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Yukon Geoscience Needs:
Results of the third Yukon Geoscience Planning Workshop

Teslin, Yukon

May, 2004

YUKON GEOLOGICAL SURVEY

Yukon
Energy, Mines and Resources

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Cover photo. Staff of the Yukon Geological Survey, left to right: Amy Stuart, Craig Hart, Rod Hill, Robert Deklerk, Lee Pigage, Jeff Bond, Grant Lowey, Diane Emond, Karen Pelletier, Bill LeBarge, Monique Raitchey, Geoff Bradshaw, Steve Traynor, Maurice Colpron, Crystal Huscroft, Mike Burke, Lara lewis, Steve Israel, Olwyn Bruce, Charlie Roots and Grant Abbott. Absent: Julie Hunt, Panya Lipovsky, Don Murphy and Ali Wagner.

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EXECUTIVE SUMMARY

This is the third in a series of five-year planning documents that have guided government geoscience in the Yukon over the last ten years. It presents a broad set of needs and priorities for Yukon geoscience for the next five years, but is not a business or work plan. Although developed primarily from the Yukon Geological Survey (YGS) perspective, the Geological Survey of Canada and universities will help to meet these needs either independently or through partnerships with the YGS. It was developed during the spring, summer of 2004 as an internal draft that was later modified and refined through consultation with the Geological Survey of Canada and the Technical Liaison Committee to the YGS.

Over the last five years, the need for geoscience information has grown and spread to a wider and wider audience. Geoscience is utilized primarily by the mining and petroleum sectors to support exploration for minerals and hydrocarbons, but it is increasingly playing a role in other industries such as forestry, fisheries and tourism. In all of these industries it is playing a role in their development and management. Decisions related to the utilization of natural resources are increasingly being made or influenced by many groups including developers, land managers, planners, regulators, First Nations, and the general public. Their decisions need to be formed with accurate information about the nature and potential of resources, and the best practices in mitigating and preventing environmental damage.

This volume includes sections on: bedrock mapping, mineral deposit studies, mineral assessments, regional geochemical and geophysical surveys, subsurface geology, energy/hydrocarbons, surficial geology and placer deposits, information management and outreach.

Bedrock Mapping remains the essential, primary activity of the YGS that defines and illustrates the geological history of an area and provides the framework of basic knowledge upon which other scientific studies, resource exploration and regulatory activities can effectively proceed. Priority areas were selected primarily on the basis of (1) known or suspected mineral potential; (2) lack of scientific knowledge and/or known geological problems; and (3) future land-use planning exercises. Two types of priority areas were selected: those requiring detailed studies at 1:50 000 scale and others where poor exposure and other factors indicated that “accelerated” mapping at a more detailed scale would be more appropriate. Some of the accelerated areas include smaller areas identified for detailed mapping and most are suitable for multidisciplinary studies that could include airborne geophysical surveys, surficial geology geochemistry, mineral deposit studies and /or topical studies.

The section on **Mineral Deposit Studies** emphasizes the need to provide concise summaries of mineral deposit information in a variety of formats, including ongoing maintenance and updating of existing databases (mainly MINFILE) that provide the foundation for future mineral deposit studies; and compilation and synthesis of existing data to generate new products. Priorities for new mineral deposit and district-scale metallogenic studies were identified with recognition of capacity constraints to undertake this type of work. The section on **Mineral Assessments** brings out the need to apply the regional mineral assessments that have been completed in the Yukon to land use planning initiatives currently underway, and to explore opportunities for the broader application of mineral assessment data to identify exploration and development opportunities for First Nations and the exploration community. Systematic regional **Geochemical and Geophysical Surveys** have proven to be some of the most successful catalysts for new mineral discoveries over the past twenty

years. This report recommends that regional coverage of the Yukon be completed for aeromagnetic, stream geochemical and till geochemical surveys. Areas of high mineral potential where detailed multiparameter geophysical surveys should be flown are also outlined. Orientation and case studies, and higher density sampling in selected areas for regional stream geochemical surveys are also needed.

The section on **Subsurface Geology/Energy/Hydrocarbons** emphasizes the need for YGS to develop the expertise to undertake hydrocarbon resource assessments of Yukon sedimentary basins. Priorities identified to meet this end include gap analysis; development and maintenance of key information databases; field studies relevant to understanding petroleum and coal potential; energy and resource modeling to determine appropriate models and analogues for Yukon oil and gas occurrences; regional baseline surveys, including regional aeromagnetic and gravity, seismic compilation, and reprocessing soil, stream and water samples to obtain new geochemical analyses. Other priorities to support hydrocarbon development include surficial mapping in areas of potential exploration and development, and outreach to First Nations and local communities to develop awareness and understanding of hydrocarbon resources.

The **Surficial Geology and Placer Studies** section identifies priorities according to the needs of specific industries and development activities, including oil and gas, mineral exploration, placer mining, forest management, park planning, pipeline construction and road building. Proposed activities include mapping of areas of potential hydrocarbon exploration and development to assess permafrost conditions and aggregate supply among other factors; mapping of areas with high mineral potential identify placer potential; topical placer studies in selected drainage basins and ongoing maintenance of the Placer database; assisting development of a forest management plan in southeast Yukon by participating in a biophysical mapping program; identifying and monitoring terrane hazards in areas of critical fish habitat and potential development, such as the Alaska highway corridor; and selective mapping in territorial parks to support development of management plans; and liaison with communities and First Nations.

The need for compilation of a Yukon-wide digital surficial map is also stressed. The **Information Management** section highlights the need to continually adapt to changing technology and suggests taking advantage of opportunities for development of innovative products in a digital environment. Issues that must be overcome to allow effective and efficient data management and product delivery, include standardization of data collection and streamlining integration of field data into comprehensive databases; streamlining development of a variety of products from individual projects such as traditional hard copies, PDF files, and interactive web-based files; the need to develop and maintain comprehensive databases of key datasets; continued development of the YGS website and the YGS interactive map server (Map Gallery); and improvements to the Geoscience Information and Sales outlet.

The **Outreach** section identifies the growing need for geoscience information by a wider and wider audience. There is clearly a need for products and activities that raise awareness of the importance of earth science and natural resources; teach the principles of geology and mining to general audiences; reduce irrational fear by the public of natural hazards; and promote realistic expectations of mineral and energy development. Priorities that set the stage for a more proactive, focused and effective outreach program include ways to make YGS people and products more accessible; ways to make YGS products and services more visible in communities outside Whitehorse; and the need to broaden the spectrum of YGS products to accommodate requests for nontechnical information. Proposed new

products include a regional geological pamphlet series, a geological road map of the Yukon and a geological history of the Yukon show.

INTRODUCTION

This is the third in a series of five-year planning documents that have guided government geoscience in the Yukon over the last ten years. The first, "Yukon Geoscience - A Blueprint for the Future", was developed at a two day workshop at Marsh Lake in 1995 (Bremner and Hill, 1995) that was attended by representatives of industry, academia and government. The second, "Yukon Geoscience: Looking to the next millennium" comes from a similar workshop held in Whitehorse in 1999 (Abbott and Emond, 2000). These documents have been used to design and implement mapping and research programs that meet the needs of the mineral industry and other clients such as land use planners. Their effectiveness and utility is demonstrated by the high proportion of high priority projects that have been completed during this time, and by the continued support and satisfaction reported by client groups for the work of the Yukon Geological Survey (YGS).

This document continues in that tradition and presents a broad set of needs and priorities for Yukon geoscience for the next five years. It is not a business or work plan. Although developed primarily from the YGS perspective, the Geological Survey of Canada and universities will help to meet these needs either independently or through partnerships with the YGS.

The previous needs documents only covered what information needed to be collected. This volume includes new sections on Information Management and Outreach to address the recently expanded mandate of the YGS, the needs of a much broader clientele, and technical advances that have revolutionized how information is managed and distributed.

A different process than the one used for the previous two documents was used to develop this one. Rather than involving other government agencies and clients from the outset in a planning workshop, YGS prepared a draft document internally to be presented to these groups for comment. There were three reasons for this. The spring of 2004 coincided with one the busiest exploration seasons in recent memory and most interested participants from the mineral industry were not available. Secondly, many representatives from the Geological Survey of Canada were involved in other initiatives which would have made it difficult for them to participate. Thirdly, the scope of YGS activities has expanded to include a more diverse client group than before, and a workshop that could accommodate them all would have been difficult to orchestrate.

The document was prepared mainly over a two-month period during which working groups for each of the main topic areas met separately to develop initial proposals (Table 1). In May, a two-day workshop was held in Teslin to further develop the proposals and reach consensus within YGS. Following the workshop the working groups completed their proposals, and the final draft was assembled by Grant Abbott. It was then forwarded to the GSC and client groups for review (Table 2).

Table 1: Working Groups

Bedrock Mapping
Grant Abbott *(Chief geologist)*
Maurice Colpron (*Project geologist, bedrock mapping)*
Steve Israel (*Project geologist, bedrock mapping)*
Lee Pigage (*Project geologist, bedrock mapping)*
Grant Lowey (*Project geologist, sedimentology)*
Charlie Roots (*GSC research scientist)*
Riona Freeman (*Oil & Gas geologist)*

Mineral Deposits
Mike Burke *(Staff geologist)*
Craig Hart *(Project geologist, mineral deposits)*
Geoff Bradshaw *(Mineral assessment geologist)*
Bill LeBarge *(Placer geologist)*
Robert Deklerk *(Geological database manager)*
Steve Traynor *(Economic geologist)*

Subsurface Geology/Energy/Hydrocarbons
Lee Pigage
Riona Freeman
Grant Lowey

Surficial Geology and Placer
Crystal Huscroft *(Surficial geologist)*
Jeffrey Bond *(Surficial geologist)*
Bill LeBarge *(Placer geologist)*
Panya Lipovsky *(Senior geological assistant)*

Outreach
Charlie Roots *(GSC research scientist)*
Karen Pelletier *(Environmental geologist)*
Lee Pigage (*Project geologist, bedrock mapping)*
Geoff Bradshaw *(Mineral assessment geologist)*
Laurie Sthamann *(Resource information officer)*
Craig Hart *(Project geologist, mineral deposits)*
Riona Freeman (*Oil & Gas geologist)*

Information Management
Grant Abbott *(Chief geologist)*
Amy Stuart *(Geological spatial database administrator)*
Diane Emond *(Publications manager)*
Olwyn Bruce *(Geological spatial database administrator)*

Table 2: Consultation List

Geological Survey of Canada
Lyn Anglin
Mike Cecile
Steve Gordey
Jim Ryan
Larry Lane
Dave Morrow
Peter Friske
Alain Plouffe

Technical Liaison Committee to the YGS
Gerry Carlson (Copper Ridge Explorations)
Moira Smith (Teck Cominco)
Jim Mortensen (University OF B.C.)
Bernie Kreft (Prospector)
Jean Pautler (consultant)
Forrest Pearson (Gartner Lee Ltd.)
Al Doherty (Aurum Geological)
Greg Lynch (Shell Canada)

Background

Both the governance framework and economic environment under which government-led geoscience operates has changed considerably over the last five years. On April 1, 2003, the Territory took an evolutionary leap forward with the devolution of responsibility for management of natural resources from the Department of Indian Affairs and Northern Development (DIAND) to the Yukon government. To reflect this increased responsibility, the Yukon Geological Survey was created to supercede the Yukon Geology Program, which included the Exploration and Geological Services Division (EGSD) of DIAND, and the Yukon Geoscience Office, the Mineral Assessment Group and the Yukon Mining Incentives Program (YMIP) within the Mineral Development Branch of the Department of Energy, Mines and Resources (EMR). EMR has responsibility for management of minerals, oil and gas, forestry, agriculture and lands. The YGS is currently part of the Mineral Development Branch of EMR, but is expected to become a directorate Branch under the Oil, Gas and Minerals Division in April, 2005. This reorganization is a result of the recognition of the need for geoscience to support energy development.

Over the last five years, the need for geoscience information has grown and spread to a wider and wider audience. This trend is expected to continue. Five years ago metal prices and exploration expenditures were at the lowest in recent memory. Today the opposite is true and expectations are for a sustained period of high metal prices and increased mineral exploration. In Yukon, mineral exploration has now evolved to a stage where more sophisticated techniques and concepts are required to discover new mineral deposits. A comprehensive, accurate, and current geoscience database is a key factor in generating exploration plays and attracting investment. Similarly, demand and prices for hydrocarbons and other sources of energy are accelerating, and continued shortages are predicted. The Yukon remains under-explored for hydrocarbons, and good geological syntheses and resources assessments will help to attract investors, most of whom will have had little or no experience in the Yukon. Development of the Alaska Highway natural gas pipeline is likely to proceed and a railway linking Alaska to the south is possible. Global warming is becoming manifest and these developments will impact areas underlain by permafrost, presenting engineering issues on a scale not seen before in the Yukon. Most Yukon First Nations have now settled land claims and have turned their attention to managing their lands and to finding opportunities for economic development. Regulation and land use issues are becoming more complex. For example, land management initiatives currently underway in the Yukon include land use planning mandated under the Umbrella Final Agreement, Integrated Landscape Management, and Integrated Resource Management. Public opinion is now much more influential on the decision-making process for natural resource development. In addition, public interest in natural history and geology is widespread and increasing, which presents an opportunity to support tourism.

As result, unlike ten years ago, geoscience information now serves not only the mineral industry, but a wide variety of industries including oil and gas, and to a lesser extent, forestry, fisheries and tourism. Geoscience is now playing a role in all phases of development of those industries including, exploration, development and management. Decisions related to the utilization of natural resources are increasingly being made or influenced by many groups including developers, land managers, planners, regulators, First Nations, and the general public. Their decisions need to be formed with accurate information about the nature and potential of resources, and the best practices in mitigating and preventing environmental damage. Awareness of Yukon First Nation needs and operating procedures has grown significantly in the last five years. The role of the YGS in working with Yukon First Nations has to remain flexible and integrated with their resource departments. The types

of information gathered by Geological Surveys will not change greatly in the future, but more flexible ways of interpreting and presenting the information must be developed in order to serve such diverse activities and clients. With such a diversity, geological surveys must carefully set priorities in order to maximize the benefit of limited resources. With that in mind, the primary focus must remain with the mineral and energy industries.

BEDROCK MAPPING

Introduction

Bedrock mapping is the essential, primary activity of the YGS and of most geological surveys. Geological maps define and illustrate the geological history of an area and provide the framework of basic knowledge upon which other scientific studies, resource exploration and regulatory activities can effectively proceed. Unlike most other Survey activities, bedrock maps are used for a wide variety of purposes. Therefore, a somewhat broader set of criteria are used to set priorities.

To set priorities for bedrock mapping, a core group of Yukon Geological Survey (YGS) geologists (Table 1) met several times to establish a list of potential regional bedrock mapping projects that could be undertaken over the next five to ten years. The group first reviewed the priorities outlined in previous planning workshops (Marsh Lake, 1995; High Country Inn, 1999) and established which areas were mapped since then (Figs. 1-2). This exercise indicated that significant progress was achieved in the five years since the last planning workshop (Fig. 2). This section summarizes the priority areas identified for bedrock geology mapping projects during the 2004 planning exercise and the rationale behind the selection of each area.

Previous planning exercises differentiated between ‘hard-rock’ and ‘soft-rock’ bedrock mapping projects based on their intended client groups. This practice is discontinued here as it is believed that all mapping projects should be dealt with in the same way regardless of the intended client group. It was felt that YGS has the capacity and mandate to undertake most of the detailed bedrock mapping, but that collaboration and partnerships with the GSC and/or universities would continue to be important for regional and specialized expertise.

The differentiation between framework (1:250 000) and detailed (1:50 000) regional mapping priorities was also removed. Recent mapping projects such as Finlayson and Glenlyon have shown that a viable approach to regional bedrock mapping is to initiate detailed studies (1:50 000) in an area which can then be used as a foundation for smaller scale “accelerated” mapping of nearby areas with poor exposure. These studies have resulted in publication of maps at the intermediate scales of 1:100 000 and 1:125 000. Accelerated mapping projects generally lack good exposure and would benefit from a multidisciplinary approach that could include multi-parameter geophysical surveys, geochemical surveys, mineral deposit studies, surficial mapping and/or topical studies to enhance available data. They are helicopter-supported regional mapping programs which have for a foundation one to two years of detailed bedrock mapping or topical studies. They usually include map compilation.

In this report, we indicate whether priority areas warrant a detailed mapping approach or an accelerated approach. Priority areas were selected primarily on the basis of (1) known or suspected mineral potential; (2) lack of scientific knowledge and/or known geological problems; and (3) future land-use planning exercises. Economic potential and scientific merit were the main factors considered; however, changes in the community now provide increased opportunities for YGS to become a resource to be called upon (for example detailed mapping of First Nation’s Settlement Lands) and this role must be considered when planning new mapping projects. Some of the priorities identified in previous planning exercises were reviewed in light of today’s political and economic climates; most were retained.

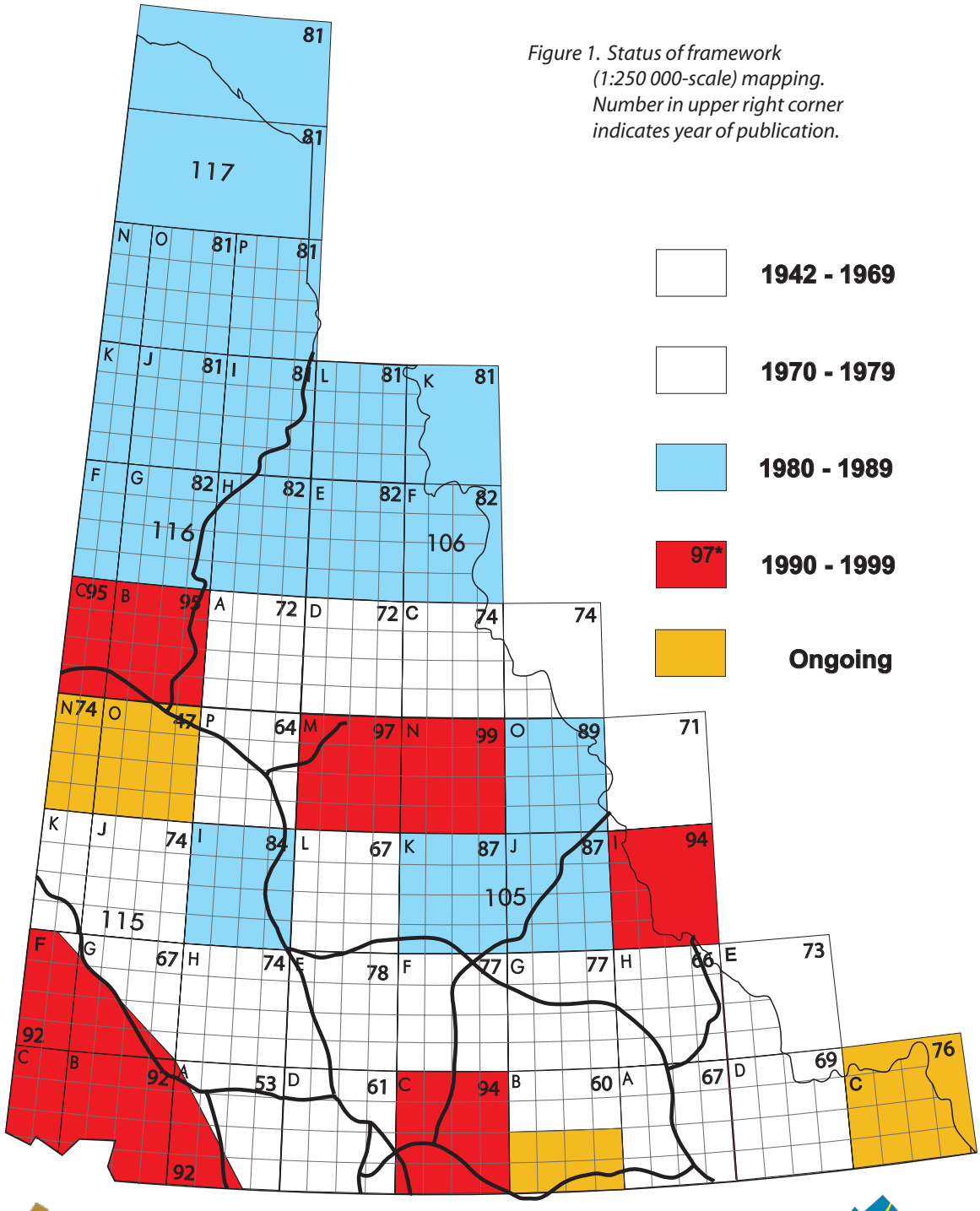

Figure 1. Status of framework (1:250 000-scale) mapping. Number in upper right corner indicates year of publication.

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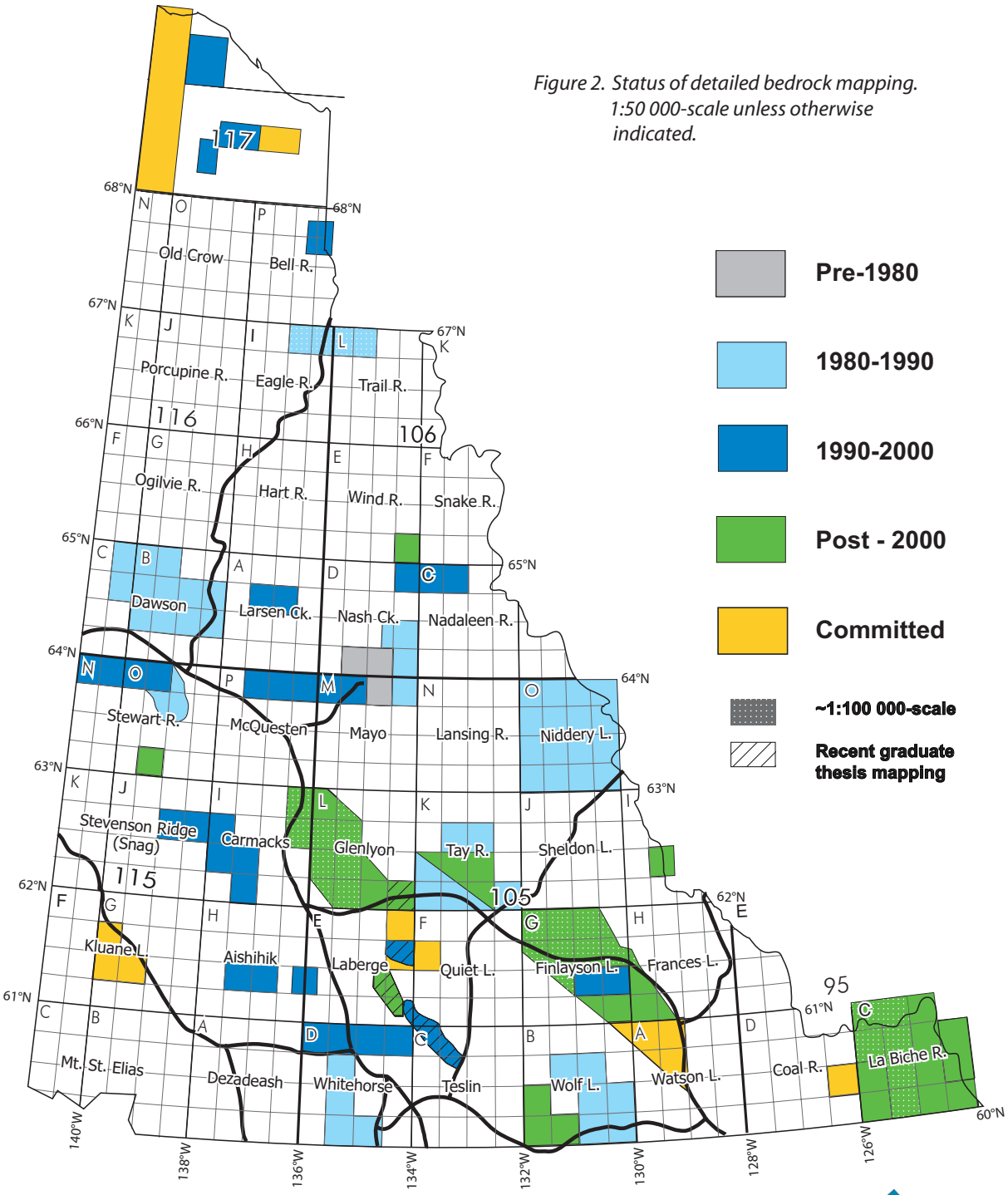

Figure 2. Status of detailed bedrock mapping. 1:50 000-scale unless otherwise indicated.

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In addition to these factors, the potential to coordinate activities with other groups at the YGS (e.g., Hydrocarbon, Mineral Deposit, Surficial Geology), with the GSC, and/or with university partners were also considered. During this process, several areas that would benefit from more problem-specific, detailed *Topical Studies* were also identified; these studies would probably be most beneficial if conducted in tandem with regional mapping projects, particularly "accelerated" mapping projects. Some of these studies may also be suitable for graduate thesis projects. The ranking of priorities from 'high' to 'low' that was used in previous documents was dispensed with in this report as we felt that the initiation of projects is commonly dictated by potential partnership opportunities and the political and economic climate at the time. Also discussed below is the need for compilation of the large quantity of unpublished information from past GSC and YGS mapping projects.

Mapping Priorities

Several areas that were prioritized in previous needs exercises have seen work. In particular accelerated mapping of large portions of Yukon-Tanana terrane (YTT) in Finlayson Lake (105G), Frances Lake (105H), Glenlyon (105L), and Wolf Lake (105B) map areas has been completed in partnership with the GSC under the Targeted Geoscience Initiative and the Ancient Pacific Margin NATMAP Project (Fig. 2). The Stewart River (115N,O) area, also in Yukon-Tanana terrane, is currently at the compilation stage. Miogeoclinal rocks of the La Biche River (95C) map area have also been mapped since 1999, again with the GSC under the Central Forelands NATMAP Project. Both YTT and the La Biche River area were major priorities identified in the 1999 document. Bulletins are in progress for many of these studies. In addition, these projects supported at least five graduate theses (two PhD; three MSc), some of which produced detailed geological maps. Compilation of the Anvil district (105K) of Selwyn Basin has also been completed since the last planning workshop.

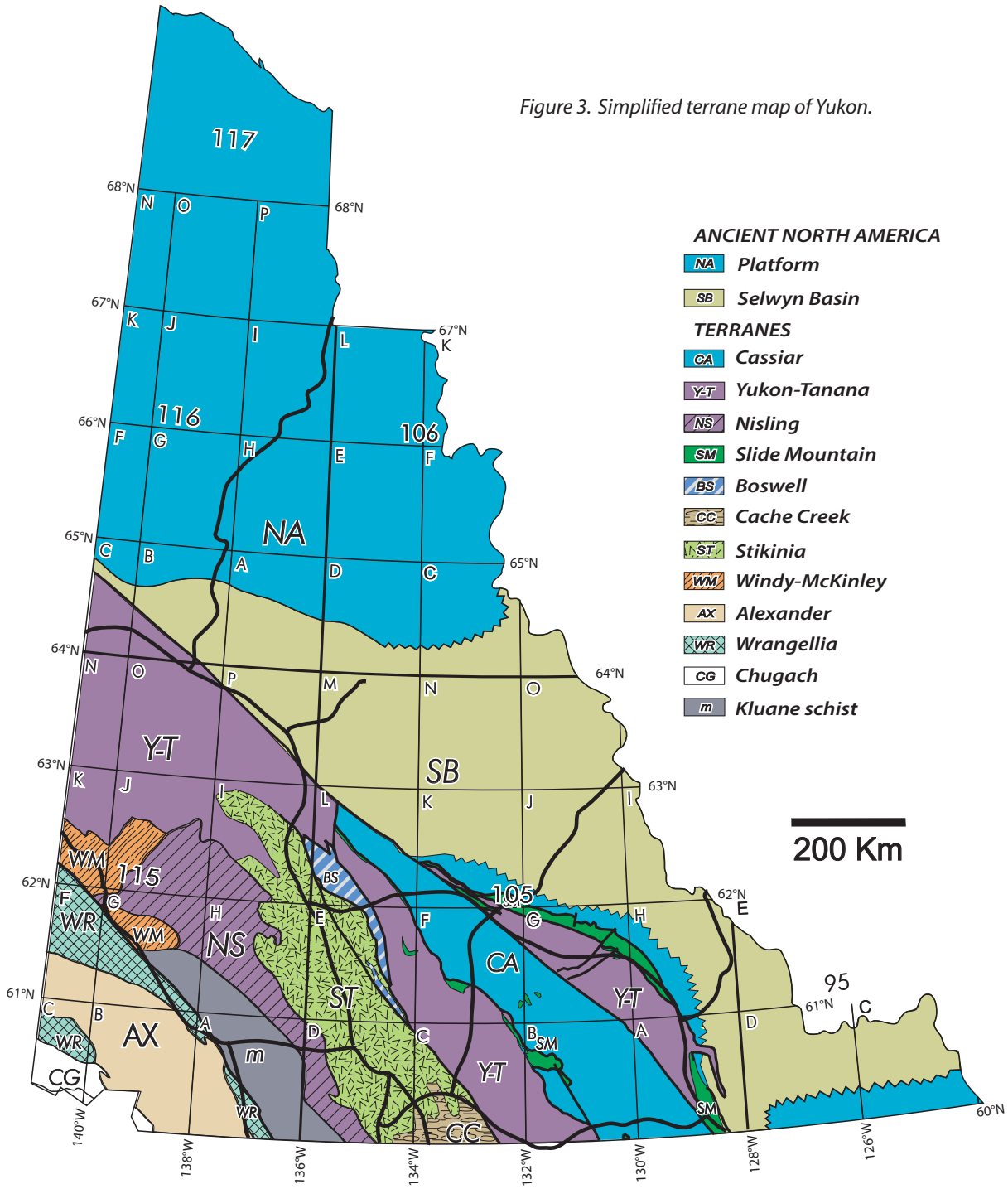
Projects that are committed or in-progress include the Kluane Ranges (115G/5, 6, 12), eastern Coal River (95D/8) and parts of Laberge map areas (105E; Fig. 2) in Wrangellia, Selwyn Basin and Stikinia), respectively. The mapping of YTT in NW Watson Lake area is scheduled to resume activity in 2005. Current YGS projects (Fig. 2) and expertise now span most geological belts in southern Yukon and address both minerals and hydrocarbon priorities.

For this exercise, we divided the Territory into eight regions which roughly reflect the main geological belts of Yukon (Fig. 3). These are North Yukon, Wernecke-Ogilvie Mountains (Proterozoic inliers and Paleozoic cover), Selwyn Basin/Southeast Yukon, Yukon-Tanana terrane, Pelly-Cassiar Mountains (Cassiar terrane), Whitehorse Trough-Intermontane Belt (Stikinia), West Yukon (Windy McKinley Terrane, Kluane Schist, Coast plutonic belt) and Insular Superterrane (Wrangellia). Priorities identified in this document are shown in Figure 4 with rationale or problems associated with each area presented below.

North Yukon

North Yukon is underlain primarily by a wide variety of Phanerozoic sedimentary rocks with local inliers of more highly deformed Proterozoic sedimentary rocks that were deposited on ancient North America and older cratons in a variety of depositional environments. Much of this area has a high hydrocarbon potential but very little exposure and is more appropriate for accelerated mapping projects.

Figure 3. Simplified terrane map of Yukon.



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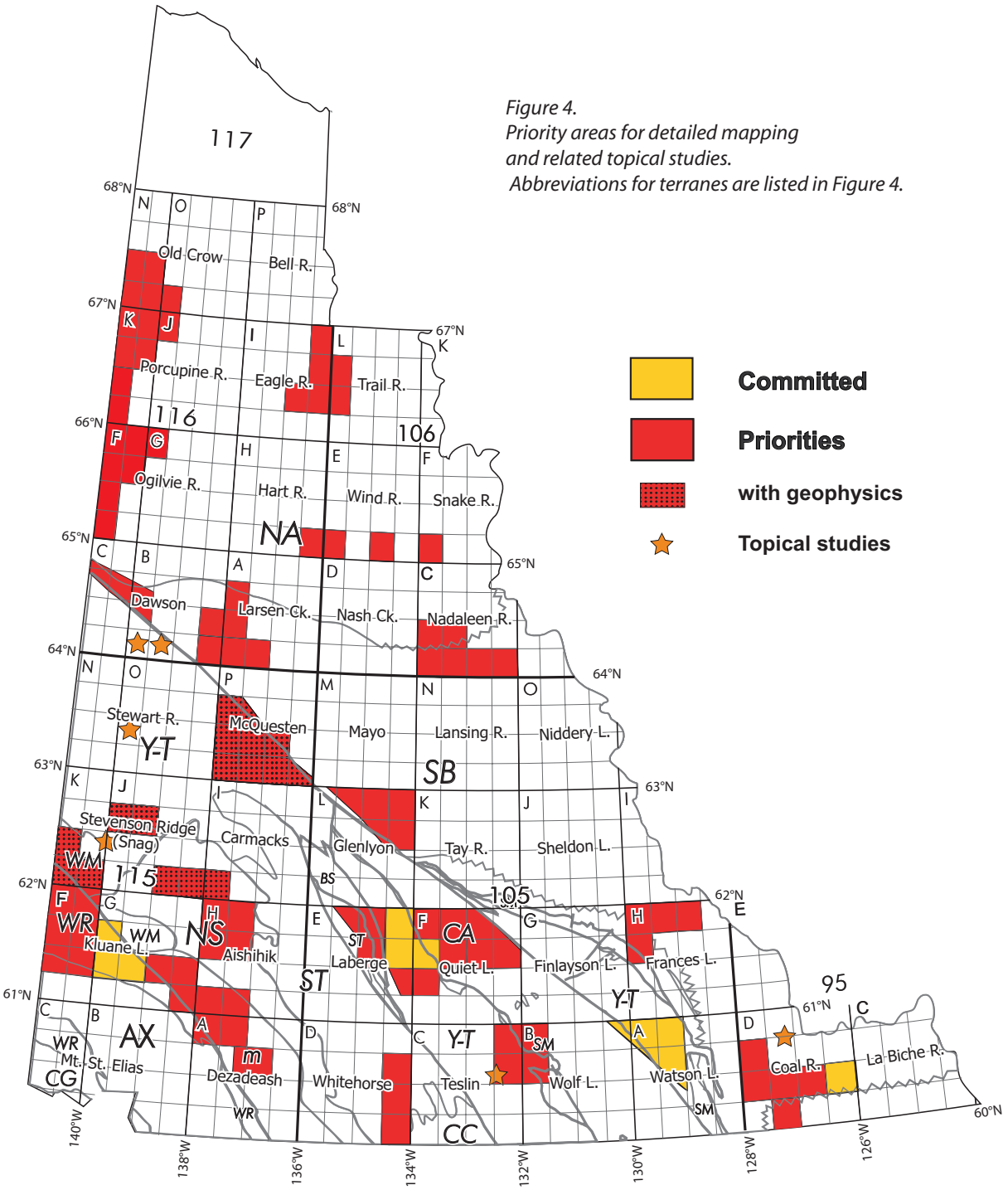

Figure 4.
Priority areas for detailed mapping and related topical studies.
Abbreviations for terranes are listed in Figure 4.

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Detailed

• Out of the areas indicated in Figure 4 and Table 2, only the Keele Range/Dave Lord Mountains area (116J/13; 116K/9,10,15,16; 116/N1,2,7,8; 116O/4) is suitable for detailed mapping. Unknown geology and mineral potential of the Proterozoic inlier in this region are the main justifications for its prioritization.

Accelerated

• The Richardson Mountains (includes 116I/7,8,9,16) and Peel Plateau (includes 106L/5,12) are areas of high hydrocarbon potential with relatively low amounts of exposure. Mapping of these areas would hopefully alleviate some of the difficulties correlating Paleozoic, Mesozoic and Tertiary stratigraphy and structures with existing seismic and well data from areas marginal to regions of hydrocarbon potential.

• The Kandik Basin (116F/2,5,7,8,15,16; 116G/16; 116K/2,7) is an area of high hydrocarbon potential, and possible sedimentary-exhalative (SEDEX) and Mississippi Valley Type (MVT) style mineralization within the surrounding older strata. Existing maps are not detailed enough to effectively portray the geology, and stratigraphic relationships and structures are poorly constrained. The basin extends into Alaska and efforts should be made to initiate an international collaborative project.

Wernecke-Ogilvie Mountains

The Wernecke and Ogilvie Mountains are well exposed and have a high mineral potential and significant scientific importance. They are underlain by Proterozoic and Paleozoic rocks of ancestral North America and older cratons. Previous detailed mapping has defined the stratigraphic and structural framework of the area so that accelerated mapping could now proceed.

Accelerated

• Proterozoic inliers in the Wernecke and Ogilvie mountains host mineralization of many types including a significant potential for Wernecke Breccia (iron-oxide-copper-gold, IOCG) occurrences. The area has a complex Proterozoic geological record and holds promises for resolving fundamental problems of Cordilleran geology. Detailed mapping priorities within this broad region include 106F/4,106E2,4 and 106H/1. Accelerated mapping should at least include all of Nadaleen (106D) map area which also incorporates the northern margin of Selwyn Basin (see below). Potential university collaboration helps prioritize this area. Potential areas of study include structural studies to clarify a complex Proterozoic history, influence of structures on the development of coal deposits in the Cretaceous Bonnet Plume Basin, and Proterozoic igneous rocks and their relationship to the Wernecke Breccias and other types of mineral occurrences.

Selwyn Basin and Southeast Yukon

The mineral potential of this area is well established. It is host to significant volcanogenic massive sulphide (VMS), SEDEX and intrusion-related mineral deposits. Many parts of this important geological belt received attention in the 1990s, but few mapping projects were completed in this belt since 1999 (Fig. 2). Most of the priorities identified in 1999 remain on our list. Many of these areas offer potential for collaboration with the GSC as part of a proposed Selwyn Basin metallogenetic study.

Detailed

• Northeast Glenlyon (105L/9,14-16) map area remains a priority. The area is the type locality of many key stratigraphic units of Selwyn Basin. It has high mineral potential for SEDEX deposits in stratigraphy that is contiguous with the Anvil District and with the Devono-Mississippian Earn Group. There is also potential for intrusive-related base and precious metal deposits associated with Cretaceous and Tertiary intrusions.

• Detailed mapping in the Brewery Creek area (116A/3,4,5,12;116B/1,8) is required for interpretation of recent multi-spectral geophysical surveys, and to better define the setting of other promising gold targets and potential SEDEX environments.

• Known copper-gold mineralization in the Shell Creek (parts of 116B/5,12; 116C/9,10,11) area in the western Ogilvie Mountains coupled with poorly constrained Proterozoic-Paleozoic geological relationships makes this a priority for detailed mapping.

Accelerated

• Southeast Yukon (95D, 105A) is a poorly exposed and little understood part of Selwyn Basin. Detailed mapping is required in certain areas such as Coal River map area (95D/3,5,6,7,8,12) where there is a significant potential for important structural and stratigraphic information. There is a good chance large-scale basement structures that may be associated with SEDEX and MVT mineralization can be found within rocks in this area. The transition from basin to platform can be found in this region and should be examined as it may also be related to mineralization.

• The Frances Lake (105H) area remains one of the least understood parts of Selwyn Basin. Fundamental questions concerning the relationship between YTT, McEvoy Platform and Selwyn Basin may be answered in the northern Frances Lake (105H/12,3,14,15) area. There is good potential for intrusion-related mineralization in addition to syngenetic sulphide mineralization. Detailed mapping of the identified map sheets could precede accelerated mapping of the whole sheet.

• Southern Nadaleen River (106C/1-6) is listed in earlier needs documents as a priority based upon high SEDEX potential and geological importance. Newly identified problems associated with Proterozoic/Paleozoic stratigraphy and structures may lead to important geological questions being answered. Detailed mapping of these map sheets could accompany accelerated mapping of Nadaleen map sheet and other parts of the Wernecke-Ogilvie Mountains (see above).

Pelly and Cassiar Mountains (Cassiar terrane)

The Cassiar terrane consists mainly of late Proterozoic through Triassic sedimentary and volcanic rocks that were offset from the North American continental margin along the Tintina Fault in late Cretaceous and/or Tertiary time. Cassiar terrane has high potential for SEDEX and VMS deposits as well as base and precious metal deposits related to Cretaceous intrusions.

Detailed

• Rocks belonging to the St. Cyr assemblage along the eastern margin of Cassiar terrane retain the high priority status that was given to them in previous documents because of their stratigraphic and economic importance. This Cambrian to Devonian assemblage does not resemble homotaxial strata of either Selwyn Basin or Cassiar Platform, and the stratigraphic and tectonic setting of known

SEDEX occurrences in these rocks is unclear. These rocks also record a complex, little understood structural history. Areas underlain by these rocks include 105F/9,10,14,15, part of 16.

Whitehorse Trough – Intermontane Belt (Stikinia, Cache Creek Terrane)
Whitehorse Trough, at the northern end of the Intermontane Belt may hold the key to some of the remaining fundamental tectonic problems of the northern Cordillera. These include the relationship between the Trough and bounding Yukon-Tanana and Nisling terranes, and their early Mesozoic tectonic history. Mesozoic sedimentary rocks of the Trough have potential for oil and gas, yet they remain enigmatic due to poor exposure.

Accelerated
• Northern Laberge (105E) and adjacent Carmacks (115I) map area have the best potential for hydrocarbons in Whitehorse Trough. Recent acquisition of seismic reflection data along Robert Campbell and North Klondike highways in northern Whitehorse Trough and stratigraphic studies initiated in 2003 are being complemented by volcanology and structural geology studies starting in 2004 both in Laberge and Whitehorse (105D) map areas. These studies provide unique opportunities to address problems raised in the 1999 document, such as the nature and significance of the Teslin fault, the relationship between YTT and Whitehorse Trough, and the potential for copper-gold porphyries in Jurassic alkalic intrusions. The Semenof Hills in eastern Laberge map area have seen recent detailed mapping and warrant further attention as part of an accelerated program (105E/11,15). This data could form the seed for accelerated mapping in northern Laberge map area, and a Whitehorse Trough compilation.

Yukon-Tanana and Nisling Terranes
The Yukon-Tanana Terrane (YTT) was considered one of the least understood terranes in Yukon and was given high priority at the last planning meeting. Since then there has been a significant amount of work focusing on this terrane that has resulted in a much greater understanding of its origin and history. This work has also identified it as having a high potential for VMS and intrusion-related mineral deposits. Further mapping is required to fully define this potential. Further work is also required to investigate the relationships of the YTT with bounding terranes. Priority areas are Wolf Lake (105B/12,13), NE Teslin (105C/9,16), Laberge (105E/8-10,14-16), Quiet Lake (105F/5,11,12,13) and NW Watson Lake (105A/11-14).

Detailed
• Mapping of YTT in northeastern Laberge map area (105E/9,16), committed for 2004, will provide continuity with recent mapping in Glenlyon map area to the north and the opportunity to compile recent graduate thesis mapping. It is anticipated that this data will be integrated with seismic, stratigraphic and structural studies of the adjacent Whitehorse Trough in a future accelerated mapping program.

• Potential topical studies relating to YTT that may be suitable for graduate student research include detailed mapping of the Thirtymile Range in Teslin map area (105C/9), and provenance and sedimentological studies of Triassic synorogenic conglomerates that occur at the leading edge of YTT in Tay River, Finlayson Lake, Frances Lake, Watson Lake and Wolf Lake map areas. At least two regional episodes of Paleozoic deformation and metamorphism have been identified in the YTT, but the details of their structural style and tectonic significance remain unknown.

Accelerated

• Southwestern McQuesten (115P SW) was identified in previous documents as having high priority status. In light of recent work in the (YTT) of the adjoining Stewart River and Glenlyon map areas, this area retains priority status for accelerated mapping. The area has high mineral potential but low exposure and would likely be most effectively mapped after a detailed multi-spectral airborne geophysical survey.

• The major advances in understanding of YTT since 1999 were focused on the eastern portion of the terrane. Its western prong, the Nisling terrane west of Whitehorse Trough remains poorly understood and needs to be mapped. Some detailed mapping and multi-spectral geophysical surveys could provide the foundation for an accelerated mapping project in northwestern Aishihik (115H/11,12,13,14), southeast Snag (115J/1,2) and southwest Carmacks (115I/4) map areas. The mineral potential of these areas is largely unknown, but could be of interest for VMS and copper-gold porphyry mineralization.

West Yukon (Windy-McKinley Terrane, Kluane Schist)

West Yukon includes rocks of the Kluane Schist, Windy-McKinley terrane and Nisling terrane northeast of the Denali fault and southwest of the Yukon-Tanana terrane. Nisling terrane is discussed above with Yukon-Tanana terrane. This geological region was identified in 2004 as the least understood part of Yukon with poorly constrained but possibly high mineral potential. Since 1999, the area has only seen one short thematic study of part of Windy-McKinley terrane. YGS is currently developing local expertise in the area.

Accelerated

• The Kluane Schist (115A/10,11,13,14; 115G/1,7,8) remains an enigmatic belt in southwest Yukon. Recent metamorphic studies of the area have provided little insights into the origin and terrane affinity of this belt. These issues still need to be addressed with further mapping. The area has low mineral potential and may be best suited for thematic (theses) studies.

• Windy-McKinley terrane (115F; 115J/11,12; 115K/1,2,7) remains a high priority area because of its poorly understood geology and possibly high mineral potential. This lack of knowledge stems mainly from poor exposure and difficult access to the area, and therefore would likely benefit from thematic studies and geophysical surveys, followed by accelerated mapping. The terrane affinity of this belt is poorly constrained.

Insular Superterrane (Alexander-Wrangellia Terranes)

The Insular Superterrane is an area of high mineral potential and complex geological relationships that is separated from the YTT, other terranes and the Coast Plutonic Belt by the Denali Fault. Much of the area is within Kluane National Park and Asi Keyi Territorial Park Preserve and/or is covered by glaciers, but the remainder has high potential for magmatic nickel, copper, platinum-group-element (Ni-Cu-PGE) deposits and for intrusion-related, shear zone-hosted, and placer gold.

Detailed

• The Kluane Ranges (115G/1,2,3,5,6,7,8,11,12; 115F/east-half) are of most interest; they contain the boundary between the Alexander and Wrangellia terranes. Complex structural and stratigraphic relationships will only be sorted out with detailed geologic mapping. Known Ni-Cu-PGE mineral deposits occur within ultramafic rocks of the Wrangellia terrane, and these are currently of interest to a number of companies. Land-use issues with both the First Nations and Parks Canada make this

area an important site of cooperation between the YGS and the non-geoscience community. The YGS is committed to mapping of 115G/5,6,12 for 2004, and will revamp previously unreleased preliminary mapping completed by DIAND in the 1980s.

Legacy Data

Over the last 30 years, much of southern Yukon was mapped by the GSC primarily at 1:250 000 scale and locally at 1:50 000 scale. For a variety of reasons, reports for much of this excellent work were never written, but draft documents and/or data are available for several areas. The absence of formal stratigraphic nomenclature and other published details of the geology of these areas is a significant hindrance to subsequent work. This report recommends that concerted efforts be made to complete the documentation for as many of these projects as possible. The following areas have the highest priority: Kluane area southwest of the Shakwak-Denali Fault (NTS 115A,B,C,F,G); Tay River (105 K) and Sheldon Lake (105J) map areas; Quiet Lake(105F) and Finlayson Lake (105G) map areas southwest of Tintina Fault; Laberge (105E) and Carmacks (115I); and Niddery Lake Map area (105O) (YGSalso). Compilation of the Kluane and Quiet Lake/Finlayson Lake areas could be integrated with ongoing and proposed detailed mapping described under Mapping Priorities. Whitehorse map area (105D) has seen significant detailed work by YGS and a new 1:250 000 scale compilation is warranted.

MINERAL DEPOSIT STUDIES

Introduction

Studies discussed in this section include a variety of activities and products that attempt to define the location, exploration history, geological characteristics, genetic classification and geological setting of mineral deposits and occurrences in the Yukon. These types of information derive from a wide variety of sources including assessment reports, exploration records and other private sector studies, and field visits and studies by YGS staff and university researchers. Accurate and current geological information allows effective mineral exploration and gives the Yukon a competitive advantage in attracting investment. Given the amount of mineral deposit information available in the Yukon and worldwide, databases and concise metallogenic summaries are essential to making these types of information accessible and easily understood.

The four tenets upon which both previous documents based their recommendations are supported here. These are:

1. District scale metallogenic studies are preferred to deposit specific studies.
2. Multidisciplinary studies involving university researchers, students, industry, MDRU etc… are encouraged for increased efficiency and the benefit of collaboration.
3. Deposit-specific geological information should be acquired from the private sector and placed in the public domain (i.e., YEG, Yukon MINFILE).
4. Metallogenic syntheses and mineral deposit models are needed.

The last document recognized the capacity limitations for mineral deposit research and the need to take a balanced approach to setting priorities that both lead and follow industry. The following eleven recommendations addressed these and other issues:

1. Support current exploration plays with a **"Hot Play Geologist"**
2. Have a **"Key Correlation" Geologist** undertake longer term studies that support current exploration plays
3. Undertake **Deposit-Specific Studies** with support and participation from industry and academia
4. Keep **Yukon MINFILE** up to date
5. Publish **Yukon 'Deposit Type' Bulletins**
6. **Archive** legacy data from closed mines
7. Synthesize the **Regional Metallogeny** of geologic belts
8. Produce and distribute **Databases and Digital Products**
9. Develop **Yukon Deposit Models**
10. Undertake **Mineral Resource Assessments**
11. Develop metallogenic maps from Yukon MINFILE maps (**METMAP**)

Progress has been significant on many of these, but limited on some. The concept of the 'Hot Play Geologist' was never formally adopted because of capacity constraints, but was partially fulfilled through the liaison function performed by the staff and YMIP geologists. In future, these positions should take on more of the "Hot Play' functions providing more synthesis and interpretation of date collected. The 'Key Correlation' geologist role was filled by two project geologists who undertook studies of intrusive-related gold deposits and the Wernecke Breccias. These types of studies, however, take several years to complete whereas exploration plays can change much more rapidly. Thus it must be recognized that this type of work cannot always keep up with exploration trends.

Several deposit-specific studies were undertaken by graduate students with support from industry, the YGS and the GSC. Mineral deposit and metallogenic studies have not proceeded as quickly as desired, largely due to a shortage of graduate students and interested university researchers. YGS has had considerable success in encouraging companies to publish deposit reports in the YEG. Yukon MINFILE now contains most current information and has seen significant revision and streamlining of the data structure. Revisions and inclusion of legacy data is underway. One 'Deposit-Type Bulletin' has been completed on VMS Deposits in the Yukon Tanana Terrane and adjacent areas. Archiving of exploration records from the Anvil Camp is underway and a process has been established to allow public access. Regional metallogeny has been addressed through the development of metallogeny posters of key mineral districts and commodities. The posters have been reduced to 11"x 17" placemats for easy reproduction and distribution. Metallogenic summaries of Selwyn Basin and the Kluane ranges have been developed for the YGS website. These have proven to be very popular and more are planned. Databases and digital products have advanced significantly and resulted in the highly successful Map Gallery. Further development and improvements are a priority. Adaptation of the B.C. Deposit Models to the Yukon has been started and is expected to be completed shortly. Capacity constraints have limited the development of derivative products from Mineral Resource Assessments. The baseline information used for the assessments, however, is available in databases and can be viewed through the Map Gallery. MINFILE maps have not been completely converted to metallogenic maps but they do include simplified geology.

Discussions for this document acknowledged the capacity constraints for deposit and district scale metallogenic studies and focused on other priorities that are more "doable". The priority list for deposit and metallogeny studies is updated here and projects are expected to be undertaken as opportunities arise. Priorities that received the most attention included: 1) on-going maintenance and updating of existing databases (mainly MINFILE) that provide the foundation for future mineral deposit studies; and 2) the compilation and synthesis of existing data to generate new products.

MINFILE

Databases play an increasingly important role in the effective transfer of information to clients. MINFILE is the principal receptacle for Yukon mineral deposits data and is the main portal of this data for clients. We emphasize an expanded and organization-wide approach to ongoing updates and improvement to MINFILE as a main priority. A review to identify specific areas for improvement, the creation of a set of procedures to facilitate these improvements, and the fostering of an organization-wide approach to updating and maintaining this database were identified as goals that were attainable.

1. Identify areas for which improvement will support more efficient updating

- An internal review should be initiated in order to identify areas of improvement, indicate resources and mechanisms required for such improvements, and have timelines associated with the goals.

- Examples of specific fields which could be improved include:
    - Tectonic element
    - Host rock
    - Additional fields identified in review

- Streamline updating of specific fields
    - GIS queries? i.e., tectonic element

2. Define procedures for efficiently updating the database that utilize expertise throughout YGS

The current method of utilizing YGS field staff to update MINFILE is not working.

- Establish set written procedures for MINFILE data collection by field staff.
- Convene a preseason MINFILE day meeting with field staff to identify MINFILE data within individual project areas that needs addressing and updating (March-May).
- Convene a post-season MINFILE day meeting with field staff to gather information for MINFILE updating (Sept-Oct).

3. Identify a list of priorities according to which updating should be done:

- By industry activity (new assessment data)
- New project areas (recent geology mapping)
- By mineral tracts
- Legacy data

4. Update MINFILE with Legacy data (mainly from pre-1990 assessment reports)

Specific regions requiring significant updates from Legacy data include Selwyn Basin, Kluane Ranges, Dawson Range, North Yukon, and the Pelly Mountains

Igneous Database

More than 90% of the mineral occurrences in the Yukon are genetically related to igneous rocks. They include a wide variety of intrusive and extrusive suites that range in age from Early Proterozoic to recent. While characteristics of some suites are obvious, others are not. For instance, Cretaceous intrusions, which generated most of Yukon's mineral occurrences, include a variety of suites of different ages which are not yet fully understood. Data that permit metallogenetic differentiation such as whole rock and trace element chemistry, mineralogy and style and depth of emplacement have never been systematically compiled. Priority should be given to developing such a database, and using it to identify chemical and physical parameters that correlate with certain deposit models and to identify data gaps and areas requiring further research.

Metallogeny of Mineral Provinces/District/Deposits

Among other products, the 1999 Yukon Geoscience Planning workshop identified the need for: 1) well defined mineral deposit models; 2) mineral deposit studies; 3) district- and regional-scale metallogenic studies; 4) metallogenic compilations, and syntheses; 5) compilations of archive data from defunct mines and camps; and 6) Yukon deposit-type Bulletins (e.g., Tungsten in Yukon). These products are reviewed and discussed below. The importance of scale is emphasized. There are three scales of mineral deposit studies and compilations: deposit, district, and province.

Mineral Deposit Models

Mineral deposit models are one of the most useful means of characterizing mineral occurrences and placing them in a global context. This type of information is now required of publicly traded companies by regulators as it provides investors with a generally accepted perspective on the significance and potential of a given mineral occurrence. Deposit models are also being used more frequently by "data miners" to search data files by computer, using keywords, and to select

promising targets. Deposit models also form the basis for mineral potential assessments that use Monte Carlo simulation, e.g., Yukon regional mineral assessments.

Concise, highly specific deposit models were first developed by the United States Geological Survey and subsequently adopted and revised by other organizations. In Canada, the British Columbia Geological Survey developed a very successful set of deposit models that are specific to the North American Cordillera. With minor modification, these models can be applied to the Yukon, although a few models, such as Wernecke Breccias, intrusive-related gold, magmatic nickel-copper-platinum group element deposits, and "Blende-type" zinc-lead-silver deposits need more extensive development. A set of Yukon mineral deposit models, based on the B.C. models needs to be developed and maintained. They should form the basis of occurrence classification in MINFILE, and should become a "checklist" that is used by field geologists when visiting and studying mineral occurrences. Descriptions of mineral occurrences are likely to be more useful and accurate if described in the context of a mineral deposit model. The process of assigning a detailed, specific model to occurrences in MINFILE will also identify which occurrences lack sufficient information to allow characterization and thus require further study. Mineral deposit models should also form the basis for district-scale and Yukon-wide studies, and compilations of mineral deposits that are described below.

Deposit and District-Scale Studies

At the district/camp and deposit scale we see a three-pronged approach. First, archival studies of defunct mines and districts are recognized as important, as data evaporates quickly after a mine closes. Second, in light of significant capacity problems in undertaking field-based metallogenic studies, there is a need for quick and easy GIS compilations, with associated geological interpretation. These outputs would be data-based, and would be used to generate ideas and identify targets. Previous planning reports have emphasized that, although clients want the raw data, expert interpretations are highly desired by exploration companies and prospectors. Third, for those deposits and districts that are exploration priorities and are poorly understood, broader, integrated field-based metallogenic studies, such as those identified in the 1999 planning document, are encouraged. Metallogenic studies could be topical and focused, or could be idea-based, such as "Gold in the Keno Camp". Deposit studies are best done with collaborative support with a company partner, and ideally as part of a graduate student thesis supported by the company with guidance and additional support from YGS. Previous planning documents emphasized the need to avoid duplication of work being undertaken by companies and to avoid the perception of favoritism by undertaking this work as part of broader district-scale and regional metallogenic studies.

Table 3 identifies the Yukon's main deposits and mineral camps and indicates which ones require either archival, compilation/generative or field-based studies with darker fills indicating higher priority. These deposits and districts are also shown on Figure 5.

Table 3: Research and Compilation Needs for Yukon Mineral Deposits and Districts (numbers and shades indicate priority 1= low, 11=medium, 111=high)

	Brewery Creek Au Deposit, Camp	MacPass SEDEX	Wheaton R IRGS and Epithermal Au	Hyland IRGS	Hart River VMS	Klondike Orogenic Au	Dawson Range Porphyry
Field-based study	11		11	111	1	1	1
Compilation/Generative	111	11	111	111	111	11	11
Archival	111	1	11		1	11	

	Keno Ag Polymetallic veins	McQuesten IRGS	Ketza IRGS	Pelly Mtns VMS	Lucky Joe IOCG?	Rancheria Manto	Kluane Magmatic Ni, Cu PGE
Field-based study	1	11	1	11	11	1	1
Compilation/Generative	11	11	11	111	111	111	111
Archival	111		111			1	111

	Minto - Williams Ck Porphyry Cu-Au	Nansen epithermal	WCB Porphyry /skarn Cu-Au	Finlayson VMS	Rusty Springs Ag Au Prospect	Sa Dena Hes Ag-Zn-Pb Manto	Clear Lake SEDEX Deposit
Field-based study	11	1	1	1	111	1	1
Compilation/Generative	11	1	1	11	1	1	1
Archival		111	11			11	1

SEDEX (Sedimentary Exhalative); IRGS (Intrusive Related Gold Systems); VMS (Volcanogenic Massive Sulphide); IOCG (Iron-oxide Copper Gold)
1=low piority; 11= medium priority; 111= high priority

Archival reports should be done by or with assistance from an expert contractor. Prioritizing archival studies should be done according to opportunity. If the data and an expert are available, the support required to make it happen should be mobilized. Once those opportunities are lost, they may never become available again.

Province-Scale Metallogenic Summaries

Yukon- or province-wide compilations and summaries done with limited fieldwork are the most effective means of providing clients with essential information and come in a variety of formats. In Yukon these include deposit- or commodity-based "placemats", web-based metallogenic summaries, and Bulletins. One of the most useful formats in the Yukon has proven to be the "placemat" in which essential elements of the metallogeny of a geological region or deposit type are presented in poster and 11"x17" format. These products have the advantage of being inexpensive and easy to produce, reproduce and distribute. Web-based summaries for Sedimentary-Exhalitive (SEDEX) deposits in Selwyn Basin and for magmatic nickel-copper deposits in the Kluane Ranges have been developed by YGS. These summaries provide more detailed information than placemats, but are not written with the rigor of a Bulletin. They have the advantage of being linked to geological maps, MINFILE, mineral claims and other data on the YGS interactive map server, and are one of the most popular products on the YGS website. Traditional Bulletins like "Volcanic-associated massive sulphide

(VMS) mineralization in the Yukon Tanana Terrane and coeval strata of the North American miogeocline, in the Yukon and adjacent areas" by J.A. Hunt generally involve more original fieldwork than other products and are more rigorous, comprehensive and definitive. They become long-lasting references, but have the disadvantage of requiring significant time and effort to write and are expensive to reproduce. All of these types of products should be developed as resources allow and levels of information warrant. Presentation of information in one format should not preclude presenting similar information in another format. Metallogenic summaries can capture certain deposit models, certain commodities or geological regions. Prioritizing could depend on availability of expert knowledge or commodity and/or deposit-type desirability.

Deposit Model Summaries

High

- Iron-oxide Copper, Gold (IOCG)
- Intrsuive-related Gold systems (IRGS)
- Orogenic Au
- Alkalic Au
- Mississippi Valley Type (MVT)
- "Blende-Type" Ag/Pb
- Mantos

Med-Low

- Porphyry Cu-Au-Mo
- Sedimentary Exhalative (SEDEX)
- Volcanogenic Massive Sulphide (VMS)
- Epithermal
- Nick
- Cu-Au Skarns
- Sedimentary Fe

Commodity Summaries

High

- Gold
- Copper
- Lead-Zinc
- PGE
- Tungsten
- Uranium

Med-Low

- Gemstones
- Silver
- Tin
- Jade
- Asbestos
- Coal

Geological Element Summaries

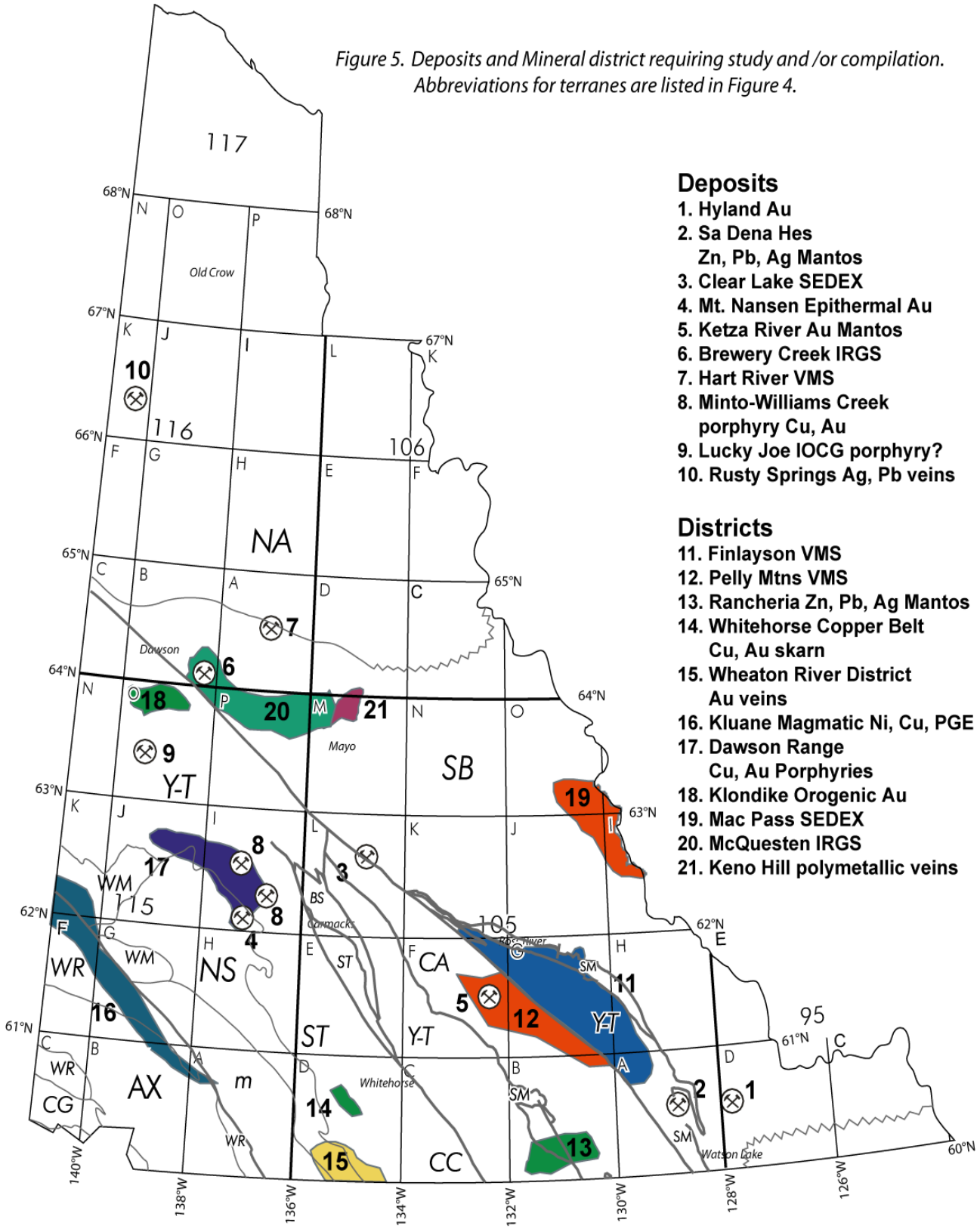
High

- Proterozoic inliers
- Cretaceous intrusive suites

Med-Low

- Yukon-Tanana Terrane (Use Julie Hunt bulletin as a basis)
- Revise Selwyn Basin
- Pelly-Cassiar Platform
- Eocene magmatic suite (Grew Creek/Skukum/Cassiar)

Figure 5. Deposits and Mineral district requiring study and /or compilation. Abbreviations for terranes are listed in Figure 4.



Deposits

1. Hyland Au
2. Sa Dena Hes
   Zn, Pb, Ag Mantos
3. Clear Lake SEDEX
4. Mt. Nansen Epithermal Au
5. Ketza River Au Mantos
6. Brewery Creek IRGS
7. Hart River VMS
8. Minto-Williams Creek
   porphyry Cu, Au
9. Lucky Joe IOCG porphyry?
10. Rusty Springs Ag, Pb veins

Districts

11. Finlayson VMS
12. Pelly Mtns VMS
13. Rancheria Zn, Pb, Ag Mantos
14. Whitehorse Copper Belt
    Cu, Au skarn
15. Wheaton River District
    Au veins
16. Kluane Magmatic Ni, Cu, PGE
17. Dawson Range
    Cu, Au Porphyries
18. Klondike Orogenic Au
19. Mac Pass SEDEX
20. McQuesten IRGS
21. Keno Hill polymetallic veins

Yukon Energy, Mines and Resources

Yukon Geological Survey

GSC Data
The GSC is the custodian of many collections of rocks, minerals and samples collected in Yukon. Some of these collections such as stream sediment and heavy mineral samples may still be useful. A list of archival sample materials stored with the GSC should be developed and the status and future of these collections determined. They could potentially be stored in Yukon if necessary.

H.S. Bostock Core Library
The H.S. Bostock Core library has benefited from extensive renovations over the last few years and is now fairly well equipped and functional for the foreseeable future. Maintenance at current levels is appropriate. Recent core acquisition has been minimal and primarily through donation. Companies should be encouraged to contribute representative holes from their properties. Opportunities to acquire core that is in danger, but of high value and easily accessible should be proactively pursued. Space is limited and core should be carefully selected. Cantung and Mactung are examples of key mineral deposits which currently lack representation. Companies could be encouraged to store core in the bush according to a generally accepted standard and to provide GPS locations in assessment reports.

The core library database is functional but remains rudimentary. It should be developed to include cross references to other information such as assessment reports and MINFILE. The database should be made available online as part of the YGS Map Gallery so that core is availability can be viewed geographically.

Proactive studies of existing core are also possible. Greater utilization of core for stand alone studies or for part of more extensive work should be encouraged by identifying potential within the collection for further study, e.g., analyses for new elements.

MINERAL ASSESSMENTS

Regional mineral assessments are now essentially complete for most of Yukon with the exception of North Yukon. These assessments were undertaken over the past five years in response to the Yukon Protected Areas Strategy, and for the identification of regions of high mineral potential for Land Claims negotiations. At the same time more detailed assessments were completed for areas selected for withdrawal from staking under these processes. These areas include Tombstone, Fishing Branch, and Asi Keyi Territorial Parks, Ddhaw Ghro and other Special Management Areas and a number of relatively small Habitat Protection Areas (Fig. 6). At the present time, no parks planning processes are underway and most land claims have been settled, but land use planning initiatives are in progress as a requirement of the Council for Yukon First Nations Umbrella Final Agreement. These processes are being supported by the YGS through compilation, collection and interpretation of data related to mineral deposits for use in regional and detailed mineral potential assessments.

Regional mineral assessments use a systematic, formal process that is semi-quantitative, reproducible, and objective. The results are presented as a map of tracts that have been assigned broad levels of mineral potential (e.g., high, medium and low). Mineral potential is considered to be the possible, ultimate mineral endowment of a tract of land. This process has many advantages over alternatives, but has had limited effectiveness within land use planning processes. The main drawback is that the results are too abstract to support the decisions required of planners. The mineral assessment process should produce results that are more immediate and relevant to the needs of land use planners. For example, results might be presented in terms of immediate, medium and long term consequences of withdrawing a tract of land. Immediate impact might include loss of foreseeable exploration expenditures. Medium term impact might include probable loss of discovery of a specific mineral resource. Long term impact might include possible loss of one or more operating mines with measurable economic benefits.

There are opportunities for the broader application of mineral assessment data. Most First Nations have settled their land claim and are now in the implementation phase. Resource assessments can be a valuable tool to help them acquire the capacity and knowledge to manage their lands and take advantage of the economic opportunities those mineral resources may provide. In order to be effective, the Yukon Geological Survey must develop close relationships with First Nations. The mineral assessment process can also benefit the exploration sector through mineral deposits-related compilation and research projects. The products produced during mineral assessments, where practical, could be modified to contribute to mineral deposit-related studies that target clients in the mineral exploration industry while continuing to fulfill their primary purpose of support for land-use planning. Baseline data (e.g., regional geochemical surveys), in particular, that are collected under the auspices of regional mineral assessments will ultimately benefit the exploration sector.

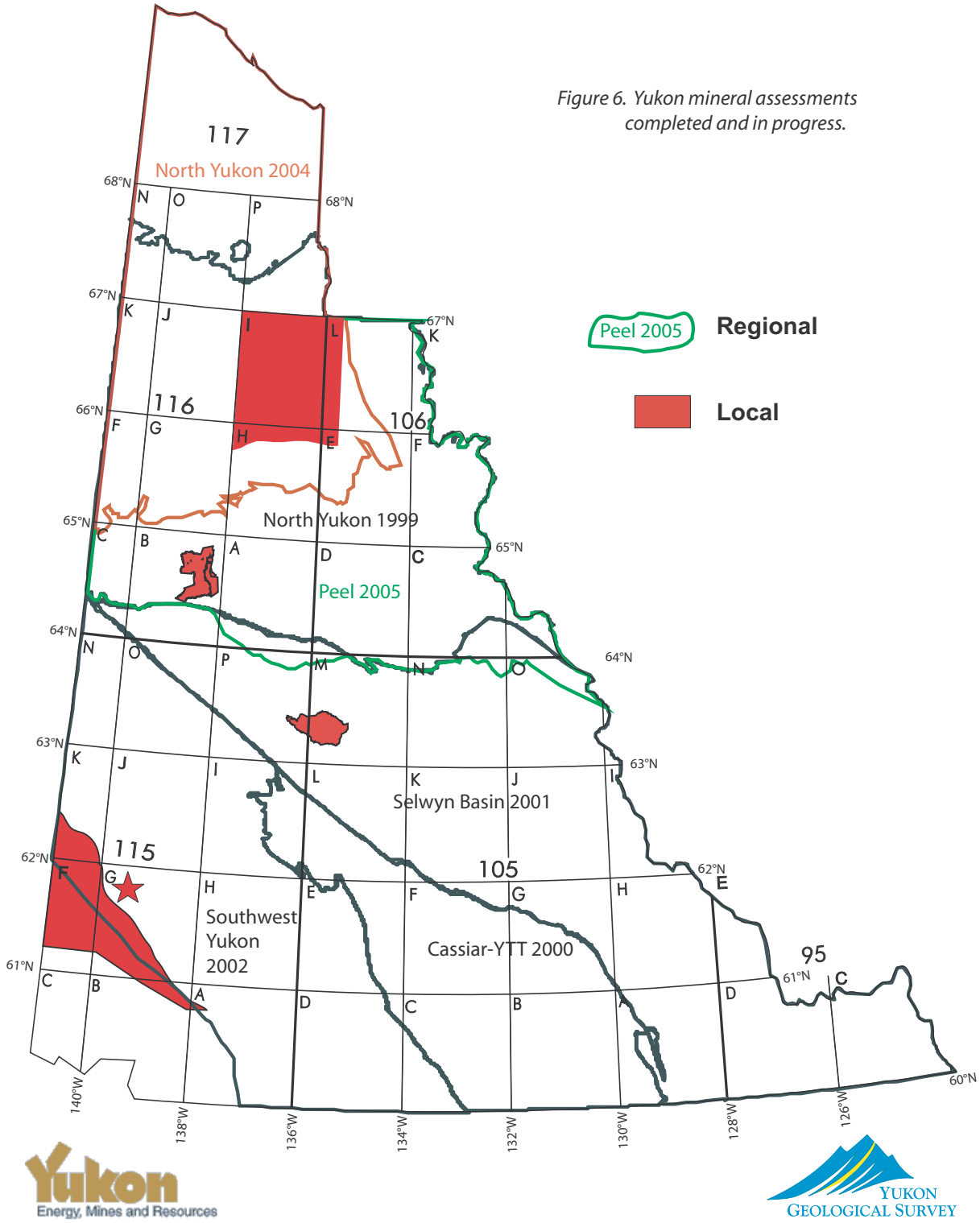


Figure 6. Yukon mineral assessments completed and in progress.

Yukon Energy, Mines and Resources

Yukon Geological Survey

REGIONAL GEOCHEMICAL AND GEOPHYSICAL SURVEYS

Introduction

Some of the most successful catalysts for new mineral discoveries over the past 20 years have been systematic regional geochemical and geophysical surveys undertaken as partnerships between the Federal and Territorial governments. These include stream and till geochemistry, and airborne magnetic and multiparameter surveys. Not only have they proven their worth through the direct discovery of mineral occurrences, but also as mapping tools (geophysics) in poorly exposed areas, as valuable sources of information for resource assessments (all surveys), and as baseline data (geochemical surveys) for environmental studies, regulation and monitoring.

For this exercise, data gaps have been identified and the notions of collecting more detailed data and conducting additional analysis of existing data, and providing interpretive evaluations of new and existing data explored.

Aeromagnetic Surveys

Regional aeromagnetic surveys provide fundamental information that is essential to our understanding of the Canadian landmass, but large areas of the Yukon still lack coverage. These gaps should be filled as a first priority (Fig. 7). One exception may be southwest Yukon in Kluane Park where no economic benefit can be expected from such surveys. Priorities include the following:

- Wernecke Mackenzie Mountains region
- Nahanni map area
- Flat River map area

Large parts of the Yukon have only been flown at 2000-m line spacing rather than the 800-m spacing required for adequate resolution of surface features. Those areas with significant economic potential should be reflown at the more detailed scale. These include;

- Mayo map area in Selwyn Basin
- Large areas north of 65°N latitude with significant petroleum potential.

Multiparameter Surveys

Multiparameter surveys that gather magnetic, VLF-EM and gamma-ray data have been flown over a few selected areas in Yukon with known high mineral potential (Fig. 7). These surveys are flown at a much lower elevation and closer line spacing that regional aeromagnetic surveys. They generally require a helicopter rather than fixed wing aircraft and are significantly more expensive than regional aeromagnetic surveys. The level of detail and greater variety of data collected, however, makes them much more useful as both a mapping and prospecting tool. The following areas have been identified as a priority.

- Wernecke Mountains - The area has high mineral potential for iron-oxide-copper-gold (IOCG) deposits (Wernecke Breccias), and detailed multiparameter surveys in selected areas of high mineral potential could result in significant interest by industry. These would be done after regional aeromagnetic surveys of the area are completed.
- YTT northeast of Tintina Fault +EM - A multiparameter survey was flown over parts of 105G/2,7,8 in 1997. Geologic mapping has identified additional areas with high mineral potential. Expanding the survey to cover more of YTT in the Finlayson district could identify additional areas of high potential and refine targets in areas of known potential.

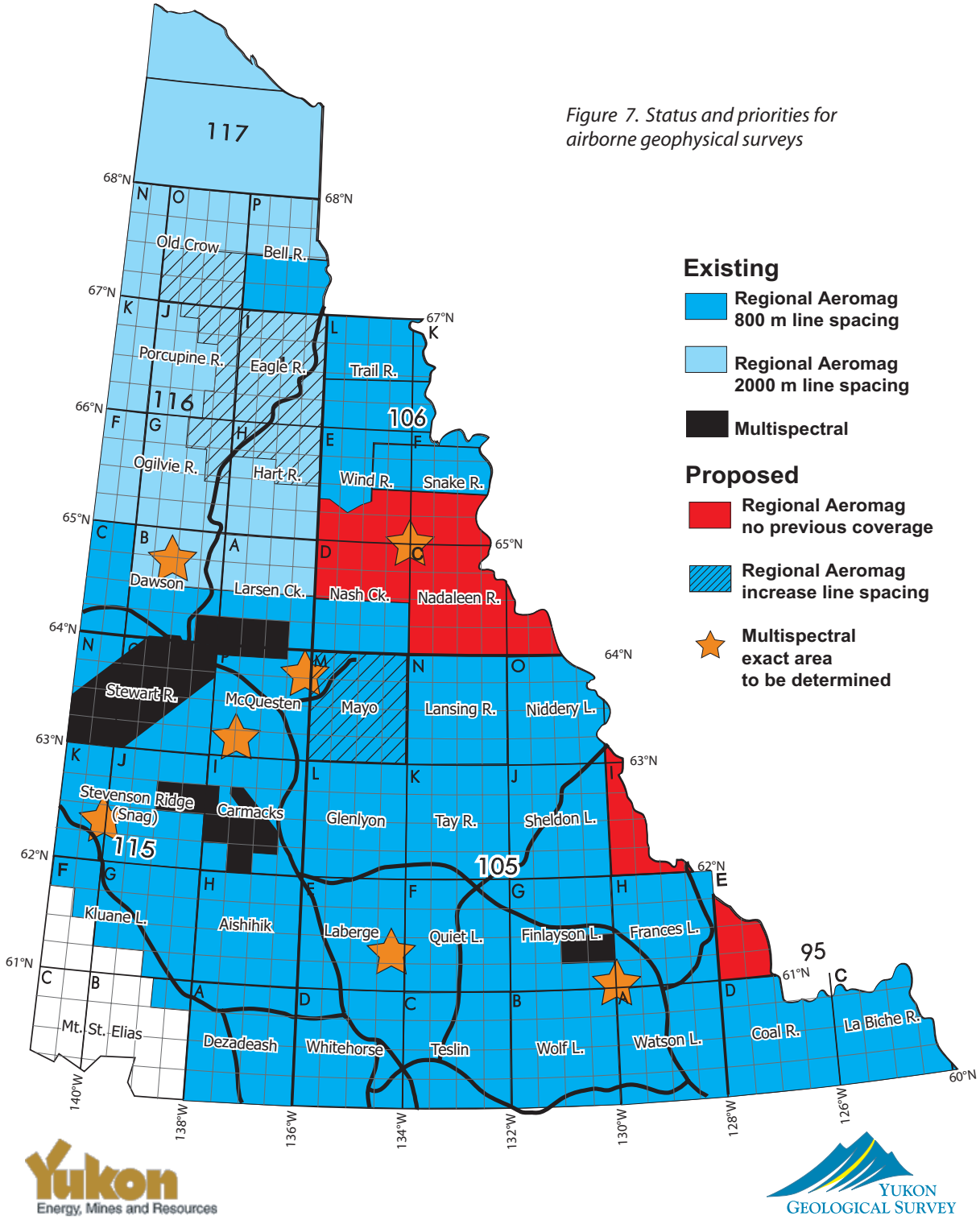


Figure 7. Status and priorities for airborne geophysical surveys

Yukon Energy, Mines and Resources

Yukon Geological Survey

- YTT in Livingstone area - Recent mapping in the area has highlighted the potential for VMS and porphyry potential in this under-explored district.
- northern Mayo-McQuesten belt - Intrusive related gold in poorly exposed areas.
- Coal Creek Inlier - high potential for IOCG (Wernecke Breccia) targets.
- southwestern Snag map area (115) -VMS potential in Windy McKinley Terrane - poorly exposed, little known; geophysical survey required to map the area.

Existing surveys still lack interpretation and remain underutilized by industry. Effort should be made to provide analysis and interpretation of existing surveys to encourage their use. Resources for interpretation should be made available as part of the original survey budget.

In recent years several large multiparameter surveys have been flown by the private sector. The possibility of acquiring this data and making it public should be investigated.

Regional Stream Geochemical Surveys

Regional stream geochemical surveys (RGS) conducted over the past 25 years by the Geological Survey of Canada, in partnership with the Government of Yukon and DIAND have arguably provided the greatest stimulus to mineral discovery in the Territory during that time. Recently, RGS data have become an essential tool for mineral assessments and have been used extensively for environmental purposes by providing documentation of natural sources of anomalous metal concentrations such as mercury, zinc and cadmium. RGS surveys now cover most of the Yukon (Fig. 8). Remaining areas generally have lower mineral potential than those previously covered, but given their effectiveness, as outlined above, stream sediment surveys should be completed for all of the Yukon outside of major parks.

In recent years, analytical techniques have improved dramatically, and more accurate analysis of a much greater number of elements is now possible. A review should be undertaken of existing RGS data to identify areas where reanalysis would be beneficial.

Orientation/Case Studies

Orientation and case study surveys are useful in providing data about background, threshold, size fractions etc… over known deposit types. However, these surveys are expensive and person-power intensive and are therefore not highly recommended except in situations with extensive company support and researcher/graduate student involvement. Student involvement is cost-effective and working on a specific deposit avoids the apparent conflict of government providing beneficial information for the use of a single company.

Suggested studies include:

- Stream sediments and fine-fraction gold characterization, as indicated in the Marsh Lake report;
- Heavy mineral concentrate studies as indicated in Marsh Lake report. Establish guidelines for sampling and analysis, compile existing data, set up database;
- Placer-Lode source studies
- Enzyme Leach, Mobile Metal Ion (MMI)
- Water surveys
- Biogeochemistry
- Lithogeochemistry is supported but only with collaborative studies, not as a stand alone study.

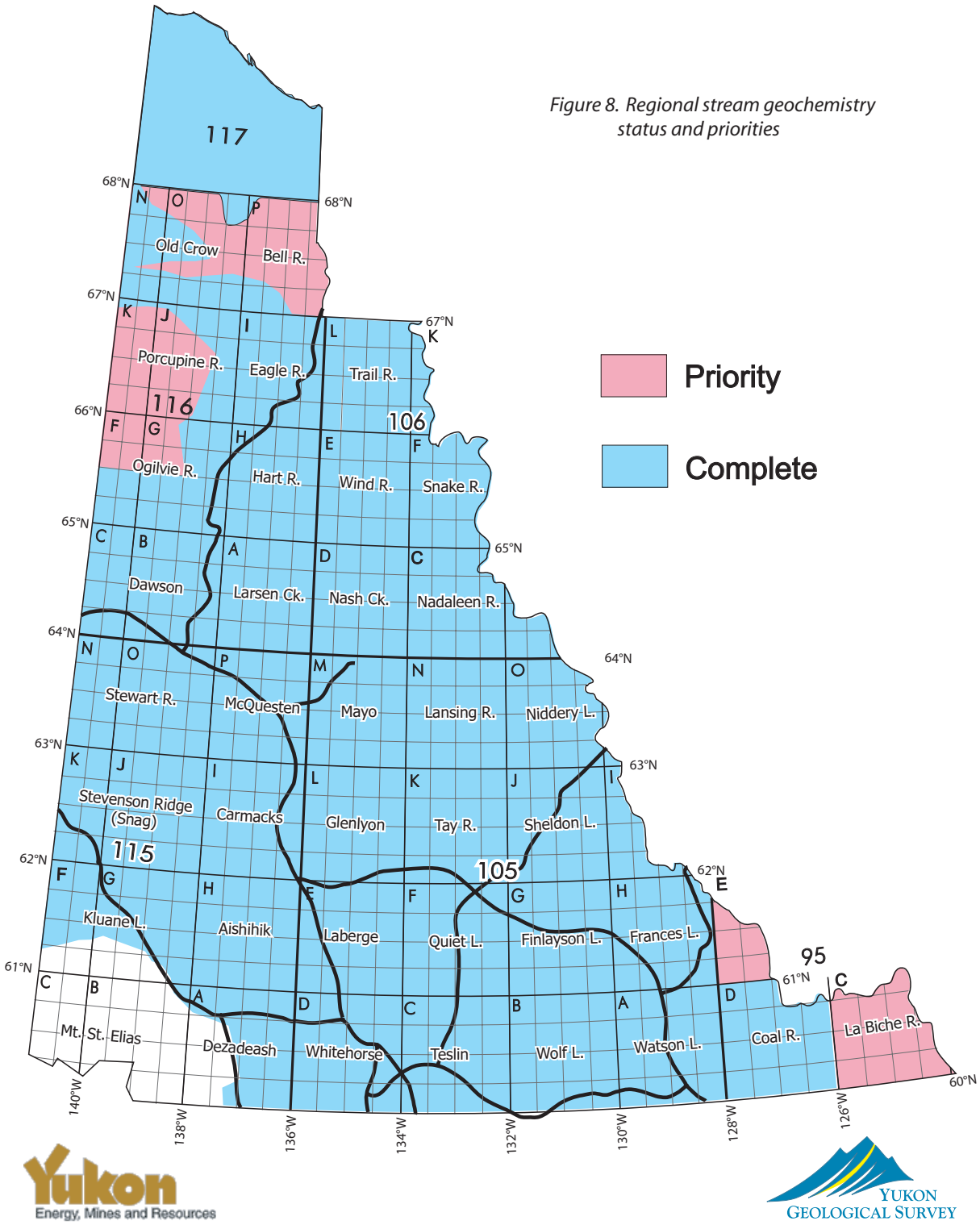


Figure 8. Regional stream geochemistry status and priorities

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Yukon Geological Survey

All geochemical data releases should be supported with an associated interpretive report. Ideally a short course dealing with the process, data and interpretations should be given in conjunction with the Yukon Geoscience Forum to promote the results and explain the applicability to client groups - particularly when new technology is involved.

Higher density silt sampling may also be desirable in areas with high mineral potential. Higher density silt sampling within existing surveys has not been the purview of government to date. These types of surveys have been conducted by industry in the past and have been an extremely effective tool. With the changes in the industry in the last decade we have seen a lack of this type of survey. Government may want to reconsider collecting this type of data. Further work is needed to determine what density is most effective and what areas would most benefit. Regions for potential targeted analysis could include:

- Yukon Tanana Terrane northeast of the Tintina Fault
    - area of high mineral potential for VMS, coloured gemstones and gold.
- Pelly Mountains
    - area of high mineral potential for VMS, gemstones and gold.
- Wheaton River – area of high mineral potential for gold.
- Werneckes – area of high mineral potential for IOCG, SEDEX.
- Selwyn Basin - SEDEX potential stratigraphy
- Taiga basin – Nick-type potential, gemstones

Till Geochemistry

A till geochemistry program covering the Anvil Range, Finlayson District and Glenlyon area was completed between 1998 and 2002. Additional areas of Yukon that are suitable for regional till geochemistry surveys were identified from regional DEM coverage. Seven potential till geochemistry project areas have been identified (Figure 9) using the presence of streamlined glacial landforms to highlight areas of extensive till cover. Surveys should be combined with surficial studies to assist with interpretation. The potential survey areas were prioritized according to their mineral potential and commodities of interest as outlined below.

1. Upper Stewart River: three drift covered areas (Fraser Falls, Mayo Lake and Lansing) are in an area of diverse mineral potential in Selwyn Basin that includes intrusive-hosted gold, sedimentary exhalative (SEDEX) and epigenetic base metal deposits.
2. Tay-Frances rivers: four drift covered areas were grouped into this region in Selwyn Basin and include the Ross lowland, Tay River valley and Macmillan River valley, and the Frances Lake valley. The potential mineral deposits in this area are similar as those outlined for the Upper Stewart.
3. Big Salmon Lake: This relatively small area of Yukon-Tanana Terrane has volcanogenic massive sulphide (VMS) and epithermal gold potential.
4. Wolf Lake: This large portion of the Cassiar Platform has potential for epigenetic base metals, intrusive-hosted gold and VMS deposits.
5. Nordenskiold River: This small area south of Carmacks has unexplained platinum potential.
6. Liard River: This large area in southeast Yukon may have gem potential and epigenetic base metal, porphyry, and VMS deposit potential.
7. Claire Lake: This portion of Whitehorse Trough has limited porphyry potential .

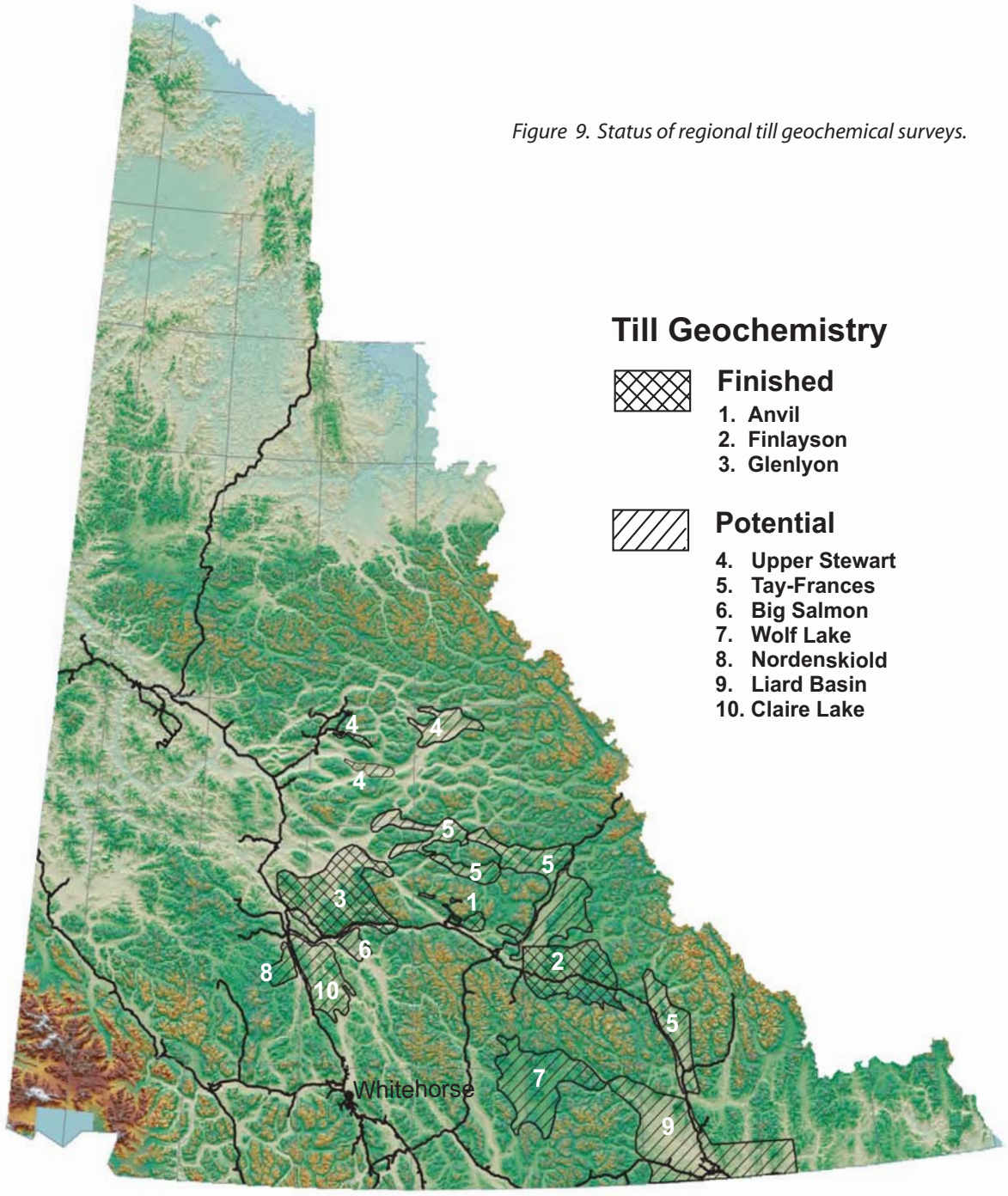

Figure 9. Status of regional till geochemical surveys.

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Heavy Mineral Sampling
Heavy mineral sampling is recognized as an effective regional geochemical tool but, other than a few directed studies, has not been applied systematically in Yukon. Government may want to consider expanding these surveys beyond the directed studies.

- Review Alaskan/USGS techniques for procedures
- Acquire heavy mineral samples archived from previous studies.
    - high priority. Easy to obtain, potential loss of data if no follow-up studies.
- Directed studies in non-typical areas for diamond exploration.
    - Rumours of diamonds in Yukon and adjacent areas raises the question whether diamond occurrences in southeastern Alaska, southwestern Yukon and northwestern British Columbia are sourced in ophiolites or in high pressure-low temperature metamorphic rocks (blueschists and eclogites) in accretionary margins associated with ophiolites.
    - Potential areas include:
        - Dawson
        - Fiftymile
        - Sixty Mile
        - unglaciated Stewart River area

- Encourage sampling to be part of placer deposit documentation.

- The potential for low-grade bulk-tonnage **Tertiary placer mineral deposits** needs to be addressed. The Indian River White Channel bench deposits are a model for other prospective areas in targeting minerals such as cassiterite, rutile, illmenite and gemstones. These areas include, Fortymile River, Sixty Mile River, Clear Creek and Tintina Trench as examples. A well-developed sampling methodology is critical (i.e., year 1) to ensure capture of appropriate fractions (light heavy). Regional sampling and mapping (year 2) and focused sampling (year 3) would follow.

- A formalized **heavy mineral study** targeting the range of heavy mineral concentrates from placer mines is recommended to address the gem and light-heavy mineral potential of hardrock sources within the drainage. An important component of this study will involve communicating with placer miners the importance of capturing and saving light-heavy fractions. Larger concentrate samples would be useful. Processing and mineral I.D. would occur at accredited labs.

SUBSURFACE GEOLOGY / ENERGY / HYDROCARBONS

Introduction

This section describes priorities related to sedimentary basins with primary economic interests being oil, gas, and coal. In previous planning meetings these priorities were presented as a soft-rock perspective. There is some overlap between this section and those on bedrock mapping, regional surveys and surficial geology, but the priorities defined in those sections are consistent with those recommended here.

Yukon has eight sedimentary basins with oil and gas potential (Fig. 10). To date only Liard Plateau in southeast Yukon has had production (gas). Geological mapping in these areas has been completed largely by the Geological Survey of Canada (Calgary) at regional scales. Resource assessments of the different areas have been completed by the Geological Survey of Canada (Calgary) or National Energy Board.

Management of oil and gas resources was transferred to Yukon Territory in 1998. Yukon initiatives after the transfer have been dominated by updating and establishing a regulatory regime for oil and gas exploration and production that is administered by the Oil and Gas Management Branch (OGMB). Recent industry interest in a Mackenzie Valley pipeline has renewed interest in oil and gas exploration and possible development of sedimentary basins in northeastern Yukon. Active dispositions for oil and gas exploration are located in Eagle Plains, Peel Plateau, and Liard Plateau.

Coal resources within Yukon are largely undeveloped. Some mining of coal for specialized and local purposes has occurred near Ross River, Carmacks, and Dawson City. Summaries of coal resources were last published in the 1980's and early 1990's. Coal bed methane potential has only recently been of interest. Yukon government has not finalized the regulatory regime for development of coal bed methane resources. Management of coal resources was transferred to Yukon Territory in 2003.

Lack of capacity and expertise to undertake hydrocarbon studies is the major challenge facing both the YGS and GSC. Demand for geologists within the private sector has outstripped supply and salaries offered by government agencies are too low to attract skilled, experienced people. The ability to deliver government geoscience could be severely compromised by this issue.

Encompassing Vision

Sedimentary basins in Yukon are underexplored for oil, gas, and coal resources. Yukon Geological Survey (YGS) can create a positive investment climate for exploration and production by publishing and updating geological information for the areas of interest. Geology data should be systematically stored in databases which are freely available for inspection and downloading from the YGS website.

Resource assessments of Yukon's sedimentary basins are essential for the successful promotion and management of Yukon's hydrocarbon resources. Assessments for oil, gas and coal should be updated regularly as new geological information becomes available both in terms of applicable geologic models and more detailed geology generated through detailed research studies. The resource assessments and underlying geological compilations should be available for review and download from the YGS website.

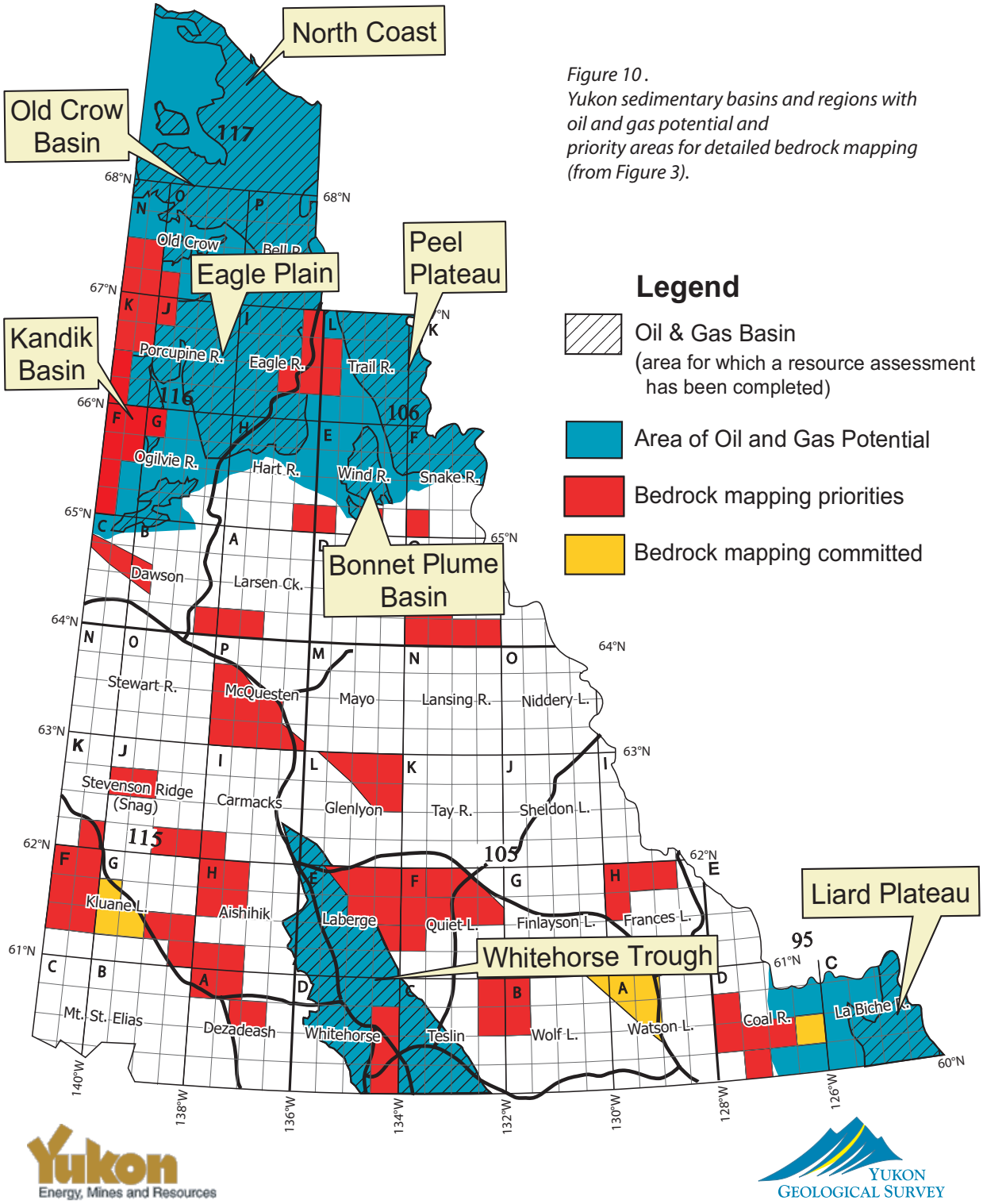

Figure 10 .
Yukon sedimentary basins and regions with oil and gas potential and priority areas for detailed bedrock mapping (from Figure 3).

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YUKON GEOLOGICAL SURVEY

Sedimentary basin analysis is an essential compilation tool necessary for the undertaking of resource assessments. Field studies should be designed with this objective in mind.

Other baseline information (regional airborne geophysics, regional gravity, RGS sampling programs) provides important information for exploration, development, and environmental concerns. Surficial geology provides important information concerning permafrost extents, slope stability, construction aggregate, terrain hazards, groundwater, and climate change for infrastructure development.

Priorities

Gap analysis
A concerted effort to obtain and compile all available oil and gas well data (well logs, wireline surveys, test results fluid analyses), seismic records, coal occurrences, sedimentary, stratigraphic, organic geochemistry/thermal maturation, bedrock geology, core, paleontology, geochronology, geophysical, surficial geology and permafrost data is needed for each of the identified sedimentary basins. In some cases early assessment reports have been lost. Compilation efforts should focus on data rather than interpretations which tend to quickly become outdated. Regional gaps in our geology information databases need to be identified. Research programs to infill the data gaps for these areas can then be proposed.

Geology Information Databases
The geology databases identified through the above analysis need to be managed to ensure that they are in appropriate formats and are accessible to YGS geologists, regulators, industry and the general public. The information must fit within the current database system of YGS and the PPD model used by the Oil, Gas and Minerals Branch to allow for integration with other datasets. Provision must be made to provide regular updating of the databases as new information is generated. YGS and GSC should closely coordinate database development and maintenance activities. For example, a database of consistent, mutually agreed upon stratigraphic picks for all Yukon wells could be developed through an arrangement similar to that currently in place between the C.S. Lord Geoscience Center in Yellowknife and GSC Calgary.

Field projects
Priorities of bedrock mapping, surficial studies and other geoscience projects should be influenced in part by their relevance to understanding the petroleum and coal potential of an area and proximity to gas pipeline development. Most sedimentary basins in Yukon are poorly exposed, and priorization of projects should also take into account the amount of data (rock exposure) that might be available. The northern Richardson Mountains and the Kandik Basin are well exposed areas and given high priority for bedrock mapping.

Resource assessment studies rely heavily on interpretive geology models for depositional environments (paleogeography) and subsequent creation of additional oil and gas reservoir traps through deformation. The validity of resource assessments in northern Yukon is limited by lack of detailed knowledge of hydrocarbon systems. Paleogeography and facies belts are reasonably well understood for Jurassic and Cretaceous-Tertiary systems and also for most platformal parts of the Paleozoic, but not for Proterozoic strata in particular, locally, late Paleozoic platformal facies and most offshelf Paleozoic facies. Field studies need to include research to: better identify and characterize source rock intervals including source rock quality (rock-eval) and maturation (vitrinite reflectance etc.); and identify and better characterize known and potential reservoirs. Detailed studies

of structure, sedimentology stratigraphy, and sequence stratigraphy in and around the sedimentary basins will greatly improve our understanding of paleogeography which will have an effect on the validity of the resource assessments.

The determination of terrain hazards, slope stability, climate change, permafrost extents, groundwater and industrial mineral resources greatly impacts oil and gas exploration and development. The priorities of both subsurface geology and surficial geoscience should be coordinated, although this is not everywhere possible. The southern Eagle Plains (116I/1-4; 116H/13-16; 116G/16; 116K/1) and Peel Plateau (106E/9-16; 106F/9-16) areas are given priority for mapping and study because they coincide with areas with the most potential for exploration and development in the near future.

Consequently, mapping projects in areas close to sedimentary basins should be multidisciplinary, with cooperative bedrock geology mapping, topical studies, surficial geology mapping, and permafrost studies being incorporated into the projects. The need to integrate detailed stratigraphic studies with regional mapping is of particular importance.

Energy Resource Modelling

Effort will be made to research and determine appropriate models and analogues for Yukon oil and gas occurrences. These are used directly in the assessment of petroleum potential. To date, most of the analogues that have been used are from the Western Canada Sedimentary Basin. There is a crucial lack of knowledge of other, especially intermontane models that can be applied in many of the Yukon sedimentary basins.

Regional Baseline Surveys

Structural components of subsurface geology are commonly only detectable through geophysics. This is particularly true in sedimentary basins. The acquisition of aeromagnetic and gravity geophysical data over oil and gas regions at a baseline level should be completed.

Existing industry seismic data is available through third party vendors. Reprocessing can greatly enhance the usefulness of many older surveys and they remain an underutilized resource from which much valuable information can be gleaned.

Baseline data concerning soil, stream, and water geochemistry is important for all areas of the Yukon. Data for areas encompassing sedimentary basins are especially important if future resource development is to be responsibly encouraged.

Regional sampling of soils for hydrocarbon microseeps is an exciting new tool for hydrocarbon exploration. A research project testing the potential of this exploration method in northern climates should be initiated in Yukon.

Outreach

First Nations and communities are a priority for the development of capacity with respect to oil, gas, and coal since the may have limited geoscience capabilities. First Nations desire to become more actively involved in geoscience planning within their traditional territories so that their issues or concerns can be addressed or answered. For example, petroleum assessment on settlement lands may be coordinated with other Yukon geoscience research. This outreach work can also be coordinated with surficial geology studies, especially terrain hazards and climate change.

Accessibility to geoscientific data, resource assessments and other reference material (e.g., stratigraphic correlation chart) is key to encouraging industry to invest in oil and gas exploration and development. Promotion of the Yukon's resources by presenting hydrocarbon geoscience at conferences, attending industry meetings and publishing reports, posters, journal articles, etc. where appropriate (including the web) is vital in the growth of the industry in Yukon.

First Steps

1) Regional aeromagnetic, gravity, and stream sediment geochemical surveys should be completed over remaining areas of Yukon.

2) Gap analysis and identification of geodatabase requirements should be initiated within Yukon sedimentary basins. Keeping in mind the potential Mackenzie Valley pipeline development, an ongoing GSC research project in Eagle Plains, and YGS research projects in Whitehorse Trough, priority should be given to data assessment and database updates for Eagle Plains, Peel Plateau, and Whitehorse Trough.

3) Identification of geodatabase needs should be completed for Liard Plateau area. The recent Central Forelands NATMAP project has added extensive geological information to this area. As Yukon's sole hydrocarbon-producing sedimentary basin, consolidation of the geology information for this economically important area should also be a priority to encourage responsible exploration and development.

4) Multidisciplinary research projects involving bedrock geology mapping, detailed stratigraphic studies, and surficial geology studies (including permafrost and landscape stability) should be encouraged within and adjacent to sedimentary basins to enhance the energy geodatabases.

5) Opportunities for community outreach should be encouraged.

SURFICIAL GEOLOGY, PLACER, AND GEOLOGICAL HAZARDS

Introduction

Since the last planning meeting in 1999, there has been a greater recognition of the value and need for surficial geology to address a variety of issues. Prior to 1999, surficial studies in the Yukon were largely limited to topical studies to determine placer potential by the YGS and regional baseline mapping by the GSC. Since then, other applications that have emerged include till geochemical surveys, the need to understand the impact of climate change (landslides and permafrost melting) on infrastructure development, and land management issues such as water quality related to placer mining, salmon habitat, groundwater, radon and aggregate supply. Future issues likely include the need for comprehensive baseline data for large scale infrastructure projects such as the Alaska Highway Pipeline. The increase in diversity of YGS clients has been in part, a naturally evolving process through collaboration, but as well, through a conscious effort to establish a broader presence for the YGS with the Yukon public.

Surficial mapping priorities recommended at the 1999 planning meeting were largely abandoned within the YGS with the inception of the Targeted Geoscience Initiatives in Finlayson Lake and Glenlyon areas. In order to capitalize on this funding, regional till geochemistry was completed (2000-2002) to complement an "accelerated" bedrock mapping initiative. Mapping priorities were again addressed with the initiation of a Whitehorse area compilation map in 2003 and are ongoing in 2004. Completion of 1:100 000-scale mapping for the Stewart River and La Biche River areas by the GSC marked the most significant advances in surficial mapping coverage since 1999. Detailed surficial mapping by YGS was completed for the Anvil District 105K (1:20 000) and Weasel Lake 105G/13 (1:50 000) between 1998 and 2000. Currently, surficial mapping is underway in Watson Lake (105A/2), as part of a multidisciplinary biophysical mapping program to support development of a forest management plan.

Proposed mapping and topical projects for the next 5-10 year period are outlined below and shown on Figure 11. They encompass a wide range of physiographic regions, client groups and data gaps, and are grouped according to their anticipated primary client group. As in the bedrock planning component, no priority ranking is given.

Compilation/Database Development

Unlike most other geological datasets, surficial geological maps in the Yukon have not yet been converted to digital format. With increased demand for both surficial maps and digital data, it is recommended that a project to compile and digitize the surficial geology of the Yukon be given highest priority. Given that most of this data was originally generated by the GSC, the project should be undertaken cooperatively between them and YGS. National standards for data model, terminology etc. should be utilized. Given the scope and size of this project, areas with the greatest demand should be digitized first. These include the Alaska Highway infrastructure corridor, southeast Yukon, and communities.

Oil and Gas

North Yukon

With initiation of the Mackenzie Valley Pipeline Project, oil and gas basins in North Yukon are likely to receive greater exploration attention in coming years. Land-use permits for seismic surveys may increase and demands for greater seasonal flexibility to conduct land-based work may also increase. To adequately assess these applications, better knowledge is required of the response of

vegetation, permafrost and surficial materials to various land-based activities. Regional surficial maps are absent for most of the North Yukon which represent a large data gap for this region. With the exception of 116L/6, 11 1:250 000-scale map areas have no surficial geology data. The following initiatives are proposed to address these issues.

- The southern Eagle Plains area (116I/1-4; 116H/13-16; 116G/16; 116K/1) is an area of hydrocarbon potential in unglaciated terrain, and includes oil and gas dispositions 1, 2 and 3. This area would benefit from 1:50 000-scale mapping.
- Peel Plateau area (106E/9-16; 106F/9-16) is also an area of hydrocarbon potential within Laurentide glaciated terrain. Oil and gas disposition number 4 lies within this area. 1:50 000-scale mapping is recommended.
- Tundra travel study
- Post-fire permafrost subsidence and slope stability studies (initiated in Dawson area).

Note: The North Yukon surficial geology projects encompass large unmapped areas. Phase 1 mapping should target representative 1:50 000-scale map sheets from both areas. See Figure 11.

Mineral Exploration

Surficial Mapping

The largest gap in the surficial mapping data-set for central and southern Yukon is in the Snag map area (115J/1-13). The 1999 Whitehorse workshop identified Snag map area as a top priority due to its placer potential, Quaternary geology (multiple glacial limits) and surficial stratigraphy. In order to connect the surficial geology between Stewart River (115N/O) and Carmacks (115I), completion of the Snag sheets is once again recommended.

- Snag (115J/1-13), surficial mapping and late Cenozoic history (Figure 11).

Quaternary history

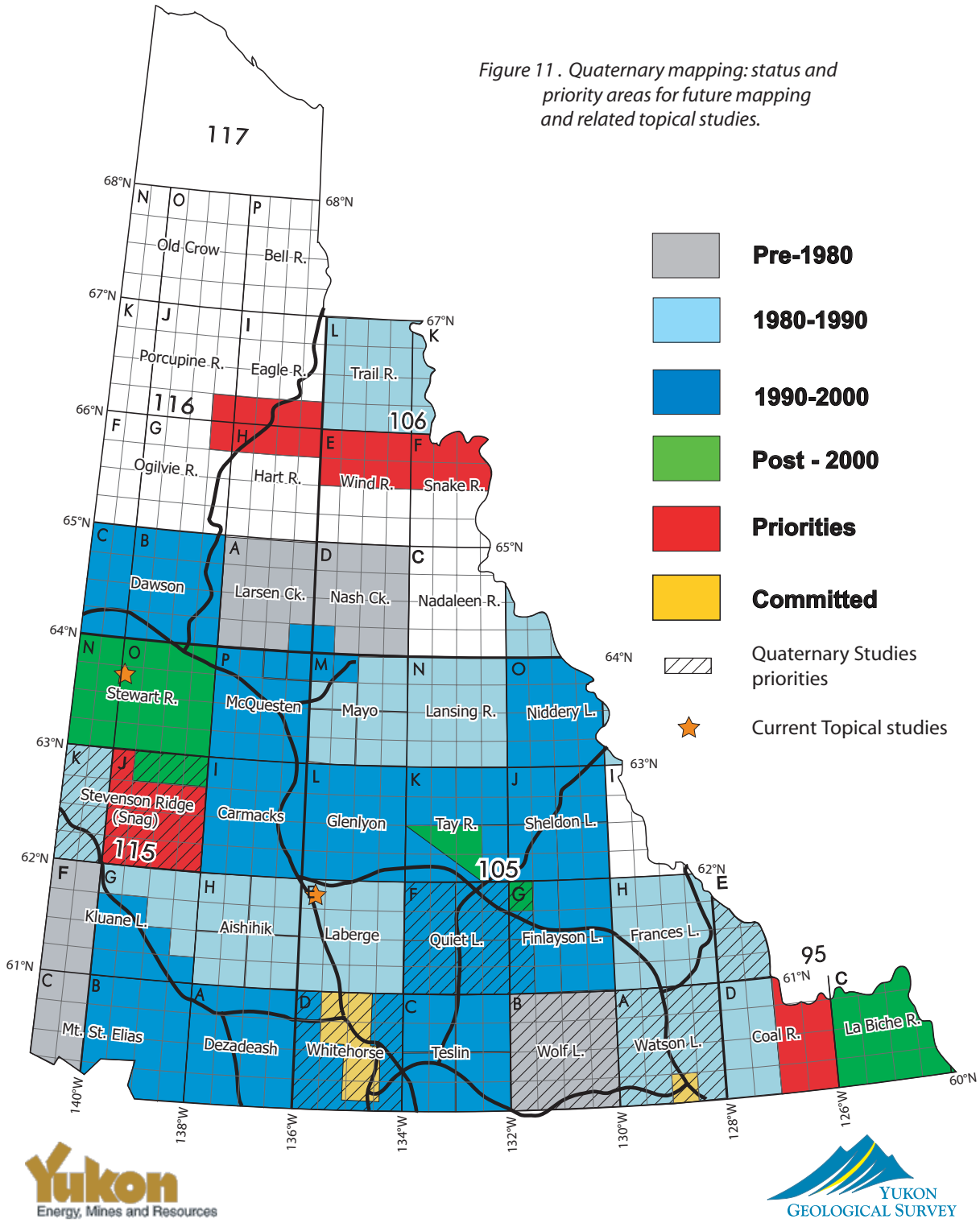
Quaternary history interpretations have not been completed for many of the southern Yukon's 1:250 000-scale map areas. These interpretations are valuable documents that describe the glacial history of a region. Most importantly, ice flow directions and changes to flow directions with deglaciation are reconstructed, which provides useful information for drift prospecting endeavors.

- Quiet Lake (105F, on-going), Whitehorse (105D, on-going), Wolf Lake (105B), Watson Lake (105A) and Flat River (95E), Quaternary history (Figure 11).
- Northern Laberge map area (105E)

Placer Industry

The focus and direction of placer research has been the subject of much discussion at previous planning workshops. As stated in the 1999 document, this reflects "the difficulties that the YGS has faced in designing and implementing effective placer research, primarily as a result of factors such as the localized nature and limited exposure of most placer deposits". Another factor was the limited exploration being undertaken by miners and general pessimism about permitting challenges on unmined creeks. As a result, the 1999 document confirmed the need for placer deposit studies and research, but placed more emphasis on liaison and contact with placer miners and the public, and on consolidation of existing information in the Yukon Placer Database. These goals were largely achieved. Placer research consisted largely of studies of the placer and surficial geology of Stewart River and southwest Dawson map areas by Grant Lowey and Lionel Jackson.

Figure 11 . Quaternary mapping: status and priority areas for future mapping and related topical studies.



Yukon Energy, Mines and Resources

Yukon Geological Survey

Discussions for this document reaffirmed the goals from 1999.

Industry Liaison

- Placer deposit studies should continue through on-site mine visits. An open-door policy is also important in the off-season.
- Maintenance of the Placer MINFILE Database is essential. Input of data from L.E. Jackson's and G. Lowey's Stewart River project will need addressing. Ideal project for a Co-op student.
- The Placer MINFILE Database, Yukon Exploration and Geology volume, Geoscience Forum and Gold Show will continue as the main information release vehicles to the placer industry.

Drainage-scale placer studies *(Fig. 12)*

Certain drainage basins with poorly known and/or complex surficial histories warrant further study. These include.

- North Dawson Range – placer study
- Florence Creek – placer and geomorphology
- Jubilee Mountain – placer and geomorphology
- Big Salmon Range – placer and geomorphology

Water Quality studies

On-going collaboration within EMR between Client and Inspections Services and the YGS in regards to investigations into placer sediment discharge are recommended. A new Yukon Placer Authorization is currently being negotiated and the results generated from focused water and sediment sampling will assist both the miners and regulators in establishing appropriate discharge standards for individual drainages. Given the importance of this information to the regulatory process, concerted efforts must be made to compile and interpret the data obtained from these studies. Both technical and nontechnical reports are required to reach the range of audience interested in this work.

Infrastructure Development and Resource Management (Forestry, Mining, Pipeline and Road Building)

Surficial Mapping

Southeast Yukon

The implementation of a forest management plan for southeast Yukon hinges on a biophysical inventory within the Kaska Traditional Territory. Surficial geology forms the basis for these inventories. The YGS initiative, and a cooperative project between YGS and the Department of Environment which is currently underway, will establish a terrain mapping blueprint for the environmental review process. The two components of the project are mapping system development and 1:50 000-scale mapping for a pilot study in Watson Lake map area in sheet 105A/2 (Figure 11). It is expected that this approach to terrain classification will become widely accepted and eventually adopted as a standard for land management in Yukon. Detailed, project specific mapping is expected to be proponent driven, but small- and intermediate-scale baseline government surficial geology maps will be necessary to support the process.

In support of infrastructure development, primarily for the forestry sector, detailed surficial mapping should be undertaken for parts of southeast Yukon. The Coal River map area (95D), in particular, has

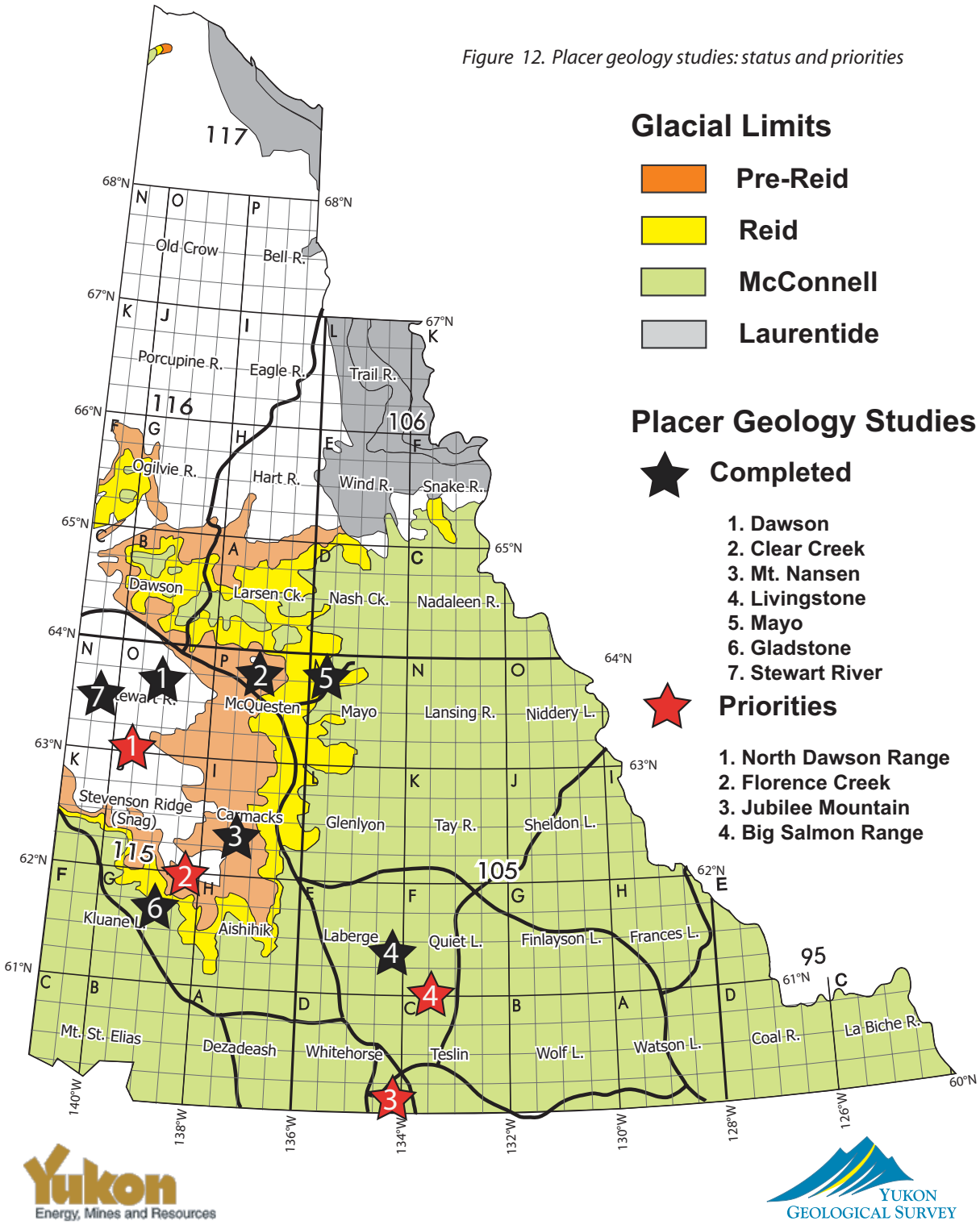


Figure 12. Placer geology studies: status and priorities

Yukon Energy, Mines and Resources

Yukon Geological Survey

some previous 1:250 000-scale mapping, an inappropriate scale for development planning. This mapping would provide the necessary baseline data for biophysical mapping and identify aggregate resources and terrain hazards

Alaska Highway Corridor

Future development along the Alaska Highway corridor will require more detailed surficial geology and permafrost distribution/characterization studies. The state of existing information, while is better understood following the recent Alaska Highway Landslide characterization study by YGS, is still unclear and consists of information held by numerous government agencies and stakeholders. This important corridor could benefit from a gap analyses on all existing information. Additional studies may include surficial map digitizing and new mapping within the corridor.

Terrain Hazards

Significant advances in our understanding of landslides in southern Yukon were made with the completion of the Alaska Highway landslide characterization study (2003-2004). In addition, a formalized methodology for characterizing landslides was developed in the process. This work has brought to the fore-front the overall diversity of landslides in the territory, as well as landslide characteristics unique to mountainous areas with sporadic permafrost. Importantly, this study established an awareness of climate change impacts and highlighted a need for baseline permafrost monitoring/mapping. Other landslide hazard studies flagged by this working group are listed below.

Regional hazard studies

- Eagle Plains – Peel Plateau regional hazard studies (oil and gas dispositions)
- Coal River (95D) regional hazard studies (see above)
- Utilizing satellite imagery to monitor permafrost-related subsidence (e.g., Beaver Creek) and landslide retrogression (Nordenskiold/Carmacks – initiated)
- Maintain a landslide inventory in association with the GSC (initiated)
- Permafrost monitoring (ongoing by the University of Ottawa and Carleton University)

Landslide case studies

- Characterize the impacts/behaviour of permafrost-related landslides
- Debris-flow frequency analysis on fans

First Nations

Many First Nation governments in Yukon are actively working towards land-use plans for their respective land claim areas and several have approached YGS with requests for support to develop capacity, and to identify economic opportunities and natural hazards. The YGS could play an important role in assisting these governments in a number of ways.

- Surficial geology and placer potential studies on some Category A and B land and Special Management areas
- Train First Nations in environmental monitoring/terrain hazard identification
- Provide reviews of regional biophysical mapping
- Provide scientific guidance and act as liaisons between First Nation governments and the geoscientific researchers.

Parks/Environment

YGS involvement in federal and territorial parks now includes providing interpretive expertise, land management studies and habitat characterization studies. Current and planned projects include:

- Reconnaissance surficial geology mapping for Tombstone Park management plan.
- Influence of permafrost degradation on salmon habitat (Nordenskiold/Carmacks – initiated).

INFORMATION MANAGEMENT

Introduction

Information management at YGS is still in a period of transition. Traditional reports and maps are now prepared digitally and printed on demand. They, and most historical products, are also available electronically, mainly as PDF files that are distributed on CD-ROM and over the internet. New maps are fully digital. More importantly, over the last few years, new technologies have allowed YGS and other geological surveys to develop new approaches to information management that enable them to cope with the exponentially increasing amounts of data and an increasingly diverse client group. Traditional maps and reports, while still essential, no longer meet all of the needs of clients, many of whom require information and diverse products compiled from a variety of sources. New ways of collecting and managing data are being developed and comprehensive databases have become essential. Project reports now include GIS compilations of datasets such as bedrock geology, surficial geology, stream sediment geochemistry, till geochemistry, mineral occurrences, paleontology, geochronology and photos that can be viewed interactively on CD. Internet-based interactive map servers such as the YGS Map Gallery are now being used to enable clients anywhere in the world to create, view and download maps and supporting information that are derived from distributed networks of databases belonging to different agencies. This technology, by allowing geoscience data to be integrated with other resource information for efficient and effective land management, is also bringing geoscience to new client groups through initiatives such as the Integrated Resource Management Regime being developed within the Government of Yukon. The following discusses in more detail the issues touched on above and others that must be overcome to allow effective and efficient data management and product delivery.

Field Data Management

The collection of geoscience data needs to be standardized within the YGS, and the process of integrating field data into project specific databases and products streamlined. In order to do that, all geologists collecting data will need to use GeoField, the data capture database software developed by YGS. GeoField must continue to be modified and updated so that it can satisfactorily collect and store all geological data that is collected by the YGS. The main gaps at present are surficial geology and geochemistry. A team of geologists is currently in the midst of updating GeoField, and more modifications will be made as it is used more extensively. GeoField will then generate a set of standardized, project specific databases, to allow data collected by each geologist to be integrated with that of previous or concurrent workers.

A standard suite of field data will thus be used internally as well as externally. Once the databases themselves are standardized there will need to be a system set up to integrate existing data into the master database so that no legacy data will be lost. All field databases along with their spatial components will then all be loaded into SDE for use within YGS and by other YTG departments.

End Products

Project-specific products will vary, but in general will include traditional hard copy reports and maps, and a digital version in portable document format (PDF) format for distribution on CD and on the internet. Some will be developed into web-based products that are viewed interactively over the internet. Bedrock geology mapping will have a GeoField database that will comprise all field observations and measurements taken, samples taken with their assay results and links to any photos that may have been taken. A map with spatial data will be produced as an ArcGIS map document,

PDF file as well as a geodatabase containing the actual geology data mapped by the geologist. Project geologists will be required to produce final products, with technical support largely limited to database management and the development of map standards and templates. A series of internal GeoField databases that contain all YGS project information will be maintained and supported by a database master. Project maps and supporting data will finally be loaded into an ArcIMS project so that it is interactively viewable on the internet. Care must be taken to safely archive not only final products, but also original field data and intermediate products.

Comprehensive Databases

Development and maintenance of comprehensive databases is the most important priority and one of the biggest challenges for information management. Their importance cannot be overstated. They not only provide easy access to information through interactive map servers and by other means, but they also allow many kinds of syntheses and other derivative products to be produced quickly and easily. As a result, the enhanced ability to readily provide information anywhere on the globe through the internet, and to reach beyond traditional clients to resource managers, regulators, schools and the general public far outweighs the effort required to produce them.

The most important comprehensive data sets and their status and ownership are outlined below:

- Bedrock geology (YGS/GSC, complete, needs update, not maintained)
- Surficial geology (YGS?/ GSC?, not yet developed)
- Regional stream geochemistry (YGS/GSC, complete, maintained)
- Regional geophysics (GSC, regional aeromagnetics and gravity complete, maintained; multiparameter, not developed)
- Mineral occurrences and deposits (Yukon MINFILE) (YGS, complete, maintained)
- Geochronology (GSC/YGS, complete)
- Regional igneous geochemistry (YGS, not yet developed)
- Placer deposits (YGS, complete, maintained)
- Paleontology (GSC, needs upgrade and update, sporadically maintained)
- Stratigraphy (GSC/ YGS?, in development)
- Organic geochemistry/thermal maturation (not yet developed)
- Oil and gas well data (OGMB, in development, maintained)
- Coal occurrences (OGMB/GSC, complete, not released, not maintained)
- Geological Processes and Terrain Hazards (GSC/YGS?, in development)
- Publications (YGS, and non YGS, complete, maintained)
- Assessment Reports (YGS, in development, maintained)
- Industrial Mineral occurrences inventory (complete, not maintained)
- Drill core (YGS, complete, needs upgrade, not maintained)

As can be seen above, most key databases have now been developed, but some have not. The most important of these which has not yet been developed is surficial geology. Maintenance of the comprehensive databases is an issue within both YGS and GSC. Resources must be found to ensure that information is current and accurate. It is also critical to ensure that the databases are simple, effective and contain only the most important data, so that they can be maintained easily. National standards are being developed for the first six datasets by the Canadian Geoscience Knowledge Network (CGKN), and at some point, these standards will be adopted for datasets maintained by YGS. Maintenance arrangements and protocols between GSC and YGS have yet to be negotiated for shared datasets.

Standardization of data structures, communications protocols, and terminology among different agencies is necessary to create seamless maps across jurisdictional boundaries, and between a variety of agencies. YGS and the GSC through many years of collaboration have overlapping data sets or are co-owners of others. Increased cooperation and integration of program delivery between the two agencies is thus necessary. Much of this cooperative work is now being done through the Canadian Geoscience Knowledge Network (CGKN), a national initiative involving the federal, provincial and territorial geological surveys.

There must be a central database manager for each database to update the data. This will allow for quality control and maximize the usage and efficacy of each dataset. If the database is not maintained within the YGS there will be a person within the YGS responsible for that database and that person will be the liaison between the YGS and external agency. This person will be responsible for passing all new data to the external agency as well as receiving all updates from the external agency. Each database manager will be responsible for maintaining documentation for all changes to the database. As the databases are populated there will be a mechanism in place to allow for use and download directly from the internet. Each database will exist as a flat file within the Map Gallery and on our internal system, as well as being a fully functional queriable database from an Internet browser.

Web Development

Website

The internet is now the main entry point to YGS products, and information. Due to the volume of new data and information, the YGS should hire a web/database manager to maintain the website and develop its potential. Suggestions for improvement include:

- Restructure to make more user friendly.
- Link project descriptions to geologist's biography as well as a dynamic project page on the map gallery.
- Develop an online research engine for the publications catalogue and link to a spatial map so that they can be accessed geographically as well.
- Enable other databases such as MINFILE, Placer.
- Obtain a more comprehensive tracking system and use to monitor volume of traffic, location of visitors, and popularity of individual products.

IMS Site (Map Gallery)

The Map Gallery now has four interactive map sites: bedrock geology, regional stream geochemistry, Selwyn Basin Metallogeny and Kluane Metallogeny. Immediate areas for improvement include:

- Utilize the Gallery as outlined above to host individual mapping project information before it gets compiled into the more universal datasets.
- Now that the main map layers are online, upgrading should consist of loading more comprehensive attribute data for many data sets.
- Actively pursue and develop innovative ways to use the Map Gallery.

The Map Gallery is an Arc IMS site that requires a complex partnership with other agencies that either provide maintenance and technical support or baseline and other data sets. Success depends upon strong partnerships and a more formal management structure to:

- clearly define roles and responsibilities for overall management, administration, maintenance and development
- ensure standardized metadata is provided with all datasets

- facilitate feedback and information exchange between data owners, administrators and users. For example:
    * base datasets and their common use in cartography within the Yukon Government framework
    * gap analysis
- facilitate quality control of data, and improvements to datasets and data delivery
- obtain commitment from data owners to take responsibility for maintenance and upgrading of datasets
- update of dataset documentation and creation of documentation of common standards
- encourage participation by other departments and agencies

Traditional Publications

"Over the counter" sales of hardcopy and digital publications remain an essential service to many clients. Some suggestions for improvement include:

- Better tracking of sales and inventory.
- Need an improved outlet with better display material and storage space.
- Look a possibility of using the outlet to distribute other EMR products.
- A reciprocal sales arrangement with the GSC bookstore in Vancouver should be investigated.

OUTREACH

Introduction

The interest in, and need for, geoscience information is rapidly spreading to a wider and wider audience. Public opinion has never been more influential on the decision-making process for natural resource development than at present. Increasing regulation and more complex land use issues demand that decision-makers have an understanding of geological processes. For example First Nations are entitled to benefits from resource development and must be legally engaged in land-use decisions. Furthermore, public interest in natural history and geology is expanding. Economic benefit may be realized from providing information to visitors that encourage them to "stay another day" and gain a greater awareness and appreciation for the Yukon's natural endowment.

There is clearly a need for products and activities that raise awareness of the importance of earth science and natural resources, teach the principles of geology and mining to general audiences, reduce irrational fear by the public of natural hazards, and promote realistic expectations of mineral and energy development. This need was also recognized in the 1999 report with a recommendation that 'Greater initiatives should be made in the area of public relations and public education with respect to Yukon geology, mineral deposits and mineral exploration.'

Currently YGS staff gives presentations or field trips when requested or invited by schools, Innovators in the schools, Yukon Science Institute, MacBride Museum and other groups. The work load is shared, although staff geologists and mineral assessment geologists do more than others. The Resource Information Officer (for the Oil and Gas and Mineral Resources Division) works to inform the media of YGS activities, and under her direction the YGS is represented at Trade Shows at National conferences and in Yukon communities. "Mining and Geology Week" in May is an opportunity to provide a public 'open house' in Whitehorse on mining and YGS activities. Most of the staff perform shifts in front of school groups. Recent efforts have also focused on presentations to First Nations administrations, resource management workshops, and to Parks interpreters.

To date, outreach materials have been produced when the opportunity or specific need arose. However, with an effective information management regime in place, as described in the previous section, outreach materials can be produced relatively easily from existing data, and a broader audience can be addressed without seriously compromising service to traditional clients. Experience to date however has shown that effectiveness depends on careful development of appropriate material and choice of audience and venue. Collaboration with other agencies can also be very effective. Examples are the Geoscape initiative by Geological Survey of Canada (GSC), aspects of which were remodeled as colourful brochures by a YGS summer student and interpretive signs erected by the City of Whitehorse which describe geological features (Miles Canyon Lookout, Hidden Lake).

Priorities

The following are specific proposals to set the stage for a more proactive, focused and effective outreach program.

Firstly, YGS must <u>improve service delivery</u> to the public. Accessibility to YGS products and people is commensurate with elevating its public profile. We compromise the investment in outreach if people cannot find what they are looking for on the geology website, or find that the document they heard about is difficult to acquire.

We propose

- Ways should be found to make the YGS website more user-friendly and current.
- Redesign the entranceways and reception areas of the two YGS offices to make them more welcoming and information-ready. Displays of pamphlets and public-oriented literature must be kept stocked and the list of technical publications checked to ensure availability.
- Information sessions should be held (perhaps twice a year) for all YGS staff to inform them of new products and how to use new services of YGS. These could include tips on how to respond to common requests from the public.

Secondly, YGS must make itself more visible to communities outside of Whitehorse, in particular land managers in First Nations communities. YGS staff should attempt to make personal contact in advance of and during fieldwork. Preparation of geoscience information relevant to the community, both on the YGS website and possibly as colourful brochures, would assist in making YGS known in the community. The information should include a folder of notes, sketch maps, images and other materials relevant to the region. This represents the accumulated experience in the community, which should allow other YGS staff to more efficiently prepare effective presentations when asked by teachers, community leaders and politicians.

Thirdly, YGS should broaden the spectrum of its products to accommodate requests for non-technical information.

- Enhance the 'General Info' section on the geology.gov.yk.ca website to include more information for novice geologists, generalists and students. As well as the summaries of various geology topics, it should contain simplified maps and images for download, as well as links to geo-education sites.
- For the use of YGS staff, maintain a sample collection and image gallery as basic resources for Outreach activities. These will increase efficiency and uniform high-quality of presentations.
- Three new products aimed at the non-geologically trained public are proposed below. These fulfill a long-expressed need for straightforward, non-technical geological information by community leaders, Yukon residents and visitors.

    - ***Regional Pamphlets*** **series**
      The objectives are attractive (initially 11" x 17", folded) brochures highlighting the influence of earth resources on human culture and industrial development, including traditional use, for various parts of the Yukon. Information would include a simplified geological map and other information such as mineral resources, explanations of causes for local landmarks, sources of drinking water, power and aggregate.

    - ***Geological Road Map of the Yukon***
      The objective is a non-technical geological map that enriches journeys on Yukon highways. The initial concept includes a 1:2 million scale map that would show simplified bedrock and surficial geology, mineral deposits and infrastructure on a shaded relief base. Stops of geological interest would be described either in an accompanying pamphlet or on the side.

- ***Geological History of the Yukon - Show***
  This will be a 5-10 minute long documentary of the evolution of the Yukon landmass. Its role is to serve as a quick general introduction to the Yukon-through-time, leaving the bulk of the presentation time (such as a meeting with a Resource Council, or a class period) open for a specific topic. Initially this would be a gallery of images which could quickly be formatted into a Power Point presentation.

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