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# Yukon Geoscience Needs: Results of the Fourth Yukon Geoscience Planning Workshop

Whitehorse, Yukon  
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Carolyn Relf (editor)



*Yukon Geological Survey Mandate: To be the authority and providers of geoscience and technical information to support sustainable development of Yukon's energy and mineral resources.*

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# **YUKON GEOSCIENCE NEEDS: RESULTS OF THE FOURTH YUKON GEOSCIENCE PLANNING WORKSHOP**

**APRIL 23, 24, 2009  
GOLD RUSH INN, WHITEHORSE, YUKON**

## **EXECUTIVE SUMMARY**

On April 23 and 24, 2009, Yukon Geological Survey (YGS) held a five-year planning meeting with members of its Technical Liaison Committee, along with additional representatives from its client groups and research partners. This report summarizes the discussions that were held and lays out the general areas specified as research priorities that were identified for upcoming five to ten years.

The report includes an overview of discussions and advice received in eight breakout sessions held during the workshop. The key take-home points made by clients and partners included the following:

- provide the new metallogenist with broad exposure to Yukon mineral deposits, with emphasis on a Dawson Ranges gold synthesis;
- in the interest of succession planning and continuity of corporate knowledge, Selwyn Basin would be an appropriate area of focus for the new bedrock mapping geologist;
- orientation geochemical surveys should be undertaken to help better interpret existing regional geochemical data, particularly in unglaciated parts of Yukon;
- YGS needs to take a lead role in defining research projects for university partners and facilitating their funding;
- a critical evaluation of how to effectively represent mineral potential on maps needs to be undertaken to ensure that land use planners understand them;
- outreach activities should be expanded to target decision-makers; and
- MINFILE data needs to be updated, and archived datasets made accessible to the public.

The issues and priorities raised at the workshop will provide a framework for subsequent discussions on project planning and priority setting. The meeting also identified a number of program gaps, some of which YGS has the capacity to address by shifting current priorities, and some of which will remain unfilled without new resources.

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## INTRODUCTION

Yukon Geological Survey (YGS) organized a workshop on April 23 and 24, 2009 in Whitehorse to identify geoscience information needs and define program priorities from 2010 to ~2015. This was the fourth 5-year planning workshop coordinated by YGS, and this report summarizes the discussions that were held and attempts to map out program directions over the next several years. Previous workshop reports (Bremner and Hill, 1995; Abbott and Emond, 2000; Abbott, 2005) laid the groundwork for this meeting and provided a starting point for discussions. The meeting was chaired by Rob Carne (Chair of the Yukon Technical Liaison Committee) and Carolyn Relf. Participants included all YGS staff, members of the Yukon Technical Liaison Committee (TLC), geoscientists from the Geological Survey of Canada (GSC), and additional representatives from industry and academia. To date, Yukon First Nations have not been involved in planning workshops, primarily because of the technical nature of the meetings. Rather than engaging them in broad program planning workshops, their input is sought on a project-by-project basis where YGS activities overlap with traditional territories, allowing specific project plans and potential impacts to be discussed in detail and adjusted where necessary.

The 2009 planning workshop had two primary objectives:

- to identify future YGS research priorities and opportunities (5-10 years); and
- to define capacity requirements for YGS (5-10 years).

As a starting point for defining priorities, the gaps identified at the 2004 planning session were re-evaluated, and the maps illustrating these gaps (Figs. 1 – 12 in Abbott, 2005) were updated to reflect work that was completed between 2004 and 2009. Those gaps that remained outstanding from 2004 were highlighted as a starting point for 2009 discussions.

At the workshop, YGS activities were divided into eight broad topics and participants were asked to identify and prioritize information gaps, assess YGS' ability to address the gaps, and define what resources (funding, staff, tools, *etc.*) would be required to fill them.

The topics of discussion were:

- Bedrock geology (mapping, integrated studies and regional geophysics)
- Surficial geology (mapping, integrated studies, placer research and regional geochemical surveys)
- Mineral assessments/metallogeny (including associated studies such as geophysics and geochemistry)
- Petroleum assessments/basins research
- Information management and services
- Hazards (permafrost, landslides and neotectonics)
- Core library (including rock/core collections and archiving)
- Outreach/community engagement

On the first day of the workshop, concurrent breakout sessions were held and each of the above topics was discussed in detail. Notes from the individual sessions were distributed on the second day, and results were presented and discussed.

## **ENVIRONMENTAL SCAN**

A number of external factors provided a contextual backdrop for discussions during this workshop. These factors, and their impact on priority setting, are discussed briefly below.

### **Economic Climate**

As a result of the global economic downturn that started in the fall of 2008, a relatively low level of exploration activity was anticipated for the spring and summer of 2009. This lull presented a potential opportunity for YGS to tap into industry expertise for some projects (*e.g.*, to contract industry to process geophysical data). It also provided industry some down time to focus on activities such as data compilation and synthesis - work that YGS could support by making archived data accessible.

### **Federal Funding Opportunities**

NRCan's Geo-mapping for Energy and Minerals (GEM) program represents a significant commitment of resources for mapping and targeted studies in Yukon, and it was clear that the Geological Survey of Canada would be a significant player in delivering geoscience in Yukon over the next few years (to 2013).

Indian and Northern Affairs Canada (INAC) recently announced the renewal of its Strategic Investments in Northern Economic Development (SINED) program, which between 2005 and 2009 funded the acquisition of new airborne geophysical datasets over several high-priority areas in Yukon. It was noted that SINED funds were not intended to leverage GEM money, but could be used to fund different geoscience activities that supported economic development. YGS will need to identify niche areas of investment that do not overlap with GEM project activities; a number of such activities were raised during the workshop.

### **Capacity**

Capacity within both YGS and GSC will influence program delivery over the next five years. For example, YGS recently hired two new indeterminate geologists (a metallogenist and a bedrock mapper), and will need to invest in training to familiarize them with Yukon geology, its exploration plays, and the survey's programs and staff. The expertise and experience of existing staff will be considered when determining where to deploy the new geologists, as retirements over the next decade are expected to play a role in priority-setting and program delivery. Knowledge transfer was identified as an important investment for YGS over the next few years.

Within GSC, assignment of staff to projects under GEM and other programs and a steady number of retirements are impacting its capacity to provide niche expertise and leadership.

For example, geochemical surveying (including re-analysis of archived stream sediment samples) and biostratigraphy were identified as areas where GSC capacity is currently very limited. GSC is investing GEM funds to hire new geoscientists, and it is anticipated that their capacity gaps will narrow over the next year.

### **Yukon Government Priorities and YGS Mandate**

YGS program planning is influenced by government and departmental plans and priorities. Strengthening Yukon's resource economy is currently the first of three priorities for the Department of Energy, Mines and Resources (EMR). EMR is also committed to advancing land use planning as outlined in the Umbrella Final Agreement, and the department recently completed an Energy Strategy for Yukon (available at [www.emr.gov.yk.ca/energy](http://www.emr.gov.yk.ca/energy)) which identifies the responsible management of oil and gas resources and increased production of renewable energy (including geothermal energy) as priorities.

Within the context of these priorities, YGS's mandate is to be the authority on, and providers of, geoscience and technical information to support sustainable development of Yukon's energy and mineral resources, which influences our annual work planning process. A key role we play is to provide high quality geological information to support mineral and energy exploration efforts.

Outreach activities are an important part of our program, as they enable Yukoners to benefit from resource development related opportunities. YGS outreach activities include school visits, community meetings, and a commitment to hire and train Yukon students as geological field assistants.

Some sub-disciplines of earth sciences lie outside of YGS' mandate but nevertheless present potentially interesting research opportunities for the survey. These include climate change studies, geotechnical research related to permafrost and geothermal energy sources. On the second afternoon of the workshop, some time was dedicated to discussing YGS' mandate and whether it should be expanded. Given finite resources, it was noted that a broadened mandate would potentially dilute the survey's core programs. A summary of this discussion is included in this report.

## **RESULTS OF BREAKOUT SESSIONS**

### **Bedrock Geology (mapping, integrated studies and regional geophysics)**

Figure 1 illustrates the status of bedrock mapping coverage in Yukon. Both regional (1:250 000) and detailed (1:150 000 to 1:50 000) scales are shown, broken out by the year of publication. Bedrock mapping undertaken in 2009 by YGS and GSC is included in Figure 1; it is anticipated that these maps will be released early in 2010.

'Integrated studies' include a range of studies designed to complement the mapping by providing a temporal framework (*e.g.*, geochronology and biostratigraphy), constraining tectonic setting (*e.g.*, structural analysis and metamorphic petrology), or resolving petrogenetic questions (*e.g.*, litho-geochemistry). Regional magnetic and gravity data currently exist for most of Yukon. Since the last 5-year planning workshop, priority areas have been infilled at greater detail, and



radiometric data have been collected for areas identified as priorities in Abbott (2005). Figure 2 illustrates the current status of geophysical coverage for Yukon. Recent surveys include those flown since summer 2008 and are divided into three categories: magnetic, combined magnetic-radiometric and combined magnetic-electromagnetic surveys. The magnetic survey over Little Nahanni River map sheet (105/I) is scheduled to be flown in spring 2010; data collection is complete for all other areas shown as ‘recent surveys’.

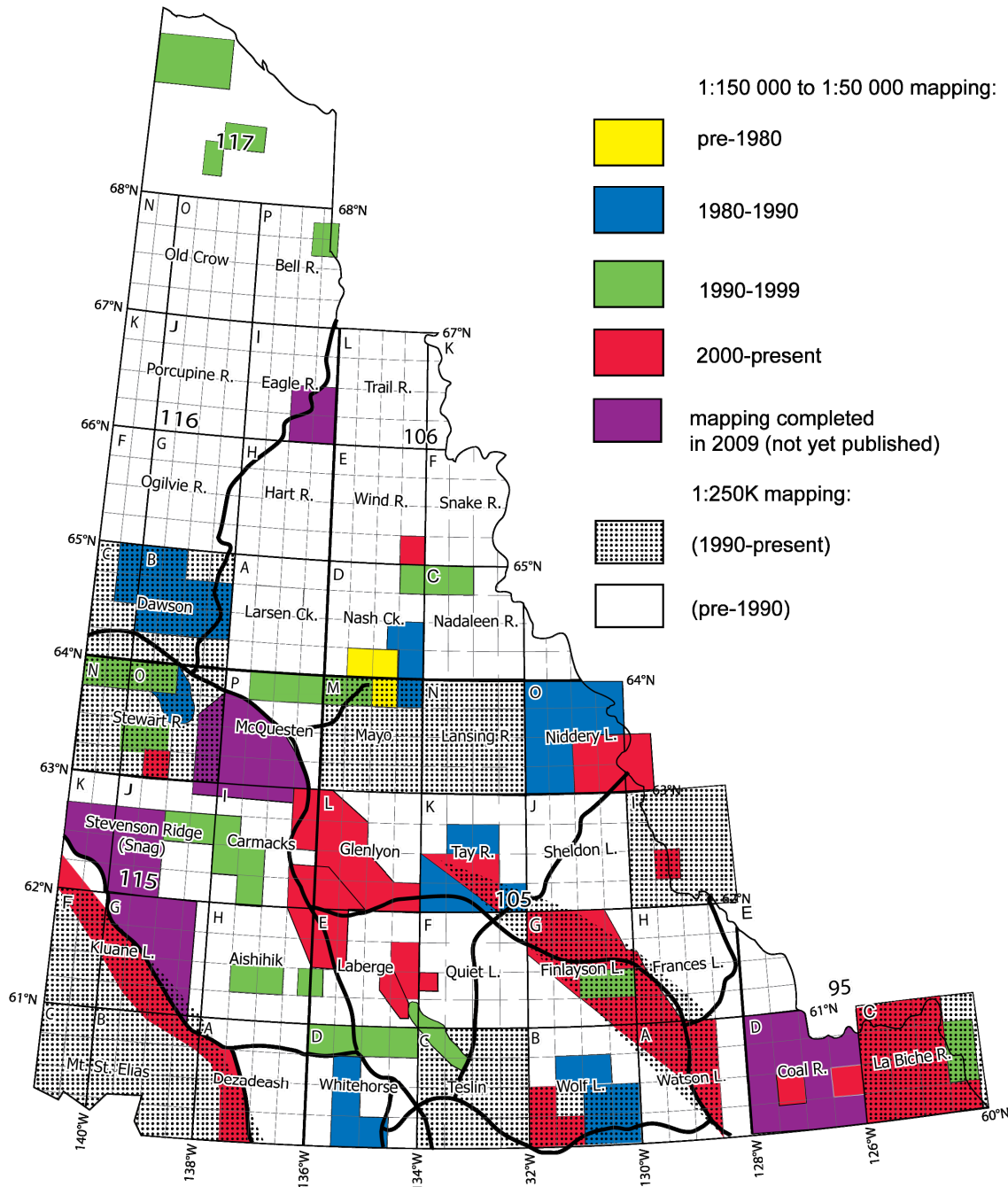
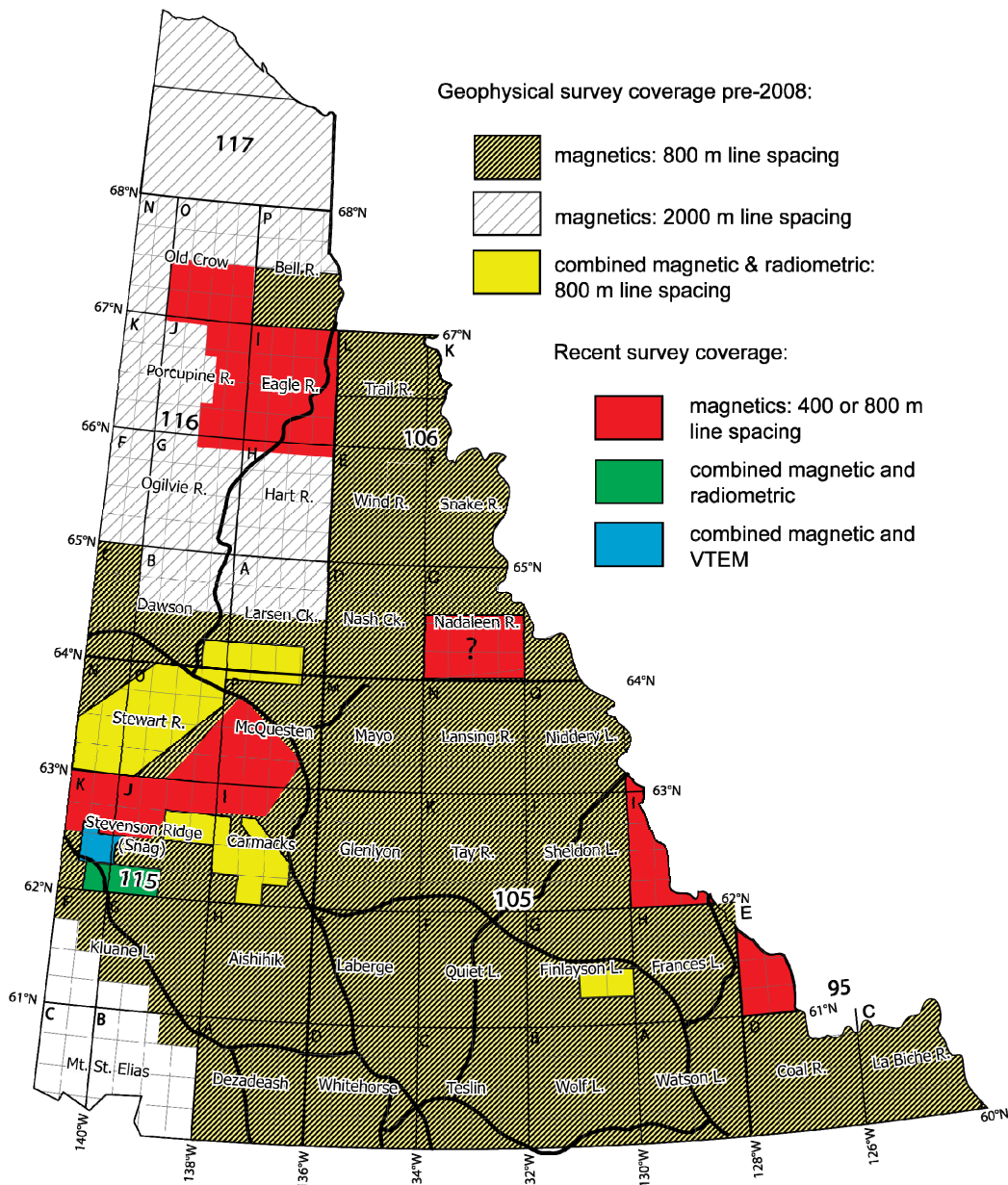


Figure 1. Status of bedrock mapping



**Figure 2.** Status and priorities for airborne geophysical surveys

With regard to bedrock mapping priorities, the TLC emphasized that YGS should focus on filling knowledge gaps rather than trying to influence exploration trends in the short term. While the latter can generate short-term success, it is ultimately the availability of regional geologic knowledge that sustains industry’s information needs in the long term. A number of factors should be considered when prioritizing areas to map, including:

- quality and vintage of existing geoscience information;
- proximity to infrastructure; and
- opportunities for succession planning in order to retain corporate knowledge.

A number of potential bedrock mapping project areas were suggested during discussions (Table 1).

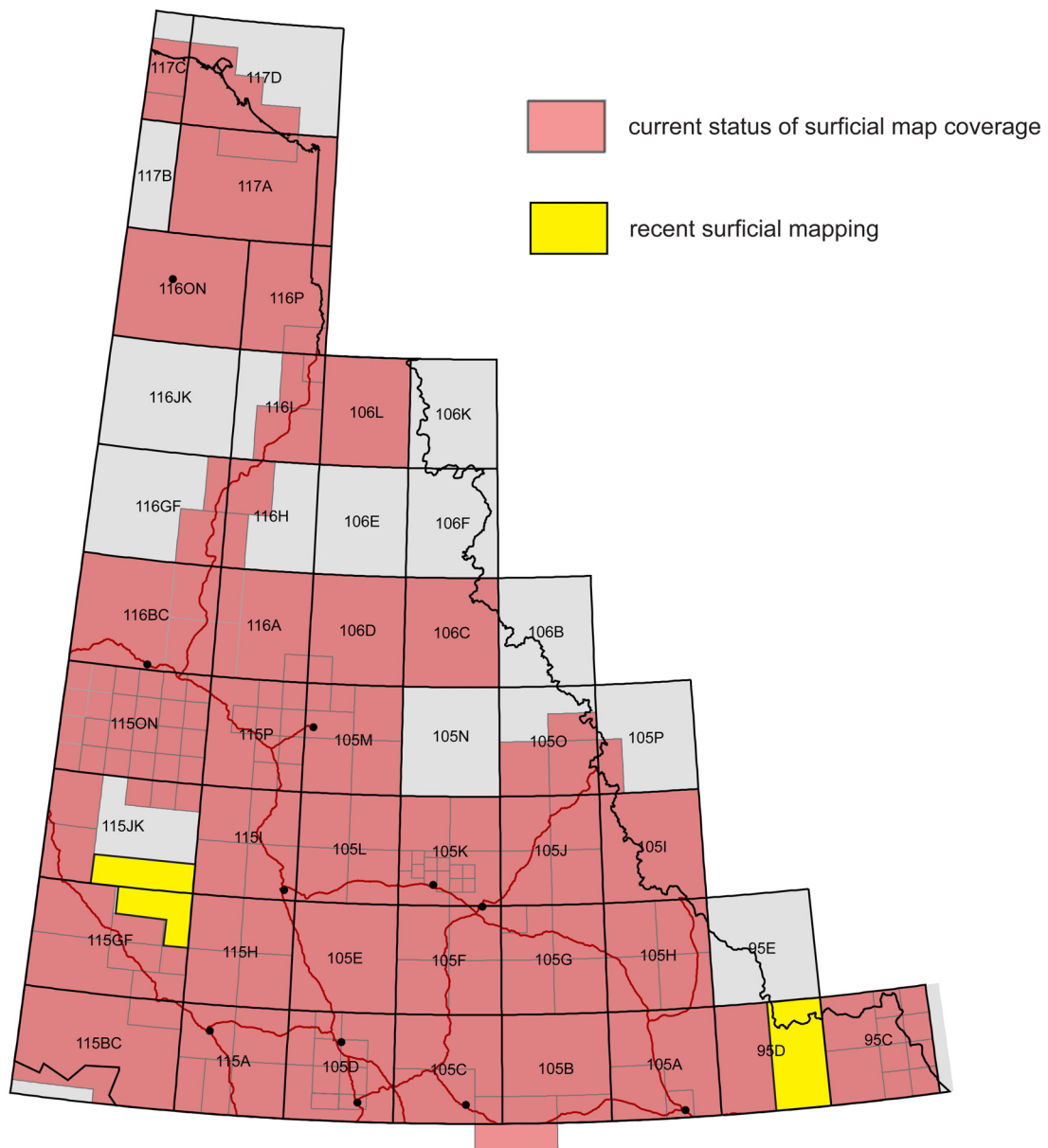
**Table 1.** Proposed priorities for bedrock mapping and integrated studies.

Activity	Key questions to address
<b>Bedrock mapping:</b>	
Nash Creek/Nadaleen	<ul style="list-style-type: none"> <li>- examine the significance and extent of Dawson fault</li> <li>- resolve/refine 1.3 Ga stratigraphy</li> <li>- metallogenic synthesis (Au, IOCG-SEDEX link)</li> <li>- regional stratigraphic correlations with Proterozoic Coal Creek and Hart River inliers</li> </ul>
Frances Lake	<ul style="list-style-type: none"> <li>- complete 1:50 000-scale bedrock mapping</li> <li>- provide context for Highland Gold Belt</li> <li>- provide context for RGS data</li> </ul>
Insular Belt	<ul style="list-style-type: none"> <li>- complete 1:50 000-scale mapping adjacent to Alaska</li> <li>- identify porphyry targets</li> </ul>
Stevenson Ridge	<ul style="list-style-type: none"> <li>- update 1:250 000-scale bedrock mapping of Dawson Range</li> <li>- integrate with existing and new geochronological data</li> <li>- characterize this highly prospective area for Au and Cu-Au mineralization</li> <li>- complete mapping in order to tie into recent mapping in southwest Yukon (south Stevenson Ridge and Kluane) and to proposed mapping in Aishihik</li> </ul>
<b>Thematic studies (with bedrock mapping component):</b>	
Aishihik	<ul style="list-style-type: none"> <li>- infill gap in recent bedrock mapping</li> <li>- evaluate porphyry, epithermal Au, VMS and placer potential</li> <li>- complete orientation geochemical survey to aid interpretation of RGS data</li> </ul>
North Canol	<ul style="list-style-type: none"> <li>- resolve outstanding stratigraphic questions</li> <li>- assess intrusive-associated Au (W) potential</li> </ul>
Quiet Lake/Pelly Mountains	<ul style="list-style-type: none"> <li>- resolve stratigraphic and structural questions in St. Cyr belt</li> <li>- assess potential for Pb-Zn mineralization</li> <li>- resolve questions related to d'Abbadie fault</li> <li>- assess Cu-Au porphyry and orogenic Au potential (<i>i.e.</i>, source of Livingstone placers?)</li> </ul>
Northeast Glenlyon area	<ul style="list-style-type: none"> <li>- define stratigraphic type sections</li> <li>- assess potential for syngenetic sulphide deposits (extension of Faro stratigraphy)</li> </ul>
Whitehorse area	<ul style="list-style-type: none"> <li>- resolve specific questions near Whitehorse (<i>e.g.</i>, geotechnical challenge related to Miles Canyon basalts) by completing selective local mapping</li> <li>- provide structural interpretation of southern Whitehorse trough</li> </ul>

In addition to the above ideas for mapping projects and thematic studies, the TLC encouraged YGS to integrate both industry and government geophysical datasets into projects and to collect physical rock property data from samples to support the interpretation of geophysical data.

**Surficial Geology (mapping, integrated studies, placer research and RGS)**

Figure 3 illustrates the current status of surficial map coverage in Yukon. In the context of surficial geology, ‘integrated studies’ include such thematic studies as stratigraphy, glacial history, geochronology (e.g. cosmogenic dating and carbon-14 dating), placer research (e.g. Au grain analyses and heavy mineral inventories), aggregate inventories and geochemistry of surficial materials (e.g. stream sediment, till and soil samples).



**Figure 3. Quaternary mapping status and priority areas for future mapping**

TLC advised YGS that the same factors noted for planning bedrock mapping priorities should be considered for surficial work: that is, the following should be considered when prioritizing areas to map:

- quality of existing geoscience knowledge;
- proximity to infrastructure; and
- opportunities for succession planning in order to retain corporate knowledge.

Additionally, given the application of surficial geology to community interests such as road building, ground water resources and climate change adaptation, community needs should be considered during the project planning phase. Table 2 lists the project ideas raised at the workshop.

**Table 2.** Proposed surficial geology project ideas.

Activity	Key questions to address
Community mapping	<ul style="list-style-type: none"> <li>- 1:10 000-scale surficial mapping</li> <li>- collection of water well and borehole data</li> <li>- documentation of changes to permafrost</li> <li>- community-specific issues:               <ul style="list-style-type: none"> <li>o Mg in groundwater near Dawson</li> <li>o heat generating tailings in Dawson</li> <li>o geothermal energy interests in Mayo</li> </ul> </li> </ul>
Remote predictive mapping of unmapped areas	- Dawson Land Use Planning areas
Aquifer mapping below permafrost	- application for drilling in Eagle Plain
Herschel Island	<ul style="list-style-type: none"> <li>- island rapidly eroding: excellent exposures of permafrost and Quaternary stratigraphy</li> <li>- support for work underway by Heritage Branch</li> </ul>
Environmental application	- baseline studies at mines/advanced exploration properties
Basal till studies	<ul style="list-style-type: none"> <li>- till geochemistry sampling</li> <li>- Mobile Metal Ion (MMI) soil survey</li> </ul>

In addition to the above, YGS is working on a digital compilation map and database of existing surficial geology maps for Yukon. The preliminary data has been released and we are currently standardizing the legends following the British Columbia terrain classification system. It is anticipated that the final compilation will be released by spring 2010.

### ***Placer Research***

Regarding research in support of placer mining, it has been recognized at previous TLC meetings that YGS contributes less to the needs of the placer mining sector than it does to the hardrock exploration sector. Some discussion was held regarding potential activities that would support the placer miners' needs; however, in the absence of a representative from the placer industry, no attempt was made to define priorities. Project ideas are listed in Table 3.

**Table 3.** Proposed placer project ideas.

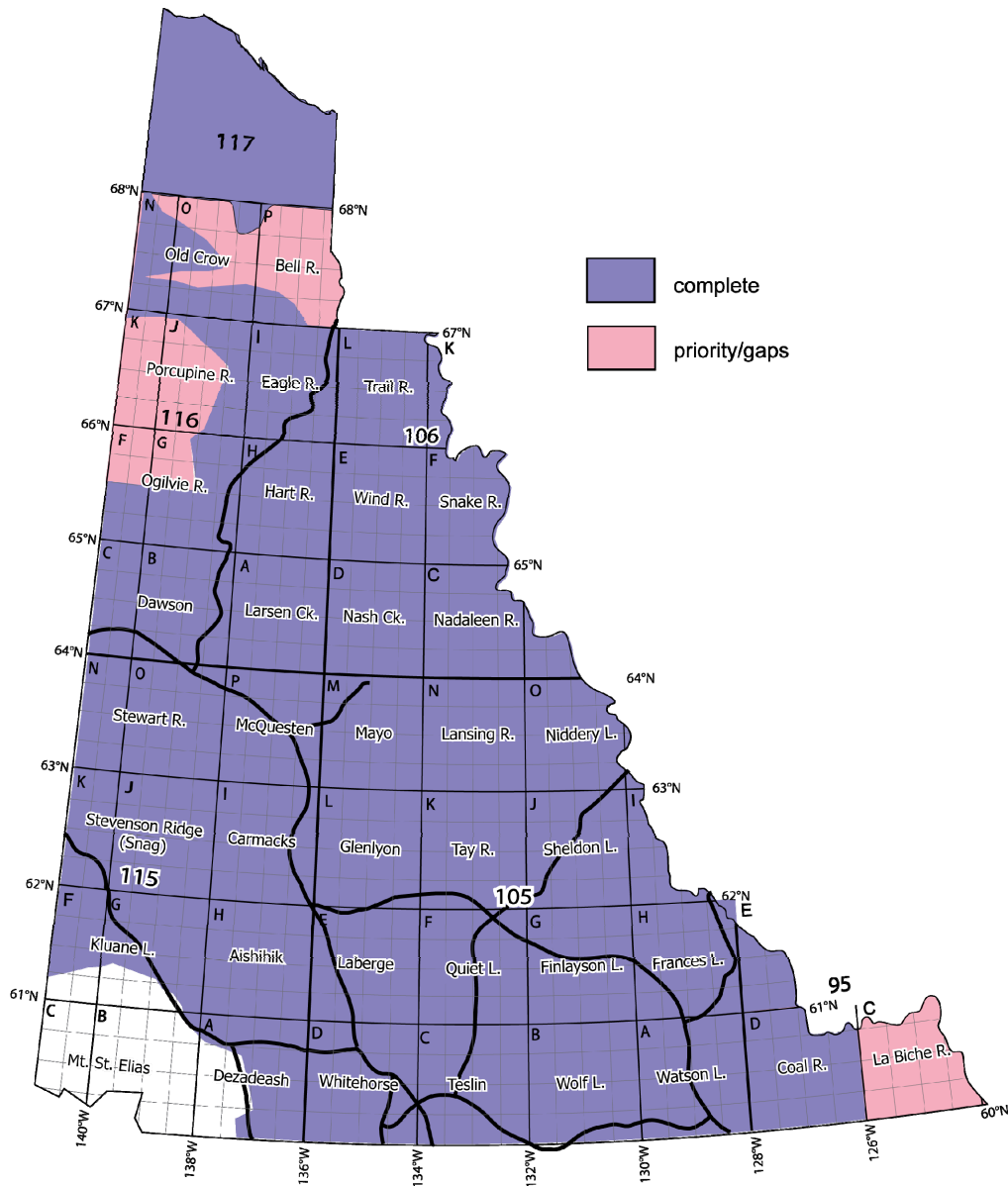
<b>Type of project</b>	<b>Project planning requirements</b>
Surficial mapping	Identify priority areas: Watson Lake, Kluane/Burwash
Fine gold extraction studies	Prioritize areas for a multi-year study
Depth-to-bedrock mapping	Identify tools: <i>e.g.</i> drilling, ground-penetrating radar
Compilation work	Compile statistics on mature districts to support new exploration ( <i>e.g.</i> Ladue, Macmillan Pass)
PGE potential studies	Heavy mineral sampling
Stratigraphic correlations	Measuring of sections, provenance studies
Placer mining methodology	Organize workshop to look at developments (geophysics, winter shafting, <i>etc.</i> )
Paleodrainage maps	Integrate several of the above studies (surficial maps, depth-to-bedrock data, stratigraphy, <i>etc.</i> )
Geophysics	Examine relative merits of ground penetrating radar, seismic, resistivity, <i>etc.</i>

As a follow-up to pursuing input for placer-related geoscience studies, YGS organized a workshop in November, 2009 for placer miners to discuss project ideas. A summary of that workshop will be written up separately.

In addition to research, it was recognized that YGS provides support to the Placer Secretariat via its knowledge of Yukon placer operations. YGS compiles and releases reports summarizing placer activity in Yukon every few years, and while valuable, it was noted that some data are missing from these reports (*e.g.* gold grades, location information, *etc.*). Site visits, sediment sampling, and sharing of information with inspectors all help to support the Secretariat's regulatory functions. The representative from the Secretariat noted the value of this role, while YGS noted its limited capacity to provide these services while also delivering geoscience. In order for YGS to fulfill both roles, it was noted that a second placer geologist would be required.

## Regional Geochemical Surveys

Presently, regional geochemical (stream sediment) surveys (RGS) have been carried out for most map sheets in Yukon (Fig. 4). As a result of the current state of coverage, the emphasis on RGS studies has shifted from first-order regional stream sediment collection and analysis to second-order studies involving improving the existing data and undertaking targeted orientation surveys to allow data to be readily interpreted. Specific project ideas that were discussed are summarized in Table 4.



**Figure 4.** Status of regional stream sediment geochemistry

**Table 4.** Proposed geochemical survey projects.

Activity	Key questions to address
Ongoing sampling/data collection	<ul style="list-style-type: none"> <li>- new sampling in areas with no RGS coverage (95C)</li> <li>- continue systematic re-analysis of archived samples (<i>e.g.</i> priority area 105N)</li> <li>- increase sample density in areas with coverage</li> </ul>
Data improvement	<ul style="list-style-type: none"> <li>- compile and level existing data and generate metadata</li> <li>- incorporate assessment report stream sediment data into compilation and/or acquire privately held datasets</li> <li>- quantify percentiles according to sub-terrane or drainage basins</li> <li>- increase on-line GIS access to data (<i>e.g.</i> web tool to grid/contour data by drainage basin)</li> <li>- re-plot sample locations at 1:50 000 scale (current GSC base is at 1:1 000 000 scale)</li> </ul>
Develop RGS approach for unglaciated areas	<ul style="list-style-type: none"> <li>- analyze sand fraction?</li> <li>- develop project with GSC</li> </ul>
Value-added interpretation	<ul style="list-style-type: none"> <li>- integrate water chemistry with RGS silt chemistry</li> </ul>
Orientation geochemical surveys	<ul style="list-style-type: none"> <li>- evaluate different sampling techniques (<i>e.g.</i> auger vs. surface)</li> <li>- evaluate different media</li> <li>- consider impact of loess</li> <li>- carry out orientation sampling around known mineral deposits</li> <li>- study by drainage basin as opposed to map sheet</li> </ul>
Whitehorse trough hydrocarbon assessment	<ul style="list-style-type: none"> <li>- soil sampling for microseeps</li> </ul>

### Mineral Assessments/Metallogenic Studies

The TLC emphasized to YGS that many mineral exploration geologists do not have an opportunity to undertake regional compilations as part of their exploration programs. As a result, they tend to have a deposit-scale perspective on a project rather than a regional geologic view. YGS could provide a valuable service by undertaking regional compilations and synthesizing key characteristics of mineral deposits in a region; this would both focus exploration efforts and provide valuable context to exploration companies and prospectors addressing property-scale challenges.

With respect to deposit-scale studies, it was recognized that YGS provides logistical and financial support to a number of university-based mineral deposit studies each year. Support currently tends to be provided on a reactive basis, whereas it was recommended that YGS should identify priority studies and then pro-actively seek university-based researchers. For example, YGS should support studies that integrate with, and complement regional mapping activities or specifically address industry needs. The latter approach could generate more commitment from industry to be involved with co-funded projects.



A number of ideas for specific studies were raised and the greatest emphasis was placed on the opportunity to compile information on the characteristics of recently discovered gold occurrences in the Dawson Ranges gold belt (*i.e.* geochemical characteristics, geologic setting, structural controls and geophysical response). Information on other areas near the Yukon/Alaska border should also be compiled, as such compilations might help to draw exploration investment from across the border. These types of studies could lead to the development of a comprehensive exploration guide to gold (and other commodities) in Yukon. Another approach discussed was a region-by-region compilation of metallogenic belts through geologic time for Yukon; this approach would be an excellent contribution to the “Geology of Yukon” synthesis volume being planned by YGS. Other project ideas are outlined in Table 5.

**Table 5.** Proposed activities to support mineral assessment and metallogenic studies.

Activity	Key questions to address
Targeted geophysics	- evaluation of different geophysical tools and/or data processing techniques around known deposits
Orientation geochemical surveys	- evaluate different sampling media and techniques around known deposits
Field trips	- field trips to various Yukon mineral deposits, covering geologic setting as well as deposit-scale characteristics
Deposit compilation	- model a compilation after NWT’s “Significant Mineral Deposits of NWT”

With respect to mineral assessments in support of land use planning, concern was expressed by the TLC that the mineral potential maps generated by YGS are not understood by the land use planning commissions who use them. One significant issue is that the maps focus attention on areas with known mineral potential, creating concerns that these areas are ‘threatened’ and triggering conservation efforts. A second issue is that land use planners do not recognize that areas ranked as having low mineral potential are generally rated as such based on a lack of geologic evidence that significant mineral occurrences exist. In fact, many large deposits have historically been found in areas where little information exists and therefore where low mineral potential rankings have previously been assigned. The key message here is that YGS needs to examine how to present mineral potential information so the inherent uncertainties are clear to land use planners and decision-makers; this will require an educational role for YGS. YGS committed to consider ways to incorporate information on the level of confidence of a mineral potential ranking system into its maps.

Specific suggestions on how to improve the existing maps included the following: adding an economic analysis layer to the map (*e.g.* include different development scenarios and their potential economic impact); projecting future (undiscovered) mineral potential onto the maps; making polygons smaller; and providing information on the negative impact of lost economic opportunity if a given area is withdrawn from staking and exploration activity. It was generally agreed that this type of information would be valuable for supporting informed land use decisions; however, it was also recognized that YGS is not qualified to undertake this role.

YGS was advised to consider playing a bigger role in education related to land use planning. For example, YGS could help diffuse myths regarding the environmental impact of exploration, provide information on the economic benefits of mineral development on communities, and help decision makers understand the need for land access to sustain the industry. These are certainly messages that YGS can bring to meetings, but to maintain credibility as an honest broker of geoscience information, YGS must be careful to avoid a mineral industry advocacy role within the land use planning process.

### **Petroleum Geology, Basin Studies**

Discussions regarding petroleum geoscience activities were animated. In contrast to its recognized excellence in the area of bedrock mapping, YGS has only a nascent petroleum geology program, and it lacks both the experience to undertake comprehensive petroleum systems analysis and the engagement of industry to provide advice on program direction. Discussions therefore focused on two levels: activities that could be undertaken in the short term with our present resources, and a longer term vision regarding YGS' potential role in delivering petroleum geoscience.

With respect to the shorter-term deliverables, a number of low-hanging fruit exist. These include scanning and web-enabling well history reports and logs for all Yukon wells, and generation of various analytical data from well cuttings and outcrops (Total Organic Carbon, Rock Eval analysis, petrophysical data, *etc.*). This work could be undertaken opportunistically as resources become available; a plan to systematically scan industry data for Yukon needs to be developed. Derivative products from these datasets that YGS could generate include maturity maps, an updated formation tops database and subsurface maps. YGS was also encouraged to document and sample microseeps and evaluate exploration tools such as soil geochemistry to gauge their applicability to Yukon basins.

Clients also noted that while YGS already has some oil and gas-related data available on its website, it is not easy to find. Efforts should be made to separate oil and gas data from other on-line information, and pro-active notification such as electronic newsletters could be used to inform clients when new data are posted. Contributions to periodicals such as the Daily Oil Bulletin and the CSPG Reservoir might be a way to promote interest in Yukon's basins.

Regarding a longer-term plan for the direction YGS should evolve its petroleum program, it was noted that basic petroleum resource assessments (*e.g.*, "blue book" assessments undertaken by GSC in the 1970s and 1980s) are not a high priority for many petroleum exploration companies. Industry clients noted that assessments have been completed for all Yukon basins, and recommended restricting further assessment work to those areas where new data may significantly change the resource estimate.

Rather than ongoing upgrading of its resource assessments, YGS was encouraged to focus on providing knowledge on the petroleum system elements of its basins, *i.e.*, depositional and burial histories, tectonic history, thermal maturation, source rock potential, reservoir potential and migration potential for hydrocarbons. In order to undertake such work, YGS will need to focus on its capacity in areas such as structural geology, seismic interpretation and petroleum systems science. A comprehensive learning plan to enhance internal capacity

could be coupled with targeted work either in partnership with GSC or university personnel, or through consultants. Multidisciplinary studies involving surficial geology (aggregate potential and permafrost) should also be encouraged.

YGS may also want to look beyond conventional oil and gas and develop expertise in shale gas, coal, coal bed methane and possibly geothermal energy. Exploration for both conventional and unconventional resources would benefit from more detailed regional gravity coverage (*e.g.* 2 km spacing), and regional aeromagnetic coverage should be completed over Yukon's basins. While costly, these are basic framework datasets that need to be acquired. It was also pointed out that shallow drilling to address specific stratigraphic questions would be beneficial, particularly in light of the paucity of wells in Yukon's basins.

Concurrent with the above geoscience activities, YGS will need to consider how to promote exploration investment in Yukon's petroleum resources. It was pointed out that many companies still hold the view that Yukon's intermontane basins contain significant amounts of volcanogenic sediments and generally have low potential for oil and gas. Coupled with the fact that Yukon's petroleum resources are stranded by a lack of infrastructure, the investment attractiveness of the territory remains low. As YGS develops its plans for a more strategic petroleum geoscience program, it should coordinate with the Oil and Gas Branch to help leverage industry interest.

## **Hazards Research**

YGS has a limited but diverse hazards program. Research in the areas of neotectonics, landslides, glacier surge monitoring and permafrost studies are undertaken opportunistically, generally in collaboration with university and government partners. In southern Yukon, much of this work is driven by the need to be 'pipeline-ready' to support government regulation of the design, construction and operation of the Alaska Highway gas pipeline should it be built. A second catalyst for this work is Yukon's interest in engaging in Canada's Climate Change Action Plan. In spite of limited investment, the impact of YGS' hazards-related studies has been significant given Yukoners' awareness of, and intense interest in, seismic hazards and climate change impacts. YGS' role has been largely focused on hazard identification and public education (via public lectures, school visits and popular media). The question was raised whether this is adequate, or whether YGS should increase its capacity for hazards-related geoscience and risk management. It was also noted that hazards research will continue to provide an excellent opportunity for media exposure and delivery of key messages to the public.

A number of gaps in YGS' hazards activities were noted at the workshop, including monitoring of production-induced seismicity in southeastern Yukon (Liard Basin) to help predict land slides, and monitoring of natural seismic activity in the Richardson Mountains. Another issue noted was the negative impact on other activities when YGS is required to support externally driven hazards studies. For example, the support YGS provided to compile background levels of radon documented around the City of Whitehorse, albeit a valuable study, was completed at the expense of other projects due to our limited capacity. Furthermore, hazards research requires long-term monitoring efforts in order to be beneficial, whereas most of our projects are undertaken opportunistically when staff time

and fiscal resources are available. Current and ongoing hazards related activities are presented in Table 6.

**Table 6.** Proposed project ideas in support of hazards research.

Type of research	Activities
Neotectonics	<i>Current:</i> 1) collaborating with GSC to assess earthquake hazards in southwest Yukon: study includes deployment of GPS's; 2) supporting detailed bedrock mapping to better characterize history and dynamics of the seismically active Duke River fault; and 3) collaborating with the US Geological Survey (USGS) to document frequency of large magnitude earthquakes along the Denali fault
	<i>Proposed:</i> 1) YGS is pursuing the acquisition of funding to continue to support differential GPS surveys and increase the seismic monitoring network by installing 1 permanent and 6 temporary seismograph stations along Duke River and Denali fault systems; and 2) in collaboration with USGS, YGS will carry out further trenching and sediment dating along the Denali fault to better constrain its paleoseismic history
Permafrost studies	<i>Current:</i> YGS recently filled a term position to compile and synthesize various permafrost data ( <i>e.g.</i> ground and air temperatures, ice content, <i>etc.</i> ) that have been collected by different organizations across Yukon.
	<i>Proposed:</i> 1) regional mapping of permafrost thickness and depth; 2) provide public education to highlight relative impacts of forest fires versus development activities on permafrost; 3) characterize gas hydrate hazards in northern Yukon; 4) support development of geophysical methods and portable drilling techniques to characterize permafrost distribution, ice-content and depth; 5) collaborate with industry to instrument existing drillholes with thermistors; and 6) encourage GSC specialists to become more active in Yukon now that focus on Mackenzie Valley is waning.
Naturally occurring 'contaminants'	<i>Proposed:</i> TLC noted that a lack of baseline environmental data frustrates the regulatory process and generates potential liabilities, <i>e.g.</i> , streams in the Eagle Plain and Tombstone areas have low pH values (~4), and background radiation levels are anomalously high at Engineer Creek.
Landslide studies	<i>Current:</i> YGS' role is limited to documenting and monitoring active landslides, maintaining an inventory, and supporting research by university and GSC (PERD) partners.
Surging glaciers	<i>Current:</i> YGS works opportunistically with Parks Canada and USGS (Alaska) to monitor glacial surges and calving events and inform the public of hazards. Monitoring is done with satellite images, remote cameras and occasional field visits.
Alaska Highway borehole compilation	<i>Current:</i> YGS is compiling a database of boreholes: data include information on the nature of surficial materials and permafrost along the Alaska Highway, which is valuable for maintenance of existing roads and planning for new infrastructure.
	<i>Proposed:</i> continue to support work on the Alaska Highway borehole database and release of an interim product.

Regarding YGS capacity: the hazards-related project ideas raised at the workshop represent existing knowledge gaps; however, YGS' mandate and finite capacity for undertaking activities to support hazards prediction and mitigation limit its level of activity, except where targeted funding allows some short-term projects to be undertaken (e.g. YGS' contribution to the infrastructure vulnerability to permafrost degradation study). While its capacity is limited, YGS does and should continue to play a role in coordinating and enabling studies via research partners such as GSC, USGS or Yukon College's Cold Climate Innovation Centre. YGS was advised not to expand its program in these areas, as it was recognized that such an expansion would reduce investment in other program areas.

The federal government's Program of Energy Research and Development (PERD) represents a potential source of short-term funding for hazards research in southwestern Yukon where pipeline proponents are examining potential routes for an Alaskan gas pipeline. This might be an avenue to explore if a need to enhance YGS' hazards program is identified.

### **Outreach/Community Engagement**

YGS provided a brief overview of its outreach and community engagement activities. Outreach includes visits to schools, teacher workshops, and participating in Mining Week activities, school science and career fairs. YGS generates publications of general interest to the public such as geologic road maps and information booklets. It also responds to media queries and provides news releases on matters of general interest. One aspect of YGS' science program that has a strong outreach component is its permafrost monitoring program: ground and air temperature monitoring equipment is installed in most Yukon communities, and staff members visit the sites annually and engage the school in data collection while teaching students about permafrost, climate change, and their impact on the landscape.

For the most part, YGS' outreach activities are largely reactive, and the need for a communications strategy was discussed. This would be particularly valuable for providing objective information to the public and decision-makers on issues of broad social and economic interest.

Regarding engagement of Yukon First Nations, YGS is taking an increasingly pro-active role in visiting communities and seeking input from First Nation governments and organizations regarding its activities. A catalyst for this has been GSC's Geo-mapping for Energy and Minerals (GEM) program, in which YGS has taken the lead in coordinating meetings and establishing relationships with First Nations whose traditional territories are impacted by GEM program activities. A portion of a YGS salaried position has been dedicated to coordinating information sessions and liaising with communities, and to date, the effort appears to be having a positive impact.

The TLC suggested that YGS invite Elders and community members to visit field camps and sites of mutual interest as part of this community engagement initiative, noting that such visits could help to alleviate concerns that may exist regarding the impact of geological field work and the footprint of exploration activities. They further advised that in order to establish relationships with communities that are based on trust, YGS will need to commit to

regular community visits and be aware and respectful of the value of traditional knowledge. Some specific engagement activities that YGS could undertake are presented in Table 7.

**Table 7.** Potential new outreach activities.

Activity	Value to communities
Provide geological information ‘layers’ to communities as a complement to existing layers, <i>e.g.</i> , cultural sites, wildlife information and ecological data	Supports decision-making regarding land and resource management.
Web enable photographs of land features ( <i>e.g.</i> , via Google earth)	Valuable to FNs ( <i>e.g.</i> , for documentation of land use, traditional knowledge, <i>etc.</i> ).
Community-scale surficial mapping	Provides learning opportunities for youth by integrating traditional knowledge with western science.

In addition to outreach, the TLC advised YGS that it should consider making greater efforts at ‘in-reach’, *i.e.*, communicating geoscience information to politicians and decision-makers. Such efforts would help ensure that YGS’ datasets are integrated into baseline information in order to implement decisions ranging from resource management to climate change adaptation. It would also help to establish stronger working relationships with other government departments (*e.g.*, Yukon Department of Environment and Public Works and Transportation) and Yukon College.

### Information Management/Information Services

With respect to information services, workshop attendees stressed their interest in having easy access to YGS data, for example, they would like to be able to access data via Google Earth, as well as have the ability to acquire all YGS data either online or on a DVD (or other media). They expressed frustration with YGS’ web applications, which crash frequently and time-out after short sessions.

Regarding the MINFILE database specifically, they noted a number of issues, including unreliable mineral occurrence locations, duplication of data, an absence of source metadata (such as datum), and gaps in data. While many of these issues are an artifact of the original database, they are still a source of frustration for users, and they strongly encouraged YGS to take a more opportunistic approach to data entry to ensure that active properties take priority in the updating process.

YGS possesses a number of donated collections of exploration and mining records such as Cypress Anvil and Faro files. To date, only some of these paper records have been inventoried and are available to clients; access is on demand and documents are only available in hard copy through the EMR Library. The TLC pointed out that collections were donated to Yukon and BC a number of years ago, and BC has scanned and web-enabled theirs, while Yukon has done very little to date to allow public access. It was further pointed out that the records likely contain previously undocumented mineral occurrence data that should be captured in MINFILE.

In addition to a need to access mineral-related data, questions were raised about oil and gas information. Yukon government has a significant amount of data ranging from well reports to petrophysical data, but neither the data itself is web-enabled, nor is there an easy means to discover what information is held by YGS or EMR's Oil & Gas Branch<sup>1</sup>. Just as many of the issues with MINFILE are an artifact of the original mineral showings database, so are the issues with petroleum data and metadata related to the transfer of responsibility for oil and gas management from the Federal government to Yukon. The ultimate result of these legacy issues for end-users trying to access the information is frustration.

YGS technical staff provided an overview of an initiative that is currently underway to merge its numerous databases into a single enterprise database. In the short term, this initiative will not address any of the data access issues noted above; however, it will significantly reduce duplication between YGS databases by migrating all databases to a single platform (Oracle), allowing more efficient updating and maintenance of data by YGS staff. In the long term, the project will involve the development of tools that will improve existing web access to YGS information, *e.g.*, the on-line Map Maker tool will continue to be supported, but clients will also be able to query and download data using Google Earth and Web Mapping Services. Work on the enterprise database is underway, and it is anticipated that some of the web applications will be interfacing with the new database by fall of 2010. Until the new system has been tested and is functioning, YGS will continue to maintain the old databases and web applications to provide continuity in service.

YGS acknowledged the need to scan and web-enable archived collections, but noted that undertaking such a project would divert resources away from other information management activities. To that end, YGS initiated a discussion on the value of annual reports such as the Property Update and Mineral Industry Summaries, and posed the question of whether these should be phased out in favour of delivering more information digitally and enabling clients to compile their own data. The TLC noted that the statistics contained in these annual reports are very useful and suggested a compromise such as maintaining the tables on an annual basis, but publishing summaries less frequently (*e.g.*, every five years). It was also suggested that linking digital information to 43-101 reports and/or corporate websites would be useful.

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<sup>1</sup> In the fall of 2009 EMR's Oil and Gas Branch (OGB) launched a web application to allow users to discover and download scanned copies of industry data such as well reports. The collection of industry data remains incomplete and is a priority for both OGB and YGS.

**Table 8.** Proposed initiatives to improve information services.

Activity	Value/rationale
Generate a searchable inventory of digital geophysical data filed with assessment work	Would provide easier access to digital geophysical data holdings and generate increased use of the data
Generate a list or database of Yukon theses that includes links to sources	Would provide easier access and increased use of theses
Web-enable YMIP reports (starting in 2009, these are submitted digitally; pre-2009 they could be scanned)	Would provide easier access and increased use of YMIP reports
Continue to generate printed material on Yukon mineral deposits	Useful marketing/promotional tool
Create a digital form for clients to capture assessment report metadata (claim number, location information, work type, etc)	Would save time on MINFILE data entry
Provide both tif and jpg images of geological maps; model distribution after GSC's Mirage application	Tif images more easily incorporated into client GIS than jpg
Distribute shape files for geological maps rather than just images	Shape files more useful for clients than tif or jpg images
Develop an RGB "legend" for shape files	Would allow users to match YGS' published maps
Website requires updating	
Web-enable air photo library	Would improve access to photos
Integrate industry data into YGS research (e.g. Archer Cathro's mag/VTEM survey west of Richardson fault array)	Would add value to geologic interpretations
Collect physical rock property data from archived samples and during mapping	Supports integration of geophysical data into geologic interpretation

With regard to map distribution, clients noted the value of having access to maps in multiple formats, *e.g.*, jpg, tif, shx files, *etc.* YGS is keen to respond; however, it was noted that the current capacity of its corporate server (managed outside of YGS) may be an issue in the short term given the size of tif files. A new image server is scheduled to come on line in the next year, and a commitment was made to follow-up with corporate web services staff regarding the distribution of georeferenced raster images. With respect to distributing shape files, YGS noted that our digital map data are not currently managed to a standard that would support distribution of shape files; however, individual geologists are happy to share files informally upon request. In addition to individual maps, YGS is currently upgrading the Yukon bedrock geology map, incorporating recent mapping to the existing compilation of Gordey and Makepeace (2001). This map will be distributed in multiple formats (both images and data), and future bedrock maps will be created to the Yukon map standard and be distributed in the same formats. The target release date for the Yukon bedrock map is winter 2010-11.



## **Core Library/Rock and Core Collections**

YGS provided an update on the recently announced funding for a new core library. The funds, acquired through the federal government's Arctic Research Infrastructure Fund, will support the construction of a new core library and warehouse, and include a greater capacity to house collections. YGS plans to dedicate a half-time position to manage the facility and provide an increased level of support for client access to core logging and lapidary facilities. Potential initiatives include digitizing core logs, photographing core and linking the images to logs. YGS has recently acquired a portable XRF analyzer and will be able to provide semi-quantitative geochemical data on drill core and hand samples.

Strong support was expressed for this initiative, and YGS was directed to assess whether support exists to consolidate YGS office space and EMR's technical library with the new core library. At the very least, the TLC suggested that the new building be designed to accommodate future expansion in case the opportunity to consolidate was to present itself in the future.

Since the workshop, progress has been made on initial design ideas for the building. The target completion date is March 31, 2011. Once the design phase is completed, updates on the status of the Core Library will be provided on YGS' website.

## **YMIP**

Following the announcement made by EMR's Minister in January 2009, a commitment was made to increase YMIP funding; the program received a one-year increase of \$1.1M. The rationale for the increase was linked to the global economic downturn, the long history of success associated with the YMIP, and the fact that YMIP could serve as a bridge to help maintain at least a minimum level of exploration activity until the economy recovered. In addition to distributing an increased number of grants, YGS took the opportunity to make some adjustments to the program. Specifically, funding levels for the three categories of grants were increased to better reflect the current costs of exploration, and more rigorous criteria were established for ranking proposals.

Strong support was expressed for Government of Yukon's commitment to the program, and YGS was advised to fund as many projects as possible and to monitor expenditures closely so unspent funds could be re-allocated. It was suggested that YGS might look into organizing a workshop for prospectors to help them market their properties, *e.g.*, the workshop could focus on developing realistic expectations for prospectors regarding property values.

## **DISCUSSION**

On the second day of the workshop, TLC Chair Rob Carne led a discussion about priority setting for YGS. He noted that the breakout sessions identified a number of gaps that clients would like to see filled, and acknowledged that YGS' capacity is finite. Some of the activities discussed – particularly those that require engineering skills – technically lie outside of YGS' current mandate, although they may be emerging priorities for Yukon government. Without additional resources, YGS must either use its mandate to maintain its

focus, or continue to expand its activities which will require it to evolve from being deliverers of science to being facilitators of research. This is a significant point, and while there is a need to monitor some activities on behalf of Yukon government's interests, YGS has high caliber geoscientists on staff whose talents would be wasted if they were to facilitate multiple projects without being able to engage in the science. As pressure increases to support climate change studies, infrastructure development and other societal needs, it will become more important to set boundaries with respect to our role so that we can continue to excel in the core areas of our program.

It was also pointed out that no discussion was held regarding Yukon College's transition from a technical college to a degree-granting institution, and whether there could be a role for YGS in terms of curriculum development or collaborative research opportunities.

It appears that a significant area of growth for YGS in the next 5 years will be in the areas of data management and information services. This is important not only to ensure that our expanding information base is maintained and archived properly, but also to fulfill evolving client needs. This growth likely represents YGS' biggest challenge since demands for fast delivery of data in multiple formats is growing and YGS will need to find ways to respond while operating within Yukon government's corporate IT environment. A work plan highlighting our objectives over the next five years needs to be developed and should include interim milestones that allow progress to be made as funding waxes and wanes. The work plan must also include flexibility so YGS can respond to opportunities such as new web tools like Google Earth. It will also require a mechanism to allow regular input by both staff and clients, in order to ensure that YGS's ultimate goal is achieved - fast, efficient delivery of information to end users (on line and in person; in paper and multiple digital formats) – and is not lost in process.

An additional message that was articulated was YGS' responsibility to foster home-grown talent. YGS regularly hires Yukon students on its field crews, and it participates as much as possible in school visits to generate interest in earth sciences among students. However, YGS has fallen short in the hiring and training of Yukoners from communities outside of Whitehorse who are not university students or geology graduates. Although there have been some hires from outlying communities, they have not been part of our core target group for seasonal recruitment.

## **ACTIONS ARISING FROM PLANNING WORKSHOP**

A number of clear messages that will help direct YGS program priorities emerged from the workshop. While we are committed to responding to the input heard at the workshop, other factors such as capacity, funding and government priorities will also influence program planning over the next five years. Specifically, we must consider the following:

- A significant proportion of our resources are already committed to projects for the next several years (*e.g.* staff and operating funds allocated to collaborative GEM projects);
- training and skills development will need to be incorporated into planning to ensure we are able to deliver the types of products identified by clients;

- external resources (such as SINED money and funding under the Climate Change Action Plan) can be leveraged by YGS, but may be targeted toward specific types of activities, some of which may not be priorities identified by TLC;
- YGS must operate its information management and delivery systems within the parameters of Yukon government standards; and
- YGS work plans need to address Yukon government priorities.

### **Priorities and Actions**

Specific priorities and actions which have been distilled from the workshop proceedings are listed below:

1. Mapping should focus on improving the existing knowledge base of bedrock and surficial geology rather than trying to stimulate exploration activity in the short term. Consideration should be given to proximity to infrastructure, as road and power access influence exploration investment decisions.
2. YGS should develop and maintain a list of graduate thesis topics that complement its planned research activities and pro-actively seek students and university partners to undertake these studies.
3. Existing RGS data need to be leveled in order to provide a seamless dataset for Yukon, and new geochemical tools need to be developed, particularly for unglaciated regions of Yukon.
4. YGS should continue to improve the integration of its regional geophysical datasets and bedrock geology.
5. Efforts should be made to identify knowledge gaps and research opportunities in support of placer development.
6. YGS should increase its oil and gas geoscience knowledge base in order to undertake petroleum system analyses of Yukon's basins.
7. YGS needs to examine options for improving how it presents mineral potential information for the purposes of supporting land use planning.
8. Bedrock and surficial geology maps should be delivered in GIS-compatible format and point data should be accessible through popular web applications such as Google Earth.
9. Efforts need to be made to make oil and gas-related data easier to acquire on YGS' website, and more effort needs to be taken to promote Yukon as a place to invest in oil and gas development.
10. YGS needs to develop a plan for accelerated data entry into MINFILE, including criteria for prioritizing entries.

11. Paper documents (*e.g.* YMIP reports and archived collections) need to be scanned and web-enabled.
12. YGS needs to improve its diligence with respect to website content to ensure information is accurate, timely and easy to find.

YGS will work to address the above priorities over the next five years, and will use these priorities as a template against which to measure progress at its bi-annual TLC meetings.

## **ACKNOWLEDGEMENTS**

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## **APPENDIX A**

### List of Workshop Attendees

#### **YGS Staff:**

Carolyn Relf (co-Chair)  
Lee Pigage  
Don Murphy  
Mike Burke  
Karen MacFarlane  
Karen Pelletier  
Tammy Allen  
Grant Lowey  
Tiffani Fraser  
Maurice Colpron  
Steve Israel  
Jeff Bond  
Panya Lipovsky  
Charlie Roots  
Steve Traynor  
Bill Lebarge (April 24<sup>th</sup>)  
Rob Deklerk  
Olwyn Bruce  
Aubrey Sicotte  
Bailey Staffen  
Rachelle Dufour  
Leyla Weston (April 23<sup>rd</sup>)

#### **Regrets:**

Lara Lewis

#### **Non-YGS Staff:**

Carmel Lowe (GSC)  
Jim Ryan (GSC)  
David Huntley (GSC)  
Denis Lavoie (GSC)  
Grant Zazula (YTG Heritage)  
Rob Carne (TLC, co-Chair)  
Shawn Ryan (TLC)  
Jean Pautler (TLC)  
Mike Power (TLC)  
Peter Moignard (TLC)  
Gerry Carlson (TLC)  
Gregg Jilsen (Consultant)  
Paul Price (MGM Energy)  
Rob Thomson (Placer Secretariat)