)	Au (g/t)	Ag (g/t)	Cu (Mlbs)	Au (oz)	Ag (oz)
In Pit Oxide							
Measured	11 361 000	0.96	0.40	4.11	239.32	145,000	1,501,000
Indicated	4 330 000	0.91	0.28	3.37	86.85	39,000	469,000
Inferred	216 000	0.52	0.09	2.44	2.47	1000	17,000
In Pit Sulphide							
Measured	5 705 000	0.68	0.16	2.54	86.05	28,000	467,000
Indicated	13 486 000	0.72	0.19	2.83	214.32	82,000	1,226,000
Inferred	1 675 000	0.51	0.13	2.24	18.92	7000	120,895

The IP surveys identified a 1000 × 600 × 400 m chargeability and resistivity high coincident with high-grade surface samples. Results were encouraging and prompted the company to include a follow-up 6-hole (474 m) RC drill program. The results from the drill program are pending.

Early in the summer, CAVU Energy Metals Corp. conducted a diamond drill program on the Hopper property located near the southeastern shore of Aishihik Lake. The 8-hole (2555 m) program targeted the Copper Castle Skarn zone and the Porphyry zone. At Copper Castle, they encountered 2.8% copper over 15.27 m in hole HOP22-DDH-03. At the Porphyry zone they encountered 0.106% copper over 306.75 m in hole HOP22-DDH-04. Later in the summer, CAVU announced a definitive agreement with Alpha Copper Corp., whereby Alpha Copper will acquire all of the shares of CAVU, merging the two company's assets. The acquisition is to be completed before the end of 2022.

Strategic Metals worked four copper projects, three lead-zinc projects, and one nickel project in 2022. The copper projects included the Batt copper-cobalt VMS project south of Haines Junction, and the CD and the Alotta porphyry copper projects in the Dawson Range copper belt. Results have been released from the work at the Batt property: surface sampling of a hand trench through oxidized and deformed volcanic and intrusive rocks returned 0.71% copper, 0.21% cobalt and 1.18 g/t gold over 5.7 m; and a sample from a large, angular, massive chalcopyrite boulder returned 19.7% copper and 41 g/t silver. The lead-zinc projects were the Rusty Mountain, Crag and Rod projects; all are located north of Keno in the Beaver River watershed area. The sediment-hosted nickel project was the Harvest project, located near Macmillan Pass. Results from work on the lead-zinc and nickel projects are pending.

Fireweed Metals Ltd. (formerly Fireweed Zinc Ltd.) continued to advance its Macmillan Pass sediment-hosted lead-zinc project, which includes the Tom and Jason deposits and the Boundary zone. The 2022 diamond drill program included 23 holes at the

Boundary zone and 9 at the Tom deposit, totalling 7000 m. Observations at Boundary zone extended known mineralization, and identified new discoveries of massive sulphide and laminated stratiform zinc mineralization with abundant sphalerite veins and vein breccias in multiple holes. At Boundary West, hole NB22-002 intersected high-grade massive sulphides and veins and ran 12.3% zinc, 1.3% lead, and 45.9 g/t silver over 124 m. The company also scanned 11 000 m of drill core using the GeologicAI core scanning system with state-of-the-art XRF and hyperspectral sensors.

Fireweed Metals also announced in early summer that it had acquired 100% interest in the Mactung tungsten project, located immediately adjacent to their Macmillan Pass project. Mactung is one of the largest and highest-grade tungsten deposits in the world. It is an advanced stage project with extensive drilling, engineering, metallurgy, geotechnical, and environmental baseline data collected by previous owners that supported a feasibility study in 2009. There is an historic resource calculation for the property from 2007: an indicated resource of 33.0 million tonnes grading 0.88% WO₃ (tungsten trioxide), and an inferred resource of 11.8 million tonnes grading 0.78% WO₃. Fireweed conducted a lidar survey, resampled historic core, and did bulk density tests at the site in 2022.

Cantex Mine Development Corp. conducted diamond drilling (63 holes, 13 000 m) at their lead-zinc-silver North Rackla property located 85 km northeast of Keno. The program targeted the Main and GZ zones. Drill hole YKDD22-245 in the Main Zone intersected 12.1% combined lead-zinc and 37.5 g/t silver over 7.0 m. Hole YKDD22-226 intersected 39.0% combined lead-zinc, and 116.0 g/t silver over 5.0 m in the GZ zone.

Metallic Minerals Corp. has a number of mineral claims in the historic Keno silver district that fall within and around Hecla Mining's claim package. Metallic Minerals drilled 23 holes (3265 m) in 2022. The program focused on resource definition drilling on the Formo and Caribou deposits and the recently discovered Fox target, as well as step-out drilling at several new discoveries. Results from the program are pending.

Alianza Minerals Ltd. explored its Mt. Haldane property, a high-grade silver vein target 27 km west of Keno, with trenching, prospecting and rock sampling. Results from the program are pending.

In southern Yukon, near Rancheria, CMC Metals Ltd. drilled 22 holes (4400 m) and mapped trenches at the Silver Hart property. Silver Hart has historically been recognized as a polymetallic vein occurrence with an historic resource of 69 500 tonnes containing 1.2 Moz of silver. However, the program this year came up with a new interpretation of the geological setting and identified significant manto-style alteration and mineralization a short distance from the veins (Figs. 13 and 14). Results from the drill program are pending.



In southwestern Yukon, in the Kluane ultramafic belt, there are two exploration projects targeting nickel-copper-cobalt-PGE occurrences. At the Catalyst project, Stillwater Critical Minerals Corp. conducted a program of airborne geophysical surveying, soil sampling and prospecting. Results from this work are pending.

At the Nickel Shaw property, Nickel Creek Platinum Corp. completed an 18-hole (3300 m) diamond drilling program: 8 holes were located to upgrade the resource estimate on the deposit, and 10 holes were to explore at the Arch target (Fig. 15). The company also undertook the collection of additional geotechnical and hydrogeological data including the characterization of the proposed waste dump and tailings sites. The property is located 26 km northwest of Burwash Landing. Results from this work are pending.

Figure 13. Oxidized manto-style alteration and mineralization in drill core from the Silver Hart property.



Figure 14. Surface exposure of a manto-style chimney at the Silver Hart property.



Figure 15. Drill site at Nickel Shāw project.

Summary

The Yukon mining and exploration industry returned to a more normalized level of activity in 2022, despite having to deal with some lingering headwinds following the COVID-19 pandemic. This year saw a slight increase in the amount of exploration and development expenditures. The YGS is expecting year-end hard rock metal production values to be 11% higher in 2022 as compared to 2021.

There were some significant new discoveries in 2022. The ongoing work at Banyan Gold's AurMac project has resulted in a significant resource update. The new discoveries of reduced intrusion-related gold systems at Sitka Gold's RC project and Snowline Gold's Rogue project are encouraging. On the base metal front, the significant drill results at the Boundary Zone of Fireweed Metals show there is opportunity for more discovery potential at this project. Finally, the new interpretation of manto-style mineralization at the Silver Hart project goes to show how a new spin on an old target can spark new life into a district. The reader is encouraged to monitor the websites of Yukon exploration companies for more releases of information as results come out through the winter months.

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Appendix 1. Exploration projects 2022.

Project	Company/Owner	Commodity	Deposit type	Work type
Gold Strike	1079170 BC Ltd.	gold	unknown	SGC, RGC, P, G
Birmingham Mine	Alexco Resource Corp./Hecla Mining	silver, lead, zinc	vein/breccia	DD
Mt. Haldane	Alianza Minerals Ltd.	silver, lead, zinc	vein/breccia	P, G, T
Stevenson Ridge	Arsenault, Chris	copper	porphyry/sheeted vein	P
Connaught	ATAC Resources Ltd.	copper, gold	porphyry/sheeted vein	SGC, RGC, T
Rackla Gold	ATAC Resources Ltd.	gold	sediment associated	DD, ES
Catch	ATAC Resources Ltd.	copper, gold	porphyry/sheeted vein	SGC, RGC, P, GGP, RC
Marg	Azarga Metals Corp.	copper, gold, lead, zinc, silver	volcanic associated	GGP
Nitra	Banyan Gold Corp.	gold	porphyry/sheeted vein	P, SGC, RGC
AurMac	Banyan Gold Corp.	gold	skarn/replacement	RGC, DD, AGP
Blende	Blende Silver Corp.	zinc, lead	Mississippi Valley-type	RGC
Kudz Ze Kayah	BMC Minerals Ltd.	zinc, lead, copper, silver, gold	volcanic associated	ES
Allover	Burke, Mike	copper	unknown	P
Mil	Burke, Ryan	copper	unknown	P
North Rackla	Cantex Mine Development Corp.	zinc, lead, copper, silver, gold	skarn/replacement	P, G, RGC, DD
Hopper	CAVU Energy Metals Corp.	copper, gold	skarn/replacement	DD
Selwyn Project	Chihong Canada Mining Corp.	zinc, lead	sediment associated	ES
Silver Hart	CMC Metals Ltd.	silver, lead, zinc, copper	manto, vein	G, RGC, T, DD
Misty	Coates, Jim	copper	skarn/replacement	GGP
Bandito	Endurance Gold Corp.	rare earth elements	skarn/replacement	AGP
Mactung	Fireweed Metals	tungsten	skarn/replacement	AGP, RGC, ES
Macmillan Pass	Fireweed Metals	zinc, lead, silver, copper	sediment associated	DD, ES
FLR	Florin Resources Inc.	gold	unknown	SGC, RGC, P, G
Livingstone	Golden Ram Inc.	gold	unknown	GGP, SGC

Abbreviations

CS – claim staking	RGC – rock geochemistry	AGP – airborne geophysics
P – prospecting	SGC – soil/silt geochemistry	GGP – ground geophysics
G – geology	DD – diamond drilling	ES - economic studies
T – trenching	RC – reverse circulation drilling	

Appendix 1 (continued). Exploration projects 2022.

Project	Company/Owner	Commodity	Deposit type	Work type
Hotspot	Golden Sky Minerals Corp.	gold	unknown	AGP, SGC
Carmacks Copper	Granite Creek Copper Ltd.	copper, gold, silver	porphyry/sheeted vein	GGP, SGC, T, ES
Cowley Park	H. Coyne & Sons Ltd.	copper, gold	skarn/replacement	DD
Groundhog	Honey Badger Silver Inc.	silver, lead, zinc	unknown	P, G, SGC, RGC
Goldorak	Hulstein, Roger	gold	unknown	P, SGC, RGC
Wels Gold	K2 Gold Corp.	gold	porphyry/sheeted vein	P, GGP, RGC
Lone Star	Klondike Gold Corporation	gold	vein/breccia	RGC, DD, ES
CDL	Mann, Bill	copper, gold	porphyry/sheeted vein	P, SGC, RGC
Carlin-Roop	Mayo Lake Minerals Inc.	gold, silver	unknown	SGC, RGC, T, DD
Keno-Lightning	Metallic Minerals Corp.	silver, lead, zinc	vein/breccia	DD
Sands of Time	Milton, Jack	copper, gold, molybdenum	porphyry/sheeted vein	SGC, P, Staking
Minto Mine	Minto Metals Corp.	copper, gold, silver	porphyry/sheeted vein	RGC, DD
Coffee Project	Newmont Corporation	gold	vein/breccia	G, RGC, DD, RC
Nickel Shāw (Wellgreen)	Nickel Creek Platinum Corp.	nickel, copper, cobalt, PGEs, gold	mafic/ultramafic associated	DD, ES
Kryptos	Richards, Gord	copper	unknown	RC
Klaza	Rockhaven Resources Ltd.	gold, silver, lead, zinc	vein/breccia	RGC, DD, ES
Raven (Alaskite)	Ryan, Shawn	zinc, lead	unknown	SGC
Keystone	Ryan, Shawn	gold	vein/breccia	SGC
Goddess	Ryan, Shawn	molybdenum	porphyry/sheeted vein	GGP
OG	Ryan, Shawn	zinc, lead	skarn/replacement	GGP
3 Aces	Seabridge Gold Inc.	gold	vein/breccia	G, GGP, T, DD
Michelle	Silver47 Exploration Corp.	zinc, lead, silver	Mississippi Valley-type	RGC, DD
Ogi	Sitka Gold Corp.	zinc, lead	sediment associated	SGC, RGC, T
RC Gold	Sitka Gold Corp.	gold	porphyry/sheeted vein	AGP, RGC, DD

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G – geology	DD – diamond drilling	ES – economic studies
T – trenching	RC – reverse circulation drilling	

Appendix 1 (continued). Exploration projects 2022.

Project	Company/Owner	Commodity	Deposit type	Work type
Rogue	Snowline Gold Corp.	gold	vein/breccia	P, G, AGP, SGC, RGC, DD
Einarson	Snowline Gold Corp.	gold	vein/breccia	P, G, GGP, RGC
Ursa	Snowline Gold Corp.	gold	vein/breccia	P, G, GGP, RGC
Cynthia	Snowline Gold Corp.	gold	vein/breccia	P, G, RGC
Cliff	Snowline Gold Corp.	gold	vein/breccia	P, G, RGC
Tosh	Snowline Gold Corp.	gold	vein/breccia	P, G, AGP, GGP, SGC, RGC
Rainbow	Snowline Gold Corp.	gold	unknown	P, G, AGP, SGC, RGC, T
Florin Gold Project	St James Gold Corp.	gold	porphyry/sheeted vein	DD
Catalyst North	Stillwater Critical Minerals Corp.	nickel, copper, cobalt, PGEs, gold	mafic/ultramafic associated	P, AGP, SGC, RGC
Golden Culvert	Stratabound Minerals Corp.	gold	vein/breccia	P, G, SGC, RGC
Harvest	Strategic Metals Ltd.	nickel	sediment associated	P
Rusty Mountain	Strategic Metals Ltd.	zinc, lead, silver	skarn/replacement	P
Scarlet East	Strategic Metals Ltd.	gold	sediment associated	P
Crag	Strategic Metals Ltd.	zinc, lead, silver	vein/breccia	P
Batt	Strategic Metals Ltd.	copper, cobalt, gold, silver	volcanic associated	P, G, SGC, RGC
CD	Strategic Metals Ltd.	copper, gold	porphyry/sheeted vein	AGP
Rod	Strategic Metals Ltd.	zinc, lead, silver	porphyry/sheeted vein	GGP
Alotta	Strategic Metals Ltd.	copper, gold, molybdenum	porphyry/sheeted vein	AGP, SGC
Koi	Strategic Metals Ltd.	copper, gold	porphyry/sheeted vein	CS, P, G, GGP, SGC, RGC, T
Shanghai Creek	Targa Exploration Corp.	gold	vein/breccia	SGC
Pike-Warden	Transition Metals Corp.	gold, silver, copper	vein/breccia	RGC, P, G, RC
Treble	Trifecta Gold Ltd.	gold, copper	porphyry/sheeted vein	CS, P, G, SGC, RGC, T
VBW	Victoria Gold Corp.	gold	unknown	AGP
Dublin Gulch (Eagle)	Victoria Gold Corp.	gold	porphyry/sheeted vein	RGC, DD

Abbreviations

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P – prospecting	SGC – soil/silt geochemistry	GGP – ground geophysics
G – geology	DD – diamond drilling	ES - economic studies
T – trenching	RC – reverse circulation drilling	

Appendix 1 (continued). Exploration projects 2022.

Project	Company/Owner	Commodity	Deposit type	Work type
Lynx	Victoria Gold Corp.	gold	porphyry/sheeted vein	RGC, DD
Raven	Victoria Gold Corp.	gold	porphyry/sheeted vein	P, G, SGC, RGC, T, DD, ES
Casino	Western Copper and Gold Corp.	copper, gold, molybdenum, silver	porphyry/sheeted vein	RGC, DD, ES
Ryan's Surprise	White Gold Corp.	gold	vein/breccia	P, RGC, DD
Betty	White Gold Corp.	gold	unknown	RGC, DD
Mount Skukum	Whitehorse Gold Corp.	gold, silver	vein/breccia	ES

Abbreviations

CS – claim staking

RGC – rock geochemistry

AGP – airborne geophysics

P – prospecting

SGC – soil/silt geochemistry

GGP – ground geophysics

G – geology

DD – diamond drilling

ES – economic studies

T – trenching

RC – reverse circulation drilling

Appendix 2. Drilling statistics by project, 2022.

Project Name	Company Name	DDH		RC/RAB	
		# of holes	metres	# of holes	metres
Birmingham Mine	Alexco Resource Corp./ Hecla Mining	34	13 577		
Nadaleen Trend	ATAC Resources Ltd.	5	1551		
Connaught	ATAC Resources Ltd.			8	2164
Catch	ATAC Resources Ltd.			6	474
AurMac	Banyan Gold Corp.	221	50 000		
North Rackla	Cantex Mine Development Corp.	63	13 000		
Hopper	CAVU Energy Metals Corp.	8	2555		
Silver Hart	CMC Metals Ltd.	22	4400		
Boundary Zone	Fireweed Metals	32	7000		
Lone Star	Klondike Gold Corporation	47	6000		
Carlin-Roop	Mayo Lake Minerals Inc.	8	1070		
Keno-Lightning	Metallic Minerals Corp.	23	3265		
Minto Mine	Minto Metals Corp.	63	28 438		
Coffee Project	Newmont Corporation	16	3456	39	6820
Nickel Shāw (Wellgreen)	Nickel Creek Platinum Corp.	18	3300		
Klaza	Rockhaven Resources Ltd.	69	12 042	16	280
3 Aces	Seabridge Gold Inc.	?	1800		
Michelle	Silver47 Exploration Corp.	5	429		
RC Gold	Sitka Gold Corp.	20	6493		
Rogue	Snowline Gold Corp.	32	13 320		
Ward (Sin)	Transition Metals Corp.			3	204
Raven (Erin)	Victoria Gold Corp.	91	25 117		
Lynx	Victoria Gold Corp.	6	1971		
Dublin Gulch (Eagle)	Victoria Gold Corp.	23	10 342		
Casino	Western Copper and Gold Corp.	24	1862	9	364
Betty	White Gold Corp.	15	2182	18	1595
Ryan's Surprise	White Gold Corp.	9	2685	12	919
		854	215 855	111	12 820

Yukon Exploration and Geology 2022 abstracts

The following abstracts are from the Yukon Exploration and Geology 2022 volume. Full versions of the individual papers are available from the Yukon Geological Survey website, <https://data.geology.gov.yk.ca/>.

Preliminary double-difference relocation earthquake catalogue for southwestern Yukon centered along the Denali fault zone

K. Biegel, J.M. Gosselin and J. Dettmer

Southwestern Yukon is a seismically active zone of crustal deformation including multiple large, dextral strike-slip fault systems with overlapping activity. In this study, we perform double-difference relocation to the USGS earthquake catalogue for this region to produce a relocated catalogue of 5536 seismic events above magnitude 1.5 from 2010–2021. The relocated catalogue demonstrates better spatial resolution of linear features and the removal of grid location artifacts in depth. The relocated catalogue has smaller travel time residuals and smaller residual standard deviations showing that the new catalogue has improved absolute locations. From bootstrapping, we estimate the location uncertainties for the relocated events to be on the order of 1.2–2.4 km in the horizontal direction and 1.5–2.1 km in the vertical direction. From the relocated events, we interpret new faults including a fault connecting the Totschunda and Denali faults, a connector fault between the Totschunda-Duke River fault system and the Fairweather fault, and multiple smaller faults connecting the Fairweather and Denali faults. The significantly reduced uncertainty in depth also permits constraining the seismicity predominantly to the uppermost 10 km of the crust.

The Sunnydale landslide, current understanding and research, Dawson, Yukon (NTS 116B/3)

J. Bodtker, D.C. Cronmiller, D. Shugar and J.D. Bond

The Sunnydale landslide is a slow-moving rock-slope deformation on the western bank of the Yukon River directly across from Dawson, Yukon. While recent data suggest acceleration of the slide, which could pose a potential hazard to Dawson if the acceleration continues to the point of rapid failure, limited data preclude certainty on probability and timing of this occurrence. Field mapping allowed for documentation of road subsidence, expanding tension cracks and recent and ongoing rockfall and production of detailed geomorphological and surficial geology maps of the slide. Differencing from 2014, 2018, 2019, 2020 and 2022 aerial lidar data, and data from physical monitoring station indicate current movement rates of up to 11 cm/yr across the slide area. Ongoing work including InSAR and terrestrial lidar change analysis and installation of a near-real-time monitoring system in early 2023 will increase our understanding of current movement trends. Additionally, in-progress geologic dating of deformation features will further our understanding of the history and context of this feature on a geologic timescale.

Fracture network analysis in the Duke River area, southwestern Yukon

F.M. Chapman, M. Miranda, R. Soucy La Roche and J. Raymond

Deep geothermal reservoir potential depends on the local temperature gradient and host rock permeability. In areas with low primary porosity, such as the Duke River area, large-scale permeability is primarily associated with fracture networks. Fractures in the Duke River area are described based on 36 scanlines collected across 9 rock types from 0.8 to 22 km from the Denali fault. The majority of fractures are steeply dipping but have no preferential strike. The linear fracture intensity is high, and most fractures range from open to moderately wide. These attributes vary slightly by lithology but can be grouped into distinct hydrostratigraphic units. The distance from the Denali fault has a non-linear influence on fracture intensity and aperture and a negligible effect on fracture spacing and length. The fracture analysis presented will be used to develop a discrete fracture network to evaluate permeability in the Duke River area.

Improvements in the regional earthquake focal mechanism catalogue for southwestern Yukon

J.M. Gosselin, K. Biegel, M. Hamidbeygi and J. Dettmer

Earthquake source characteristics provide a valuable constraint on fault behaviour, crustal stress, and regional plate tectonics. In southwestern Yukon, a region of complex active tectonics, studies of earthquake sources have historically been limited by sparse seismic network coverage. In this work, we leverage recent improvements in station coverage to estimate focal mechanisms for small and moderate-magnitude ($M \geq 2.0$) earthquakes from P-wave first-motion polarity data. We invert these data using a probabilistic method that rigorously quantifies mechanism uncertainties. We present preliminary solutions for 363 events, which improve the spatial coverage of the focal mechanism catalogue for this region. We observe contrasting P-axis orientations for events on either side of the Fairweather fault. For events within southwestern Yukon, the distribution of faulting mechanism types and P-axis orientations are relatively consistent. Our focal mechanism solutions support the existence of an unmapped fault south of the Duke river fault. Finally, our results provide a valuable input for subsequent detailed analysis of crustal stress throughout the region.

Geomorphic assessment of Ts̱̱njik Cẖ́ (Nordenskiöld River) near Carmacks, Klondike region, Yukon

C. Hatton, A. Ielpi, D.C. Cronmiller and M. Painter

Rivercourse migration is controlled by discharge, sediment supply, and bank vegetation, and its study informs watershed responses to environmental stressors like climate change and permafrost thaw. We presents a preliminary characterization of Ts̱̱njik Cẖ́ (Nordenskiöld River) near Carmacks (Klondike region, Yukon), based on geomorphic observations, time-series photogrammetry, and hydrological analysis. We report channel-migration data in relation to flooding patterns, including the records of a recent ~10-year recurrence flood that took place in the spring of 2022. Boreholes drilled in the river's floodplain have encountered discontinuous permafrost at depths of >0.7 m, and preliminary morphodynamic analyses show similar relationships between channel size, curvature, and migration rate to rivers outside the permafrost zone. Results provide a coarse characterization of hazards related to bank erosion and channel overspill at Carmacks, and will inform future work that integrates aspects of fluvial morphodynamics and biogeochemistry in relation to flooding elsewhere in Yukon.

A preliminary geological interpretation of the Mount Grant-Evelyn Creek area, southern Yukon (parts of 105C/11,12,13,14)

D. Moynihan

The Evelyn Creek-Mount Grant area includes a large region of igneous and meta-igneous rocks, here termed the Mount Grant batholith. The batholith comprises mostly deformed Mississippian metatonalite of the Simpson Range suite and variably, but mostly non-deformed Cretaceous granitic rocks of the Cassiar suite. The metatonalite has a sheet-like geometry and is in contact with contrasting metasedimentary successions. Overlying the metatonalite is the Slate Mountain succession, which includes quartzite, psammite, phyllite and limestone. The metatonalite overlies rocks of the Evelyn Creek succession (new), which has a tripartite stratigraphy; its lower part is dominated by chert and siliceous argillite, the middle unit comprises chlorite-muscovite schist and quartzite, while the upper unit is a prominent interval of pale coloured marble/calc-silicate. The contact between the Evelyn Creek succession and the overlying Mississippian metatonalite is interpreted to be structural rather than intrusive. Rocks of the Cassiar suite include large volumes of non-deformed granite and quartz monzonite and lesser amounts of foliated equivalents. Low pressure metamorphism is recorded by andalusite and/or sillimanite bearing schists that are restricted to the eastern part of the area. This metamorphism and deformation did not affect the remainder of the area, where latest penetrative structures are crosscut by Early Jurassic rocks of the Lokken suite.

The State of glaciers in Yukon and northern British Columbia

M. Painter, D.C. Cronmiller and J.D. Bond

Glacier mass loss is accelerating throughout Yukon. Multiple studies and methods confirm this mass loss. New remotely-sensed and field-measured terminus retreat rates for select glaciers representative of the glaciated watersheds throughout Yukon are presented and compared to previous studies. Photographic data and measurements from field monitoring stations occupied from 2004–2022 confirm rapid mass-loss and provide relatable images for communicating the striking rate of glacier retreat. The rapid rate of glacier mass loss in Yukon will have variable impacts on downstream hydrology including discharge, temperature, chemistry, sedimentation and turbidity that are with some exception, poorly quantified at present.

YGS list of publications and maps for 2022

YGS released 15 publications in 2022: 1 Bulletin, 9 Open Files, 3 Educational publications and 2 Annual Reports.

Bulletins

Lipovsky, P.S. and Bond, J.D., 2022. Surficial geology and Quaternary history of Stevenson Ridge and northern parts of Kluane Lake map areas, Yukon (115K and 115F). Yukon Geological Survey, Bulletin 18, 84 p. plus appendices

Open Files

Colpron, M. (compiler), 2022. Yukon Bedrock Geology Map. Yukon Geological Survey, Open File 2022-1, 1:1 000 000 scale map and legend.

Sack, P.J., Colpron, M. and Crowley, J.L., 2022. U-Pb zircon geochronology from a Late Triassic pluton in the Mount Nansen area. Yukon Geological Survey, Open File 2022-2.

Moynihan, D., 2022. Preliminary geological map of the Boswell River area (parts of NTS 105C/13, 14, 105F/4 and 105E/1). Yukon Geological Survey, Open File 2022-3, scale 1:50 000.

Sack, P., Eriks, N. and van Loon, S., 2022. Revised geological map of Mount Nansen area (NTS 115/I3 and part of 115/I2). Yukon Geological Survey, Open File 2022-4, 2 sheets: sheet 1 scale 1:50 000 and sheet 2 scale 1:20 000.

Ambrose, T., 2022. Preliminary bedrock geology map of the Rusty Mountain and Bonnet Plume Pass areas, southern Wernecke Mountains, Yukon (NTS 106C/3,4, 5, 6, 11, 12 and 106D/1, 8). Yukon Geological Survey, Open File 2022-5, scale 1:50 000.

Skipton, D.R., 2022. Preliminary geological map of the southern Nash Creek area, central Yukon (parts of NTS 106D/2, 3, 6, 7). Yukon Geological Survey, Open File 2022-6, scale 1:50 000.

Tschirhart, V., Craven, J., Colpron, M. and Quantec Geoscience Ltd., 2022. Audiomagnetotelluric and broadband magnetotelluric data for geothermal exploration in the Burwash Landing area. Yukon Geological Survey, Open File 2022-7.

Witter, J.B., 2022. Analysis of geoscience data for geothermal exploration along the Tintina fault near Watson Lake, Yukon. Yukon Geological Survey, Open File 2022-8, 50 p. plus digital appendices.

Cobbett, R., 2022. Preliminary geological map of the Castle Mountain area, central Yukon (parts of NTS 106D/5, 6, 11, 12). Yukon Geological Survey, Open File 2022-9, scale 1:50 000.

Educational publications

Weston, L., 2022. Exploring Geothermal: What is geothermal energy? Yukon Geological Survey, Educational Series.

Weston, L., 2022. Exploring Geothermal: How is geothermal energy used? Yukon Geological Survey, Educational Series.

Weston, L., 2022. Exploring Geothermal: Examining the potential. Yukon Geological Survey, Educational Series.

Annual reports

Yukon Exploration and Geology Overview 2021. K.E. MacFarlane (ed.), 2022. Yukon Geological Survey, 74 p.

Yukon Geological Survey, 2022. Yukon Exploration and Geology 2021, K.E. MacFarlane (ed.), 2022. Yukon Geological Survey, 265 p.

Annual overview papers (YEG overviews 2021)

Relf, C., 2022. Yukon Geological Survey 2021 Overview. *In: Yukon Exploration and Geology Overview 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 1–15.

van Loon, S. and Bond, J.D., 2022. Yukon placer mining 2021 development and exploration overview. *In: Yukon Exploration and Geology Overview 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 17–27.

Torgerson, D., 2022. Yukon Mineral Exploration Program 2021 update. *In: Yukon Exploration and Geology Overview 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 29–34.

Casselmann, S.G. and Lewis, L.L., 2022. Yukon hard rock mining, development and exploration overview 2021. *In: Yukon Exploration and Geology Overview 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 35–52.

Weston, L., 2022. Yukon Geological Survey's Outreach Program: 2021 highlights. *In: Yukon Exploration and Geology Overview 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 53–62.

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Bullen, W., 2022. Updates to the Yukon Geological Survey's mineral potential mapping methodology. *In: Yukon Exploration and Geology 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 1–12.

Ambrose, T., 2022. Update on the bedrock geology of the Rusty Mountain and Bonnet Plume Pass (west half) areas. *In: Yukon Exploration and Geology 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 13–36.

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Finley, T., Salomon, G., Stephen, R., Nissen, E., Cassidy, J. and Menounos, B., 2022. Preliminary results and structural interpretations from drone lidar surveys over the Eastern Denali fault, Yukon. *In: Yukon Exploration and Geology 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 83–105.

Kennedy, K., Sack, P.J. and Clarke, H., 2022. Surficial geochemical setting of the southern Carmacks-Minto copper belt. *In: Yukon Exploration and Geology 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 107–124.

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Colpron, M., 2022. The Yukon Digital Bedrock Geology compilation. *In: Yukon Exploration and Geology 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 143–159.

Skipton, D., 2022. Updated bedrock geology of the southern Nash Creek area in central Yukon (parts of NTS 106D/2, 3, 6 and 7). *In: Yukon Exploration and Geology 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 161–183.

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Moynihan, D. and Crowley, J.L., 2022. Preliminary observations on the geology of the southern Big Salmon Range, south-central Yukon (parts of NTS 105C/13,14, 105F/4 and 105E/1). *In: Yukon Exploration and Geology 2021*, K.E. MacFarlane (ed.), Yukon Geological Survey, p. 217–265.

Contributions to external publications

Pinet, N., Sack, P., Mercier-Langevin, P., Davis, W.J., Petts, D.C., Lavoie, D., Percival, J.B., Dubé, B., Colpron, M., Ardakani, O.H. and Brake, V.I., 2022. Yukon's Carlin-Type Gold Deposits (Rackla Belt, Canada): Main Characteristics and New Insights on Alteration Styles and Geochemistry. *Economic Geology*, vol. 117, p. 875–904, <https://doi.org/10.5382/econgeo.4899>. **YGS Contribution 054.**

Pinet, N., Davis, W.J., Petts, D.C., Sack, P., Mercier-Langevin, P., Lavoie, D. and Jackson, S.E., 2022. U-Pb Vein calcite dating reveals the age of Carlin-type gold deposits of central Yukon and a contemporaneity with a regional intrusion-related metallogenic event. *Economic Geology*, vol. 117, p. 905–922, <https://doi.org/10.5382/econgeo.4898>. **YGS Contribution 055.**

McClelland, W.C., Strauss, J.V., Gilotti, J.A. and Colpron, M., 2022. Paleozoic evolution of the northern Laurentian margin: Evaluating links between the Caledonian, Ellesmerian, and Cordilleran orogens. *In: Laurentia: turning points in the evolution of a continent*, S.J. Whitmeyer, M.L. Williams, D.A. Kellet and B. Tikoff (eds.), Geological Society of America, vol. 220, [https://doi.org/10.1130/2022.1220\(30\)](https://doi.org/10.1130/2022.1220(30)). **YGS contribution 057.**

Colpron, M., Sack, P.J., Crowley, J.L., Beranek, L.P. and Allan, M.M., 2022. Late Triassic to Jurassic Magmatic and Tectonic Evolution of the Intermontane Terranes in Yukon, Northern Canadian Cordillera: Transition From Arc to Syn-Collisional Magmatism and Post-Collisional Lithospheric Delamination. *Tectonics*, vol. 41, <https://doi.org/10.1029/2021TC007060>. **YGS Contribution 058.**

van Drecht, L.H., Beranek, L.P., Colpron, M. and Wiest, A.C., 2022. Development of the Whitehorse trough as a strike-slip basin during Early to Middle Jurassic arc-continent collision in the Canadian Cordillera. *Geosphere*, <https://doi.org/10.1130/GES02510.1>. **YGS Contribution 059.**

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