Mineral Resource Assessment Process

Outline

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1. Introduction

DEFINITION

The assessment of resource values has become an important government responsibility as communities of every scale face the challenges of balancing environmental goals with responsible development initiatives. In the Yukon, land is coming under increasing pressure from competing and commonly conflicting interests. Several government land use initiatives are under way that affect land status and may limit the amount and type of activity allowed on that land.

Mineral Resource Assessment (MRA) is a process that has been developed by geoscientists over the years in order to assist decision-makers in land-use planning. The MRAs are a reproducible, unbiased evaluation of the geological potential of a given area to host specific types of mineral deposits. By contributing essential information on mineral resources into a multidisciplinary approach, they support informed decision-making and help alleviate potential land use conflicts.

The methodology used by YTG to produce regional mineral potential maps was developed by the U.S. Geological Survey (Drew and others, 1986) and refined by the British Columbia Geological Survey (Kilby, 1995; Grunsky and Kilby, 1996) to best fit the geology and mineral deposit types of

the Canadian Cordillera. These methodologies were used extensively in the context of land-use planning in Alaska and British Columbia, which have geological environments similar to the Yukon. The methodology used by YTG for detailed or site-specific MRAs uses some of the same principles as the regional MRAs, elaborates on similar guidelines as those developed by GSC (MERA Process), and has been adopted in other jurisdictions such as NWT.

Assessments are based on the compilation of the best available regional and detailed geoscientific knowledge at the time. If needed, new surveys are conducted to expand the database. The results of the assessments are presented as maps showing the relative ranking of the potential of different groups of rocks to host specific types of mineral deposits.

Mineral potential maps provide a comparative ranking of an area that reflects current thinking on geological potential. Assessments are based on the known resources of the area and on the ability of experts to estimate the potential of specific rock packages to host undiscovered mineral deposits. These estimates are in turn based on, and limited by, available geoscientific information such as exploration history, known mineral occurrences, regional geochemistry, comparisons with similar host rocks and deposits elsewhere in the Cordillera and the knowledge and experience of the expert panel.

Assessments are made for all or some of the following: precious (gold, silver, platinum group elements) and base (copper, lead, zinc, etc.) metals, selected industrial minerals, coal and placer deposits if applicable. Assessment for oil and gas potential follow a separate process and are carried out by the YTG Oil and Gas Branch (see Oil and Gas Resource Assessment paper).

MRAs also provide necessary information for other processes related to protected area planning such as Multiple Accounts Analyses and Socio-Economic Analyses.

MRAs also provide benefits to the geoscientific community such as improvements in the geoscientific database and the publication of products and new data, once land allocation has been made.

YPAS Commitments

In the Yukon Protected Areas Strategy (1999), the Yukon Government committed to: avoid setting aside areas of high mineral potential and development activity where reasonable options exist; carry out Mineral Resource Assessments at a reasonable level of detail, and within a prudent time frame; and to carry out Mineral Resource Assessments at regional (YPAS Step 1) and detailed (YPAS Steps 3 and 5) scales.

2. Methodology

Two phases of assessment are required under the Protected Area Strategy. First, a regional-scale assessment, carried out in support of YPAS Step 1, is conducted to help identify initial broad areas of interest for potential protection. The broad scale and scope of this analysis, carried out at a 1:250 000 scale, is inadequate for detailed analysis and should not be confused with a detailed or site-specific mineral assessment. The completion of individual regional MRAs for different areas will eventually result in a Yukon-wide mineral potential map (see fig.1).

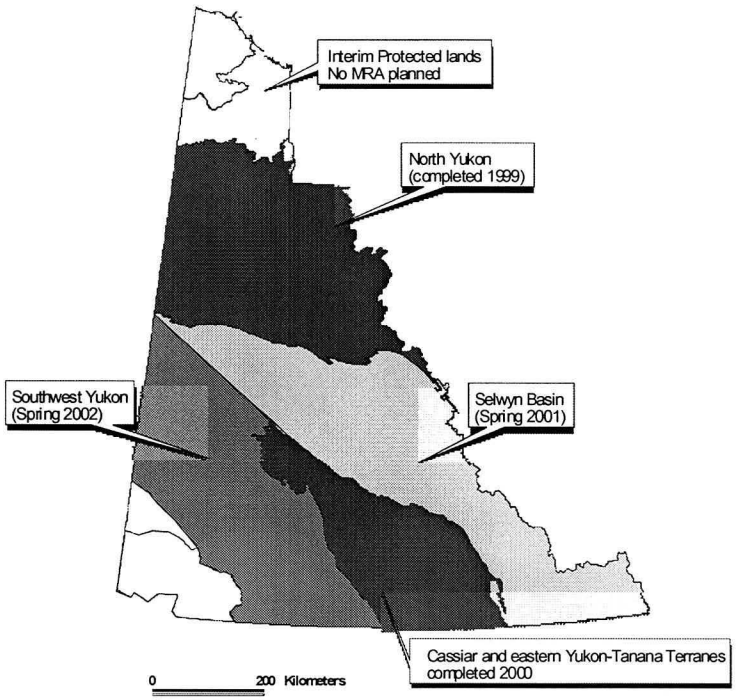

Figure 1. Map of Yukon, showing areas of completed and outstanding Regional Mineral Resource Assessments.

Once one or more specific areas of interest have been selected, a detailed mineral assessment of the area(s) is completed. This assessment is based on a more refined geological framework and uses more detailed information than the regional process. It is carried out in support of YPAS Step 3 (identifying study areas). If needed, additional fieldwork or laboratory work is carried out in support of Step 5 (identifying final boundaries). The scale of this analysis depends on the size of the area under study. A third, more detailed phase may be needed to refine final boundaries in order to resolve specific concerns or eventual conflicting interests. Any new information on geochemistry or mineral occurrences collected for the purpose of the assessment is kept confidential until final land designation.

The methodology is similar for the initial stages of both scales of assessment, up until the final assessment stage. Both processes consist of digital data compilation of available geoscientific data, identification of gaps in the geoscientific database, additional fieldwork (if necessary and if possible), final compilation and tract definition. This is followed by an assessment stage conducted by an expert panel of government and industry geologists (also called estimators). The process concludes in an overall relative ranking of the different geological tracts which is diplayed as a mineral potential map of the area.

The assessment stage differs depending on the scale of the assessment. For the regional-scale projects (supporting YPAS Step 1), experts estimate the probability of finding undiscovered mineral deposits in each geological tract. Each tract is evaluated separately, without being compared to other tracts. The estimates are then digitized and tabulated using the Monte Carlo statistical simulator software (Root et al., 1992). The software converts the experts' estimation into probability graphs and combines the estimates with known grade and tonnage data to predict the amount of each commodity that is estimated within each tract. This is used as a means to compare one tract to another.

For the detailed/site-specific projects (in support of YPAS Step 3), the estimators rank the tracts with respect to one another, without the probabilistic estimation. In both cases, the estimators sign a confidentiality agreement if confidential information is being used.

The specific steps for each type of assessment are outlined below.

REGIONAL MRA

Digital compilation. Digital compilation in GIS format of all existing public and confidential data at 1:250 000 scale. These include regional geology maps, geochemical surveys, regional airborne geophysical surveys, mineral occurrence information (Yukon Minfile), past production records, academic studies, mineral deposit models, and correlation with geological information in other jurisdictions (similar rock types, mineral deposit types, etc.)

Identification of gaps in geoscientific database. The regional MRAs completed to date have been conducted with existing information only, even though data coverage has been incomplete.

Tract definition. The region under study is subdivided into polygons of similar geology of approximately equal areas called tracts. Because the size of the tracts determine the coarseness of the assessment, it is therefore important to define tracts in a way that will be relevant for land use planning.

Mineral assessment workshop. A panel of experts in the geology and relevant mineral deposit types is convened. After an analysis of the compiled geoscientific information, each panellist estimates the probability of finding one or more undiscovered mineral deposits of a specific type within a tract. This is done separately for each tract. The estimators also rank their confidence in the quality of the data used for each estimation.

Computer statistical simulation. The experts' estimations are then tabulated, digitised and converted into probability graphs by the Monte Carlo simulator program. The program combines the estimates with known grade and tonnage data to predict the amount of each commodity (ex: copper, gold) that is estimated in each tract.

Relative ranking. The value of all commodities in each tract is totalled, including the known reserves. The results are tabulated and used to rank tracts relative to one another. The final product is an overall relative ranking of the tracts, from highest to lowest potential.

Products. Products include annotated Regional Mineral Potential Map displaying relative ranking of tracts and accompanying report.

Future reviews. Regional Mineral Potential Maps reflect a snapshot in time. They are based on current knowledge at the time of the assessment. A review should be triggered by significant advances in the knowledge of geology and mineral deposit types applicable to the Yukon, by updates to the database, or by new discoveries in the study area.

See Figure 1: existing and outstanding Regional Mineral Potential Maps

DETAILED/SITE-SPECIFIC MRA

Digital compilation. Digital compilation in GIS format of public and confidential exploration and geological data. The scale of the analysis is dependent on the size of the area and the type of coverage available. Information includes: regional geology maps at 1:250 000 and 1:50 000 scale, geochemical surveys, regional airborne geophysical surveys, mineral occurrence database (Yukon Minfile), mining records (past production), academic studies, mineral deposit models, and correlation with geological information in other jurisdictions (similar rock types, mineral deposit types, etc.). Confidential assessment reports may also be used .

Identification of gaps in geoscientific database. Identify areas where essential information is missing and define types of surveys needed for the assessment.

Fieldwork and/or laboratory work. Data collection to fill major gaps in the geoscientific database (1-2 field seasons).

Final compilation.

Tract definition. The area under study is subdivided into polygons of similar geology called tracts. The size of the tracts determine the coarseness of the assessment. Tract size is much smaller than in regional MRA's and is defined in order to be pertinent in the context of land use planning. Tracts will differ in size in order to accommodate the geological characteristics of the area and provide a workable land-use planning tool.

Mineral assessment workshop. A panel of experts in the geology and mineral deposit types to be assessed is convened. After an analysis of all the compiled geoscientific information, the panellists rank the tracts according to their relative potential to host mineral deposits.

Relative ranking. The tracts are ranked from highest to lowest mineral potential. This is a relative ranking within a given land base, not an absolute one.

Product. The product is an annotated mineral potential map displaying the relative ranking of the tracts.

Figure 2. Map of Yukon, showing the four completed site-specific mineral resource assessments as of September, 2000.

3. Limitations

The soundness and reliability of the conclusion derived from such a study is directly related to the quality of the database. Where information is lacking, the confidence in the assessment diminishes. Assessments done with only partial information coverage therefore need to be reviewed as the geoscientific database gets updated. New contributions to geological knowledge, such as recent discoveries or mapping, should also trigger reviews.

Given that the ranking displayed on a detailed assessment is relative to a given land base, detailed assessments must be viewed within the context of a regional assessment. This allows for appropriate weight and consideration within a broader context.

The greatest challenge, however, is to ensure that end-users understand the use and limitations of this product. Planning initiatives should involve the participation of knowledgeable geological staff who understand the process and can help with the interpretation of potentially complex maps.

4. Requirements

REGIONAL MRA

Mandatory Requirements:
Geological coverage. Adequate geological coverage at 1:250 000 scale (see fig.3). The adequacy is determined by the vintage of the map and the amount of groundtruthing done at the time of the mapping.

YUKON MINFILE. Updated mineral occurrences database maintained by Geology and Exploration Services, DIAND.

Assessment panel. Access to experts who have experience with the geology and types of mineral deposits to be found in the area under study.

GIS capability. GIS support for data integration and map production.

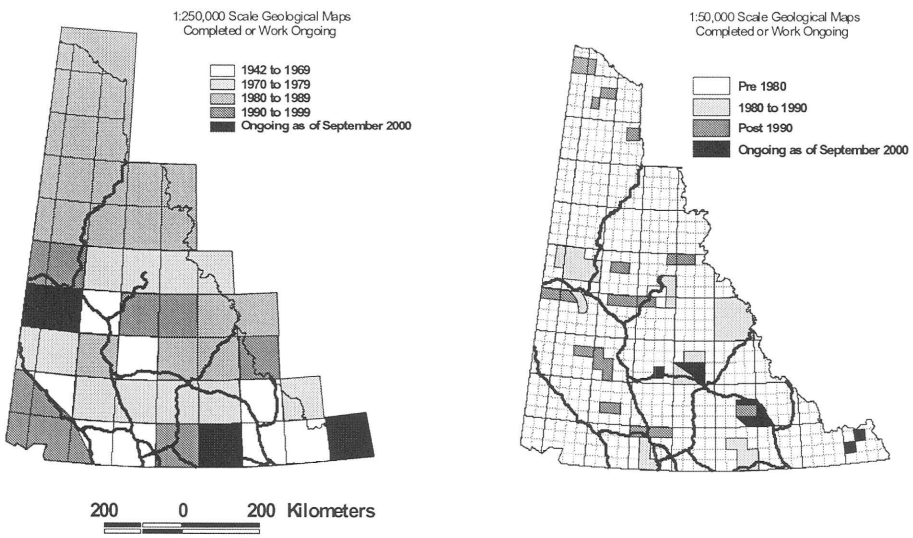

Figure 3. Map of Yukon showing vintage of bedrock geological information.

Desirable:
Regional geochemical stream sediment (RGS) surveys. RGS at an adequate density (minimum 1 sample per 13 sq. km.) and with analysis of an adequate suite of elements (see fig.5). RGS should be mandatory, but Yukon does not have full geochemical coverage as of September 2000. Existing regional mineral potential maps should be revisited when the geochemical coverage is completed.

Regional geophysical surveys. Geophysical coverage (fig.4) is important and useful for assessments. Unfortunately, the quality and extent of the coverage is quite heterogeneous. It would therefore be unrealistic to list this type of data as mandatory.

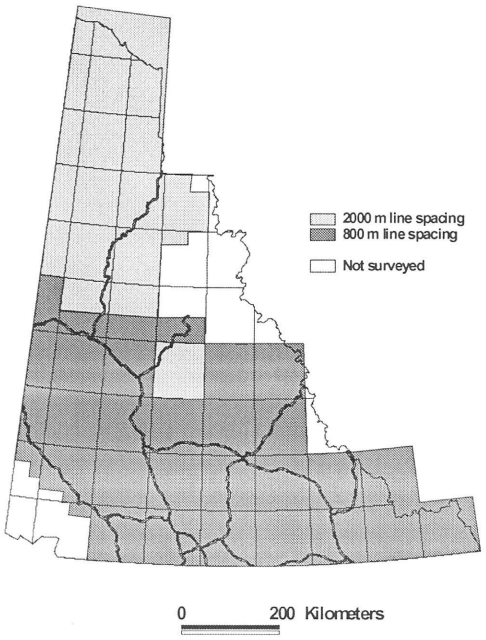

Figure 4. Airborne geophysical information (total field magnetics, gravity, gamma-ray) is collected at different densities, depending upon available funds and objectives of the survey. This map shows the areas systematically surveyed within Yukon, as of September, 2000.

DETAILED/SITE-SPECIFIC MRA

Mandatory Requirements:
Geological coverage. Adequate geological coverage at 1:250 000 scale and/or 1:50 000 scale for critical areas (see fig.3). The adequacy is determined by the vintage of the map and the amount of groundtruthing done at the time of the mapping.
Regional geochemical stream sediment (RGS) surveys. RGS at an adequate density (minimum 1 per 13 sq. km.) and with analysis of an appropriate suite of elements (see fig.5).

YUKON MINFILE. Updated mineral occurrences database maintained by Geology and Exploration Services, DIAND.

Assessment reports. Access to public and confidential mineral exploration assessment reports.

Fieldwork. Fieldwork to test the quality of the data, add to the database, test the relevancy of mineral deposit models; additional surveys to fill major data gaps if deemed necessary. This need will be established on a case by case basis.

Assessment panel. Access to experts who have experience with the geology and types of mineral deposits to be found in the area under study.

GIS capability. GIS support for data integration and map production.

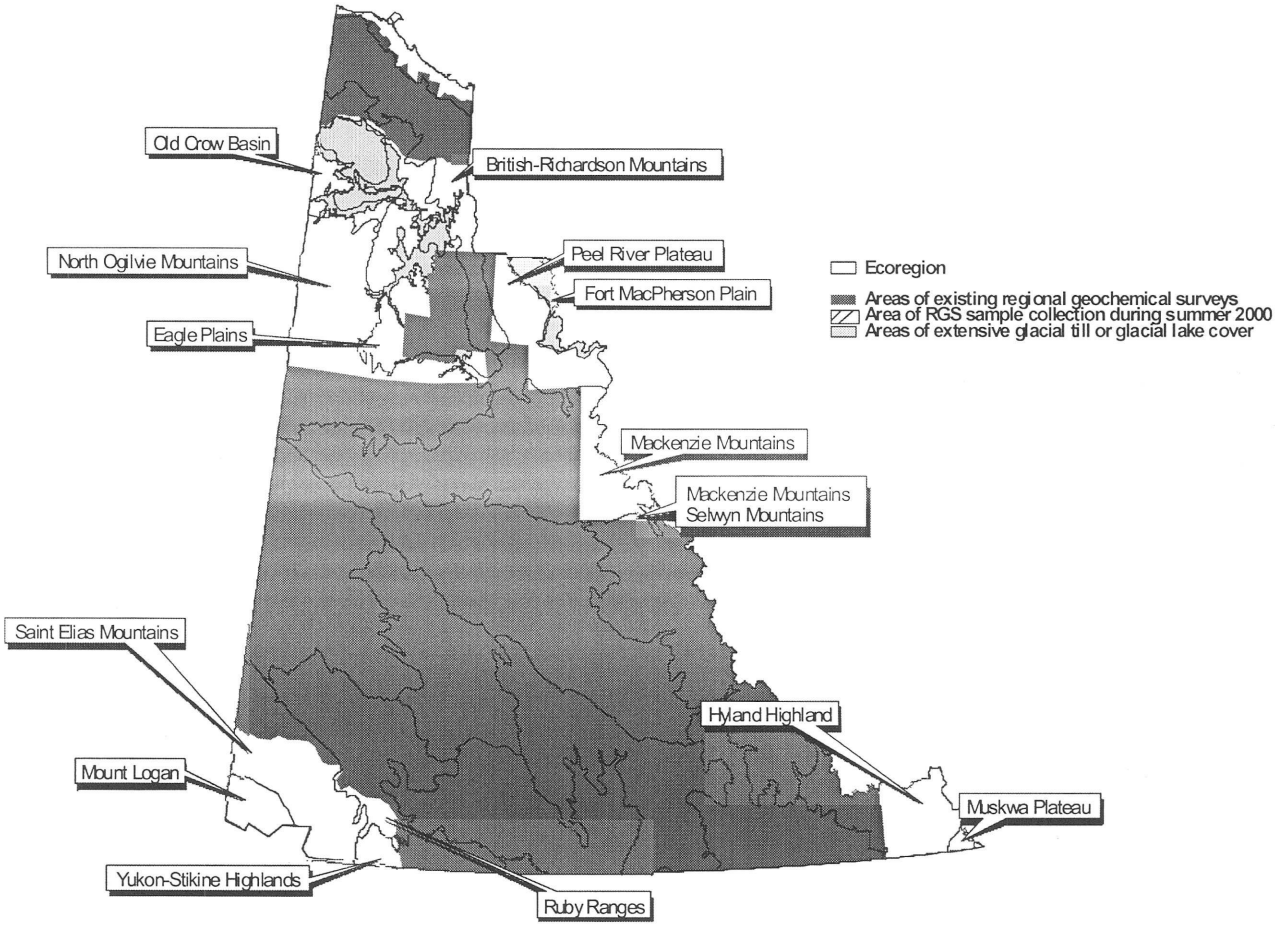

Figure 5. Map of Yukon showing land base and portions of ecoregions that are not fully covered by regional stream sediment geochemical surveys (RGS, September 2000), and areas of extensive till cover, where till surveys are more appropriate than RGS.

Desirable:

Geophysical surveys. Regional geophysical (aeromagnetic) coverage (fig.4) is important and useful for assessments. Although not listed as an essential requirement, they greatly enhance the ability of the assessors to estimate the likelihood of finding certain types of mineral deposits. Specific geophysical surveys may be recommended in certain situations where the geology and mineral deposit types warrant it.

Other geochemical surveys. Till or lake sediment geochemical surveys for areas covered by thick glacial deposits.

ESTIMATED COSTS

The cost for assessments will vary from project to project. The quality and completeness of the available database, the scale of the analysis, the size of the area under study, whether or not additional fieldwork is required as well the amount of information available determine the cost.

REGIONAL MRA: $ 16-30k for each 3-6 day assessment panel

DETAILED/SITE-SPECIFIC MRA: costs will depend on the size of area and the quality of data.

$ 8-10k for a one to two day assessment panel
$ 150k/year for a full season of field work
$ 200 to $ 750k for new RGS surveys depending on size and remoteness of area. RGS survey costs can be substantially reduced if Yukon Government engages in partnerships with Federal Government (e.g. RGS over La Biche River map sheet could cost $ 75 k to YTG)

TIME REQUIREMENTS

The time frame assessments will vary from project to project. The quality and completeness of the available database, the scale of the analysis, the size of the area under study, whether or not additional fieldwork is required as well the amount of information available determine the time needed. Having adequate lead-time will ensure resources can be dedicated to specific projects.

REGIONAL MRA:

A total of 6-7 winter months per large area (two outstanding).

-digital compilation of all existing public data in GIS format. (4 months)
-tract definition. (1-2 weeks)
-assessment panel (3 to 6 days)
-computer statistical simulation (1 month)
-products: mineral potential map and report (1 month)

DETAILED /SITE-SPECIFIC MRA:

Either: minimum 7 months total (May through November) if RGS data exists
or
minimum 20 months total (May through November of following year) if RGS data is lacking

-digital compilation of existing exploration and geological data (2 months)
-data collection to fill major gaps in the geoscientific database (1-2 field seasons)
-assessment panel and relative ranking (1-2 days)
-annotated mineral potential map (1 month)

YPAS Step	Mineral Resource Assessment	Time and resources required (in house and consultant costs at current values)
Step #1 – Area of interest	Regional Mineral Resource Assessment	GIS support. Minimum per assessment: 1. Assessment panel cost: $16,000-30,000. 2. Time: 6-7 winter months.
Step #3 – Study area identification	Detailed Mineral Resource Assessment	GIS support. Minimum additional information: 1. Assessment panel cost: $8,000-10,000. 2. Time: 7-20 months (depending on existence of RGS data) 3. Field work cost: up to $150,000 (for a full season) 4. RGS survey cost: $200,000-750,000/map sheet
Step #5 – Final Protected Area Boundary determination	Additional information/fieldwork as required	GIS support Additional field work if necessary

Table 1. Table summarizing minimum requirements and estimated costs for the different levels of detail of MRAs carried out by the YTG Mineral Resources Branch.

5. Summary

Mineral Resource Assessments are an intrinsic land value and are an important consideration in land-use planning. MRAs are an integral part of protected area planning and YTG has committed to the completion of various scales of MRAs within the YPAS process. Considering mineral resource values before land alienation occurs will contribute to our conservation goals while maintaining crucial access to the land-base for development activities. As a result, integrating MRA's within land-use planning assists balanced decision-making, and may alleviate potential conflict. YTG Mineral Resources Branch makes use of sound, scientifically rigorous and reproducible methodology for regional and site-specific MRAs. The same process is recognized and used in other jurisdictions to assist land-use planning.

Appropriate time and budget allocation for MRAs are critical. The economic cost to society in loss of possible opportunities far outweigh the cost of the assessment themselves. MRAs also provide necessary information for Multiple Accounts Analyses and Socio-Economic Analyses. Other valuable benefits are derived from this process such as improvements in the geoscientific database and the publication of products and new data that will be of use to the geological community.

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