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Mineral and energy resource assessment of the proposed Thaidene Nene National Park Reserve in the area of the East Arm of Great Slave Lake, Northwest Territories

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Publications in this series have not been edited; they are released as submitted by the author.

Cover photo
Photograph looking east over Wildbread Bay from the Douglas Peninsula. Image courtesy of Ross Knight (2008).

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EXECUTIVE SUMMARY

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INTRODUCTION

In 1970, an area of approximately 7400 km^2 comprising the East Arm of Great Slave Lake and adjacent lands and waters was withdrawn under the Territorial Lands Act for a proposed national park (Fig. 1). However, there was little activity toward creating the park until the early 1980s when negotiations for a national park resumed. At that time the Geological Survey of Canada (GSC) published an Open File report (Roscoe et al., 1987) documenting a mineral and energy resource assessment (MERA) for the Area of Interest (AOI) between Artillery Lake and Hearne Channel on the East Arm of Great Slave Lake. In October 2002, the Federal Government announced its Action Plan to Protect Canada's Natural Heritage and as part of this plan, the Federal Government committed to the expansion of the national parks system. The Lutsel K'e Dene First Nation (LKDFN) formally agreed to enter into negotiations with Canada for planning a protected area in their traditional territory in 2004 and defined 57,000 km^2 (named Thaidene Nene – Land of the Ancestors) for consideration as a national park. In October 2006, Parks Canada Agency and the Lutsel K'e Dene First Nation signed a three (3) year Memorandum of Understanding (MOU) within the Akaitcho Process, agreeing to work cooperatively towards completing work on aspects of a feasibility study for the possible establishment of a national park. In 2007, a larger land parcel was withdrawn for a five year period under the Territorial Lands Act for proposed national park purposes. This area in combination with the original 1970 land withdrawal (approximately 33,500 km^2) became the current AOI for this national park assessment (Fig. 1).

The current AOI encompasses regions with deposit types that were previously known (e.g. Ni-Cu, rare metals) but not considered in detail by Roscoe et al. (1987) because they were outside the study area being evaluated at the time. In addition, deposit types not known to exist in this area in the 1980s, for example kimberlite-hosted diamonds, have been identified in the region of/proximal to the expanded AOI. Furthermore, new and revised mineral deposit models have been developed that could be applied to the area of the proposed park and thereby update knowledge about areas of mineral interest.

This MERA was thus undertaken for the new, expanded AOI to complement and expand the previous MERA.

STUDY AREA

The study area evaluated for mineral and energy potential includes the expanded AOI plus an additional area of up to 30 km surrounding the AOI (Fig. 1). The combined area, here termed the Area of Compilation (AOC), encompasses approximately 79,300 km^2. The irregular boundary of the expanded AOI (hereafter termed just AOI) is based largely on drainage patterns. It extends approximately 315 km northeast from Hearne Channel in the East Arm of Great Slave Lake, up to and including Sifton Lake. The 33,500 km^2 AOI includes the Pethei, Kahochella, and Douglas peninsulas, Redcliff Island, and extensive water areas in McLeod and Christie bays in Great Slave Lake as well as Artillery Lake. In order to provide adequate understanding of the geology and metallogenic domains that transect the core of the AOI, it was deemed necessary to expand the study area to that outlined by the AOC (Fig. 1).

COMPILATION AND ASSESSMENT METHOD

The MERA includes field surveys, conducted in 2008 and 2009, laboratory studies, and analyses in order to obtain improved geochemical and geological knowledge. This additional knowledge improves the level of certainty and confidence in assessing the mineral and energy potential. This MERA report has five major components:

1. Bedrock Geology. A total of 566 field sites were documented over two field seasons, resulting in an updated bedrock geology map, which was the essential context for assessing the potential for various resource deposits in the AOC.
2. Mineral and Hydrocarbon Occurrences. During the two field seasons, 51 mineral occurrences were examined to verify the commodity and investigate the geological setting. Based on the data compiled from existing sources and site visits, the mineral occurrences were interpreted to represent fifteen different deposit types, thirteen of which have been qualitatively assessed.
3. Mantle Teleseismic Tomography. Ten teleseismic

Wright, D.F., 2013. Executive Summary *in* Mineral and Energy Resource Assessment for the Proposed Thaidene Nene National Park Reserve in the Area of the East Arm of Great Slave Lake, Northwest Territories, (eds.) D.F. Wright, E.J. Ambrose, D. Lemkow, and G.F. Bonham-Carter; Geological Survey of Canada, Open File 7196, p. 1-11.

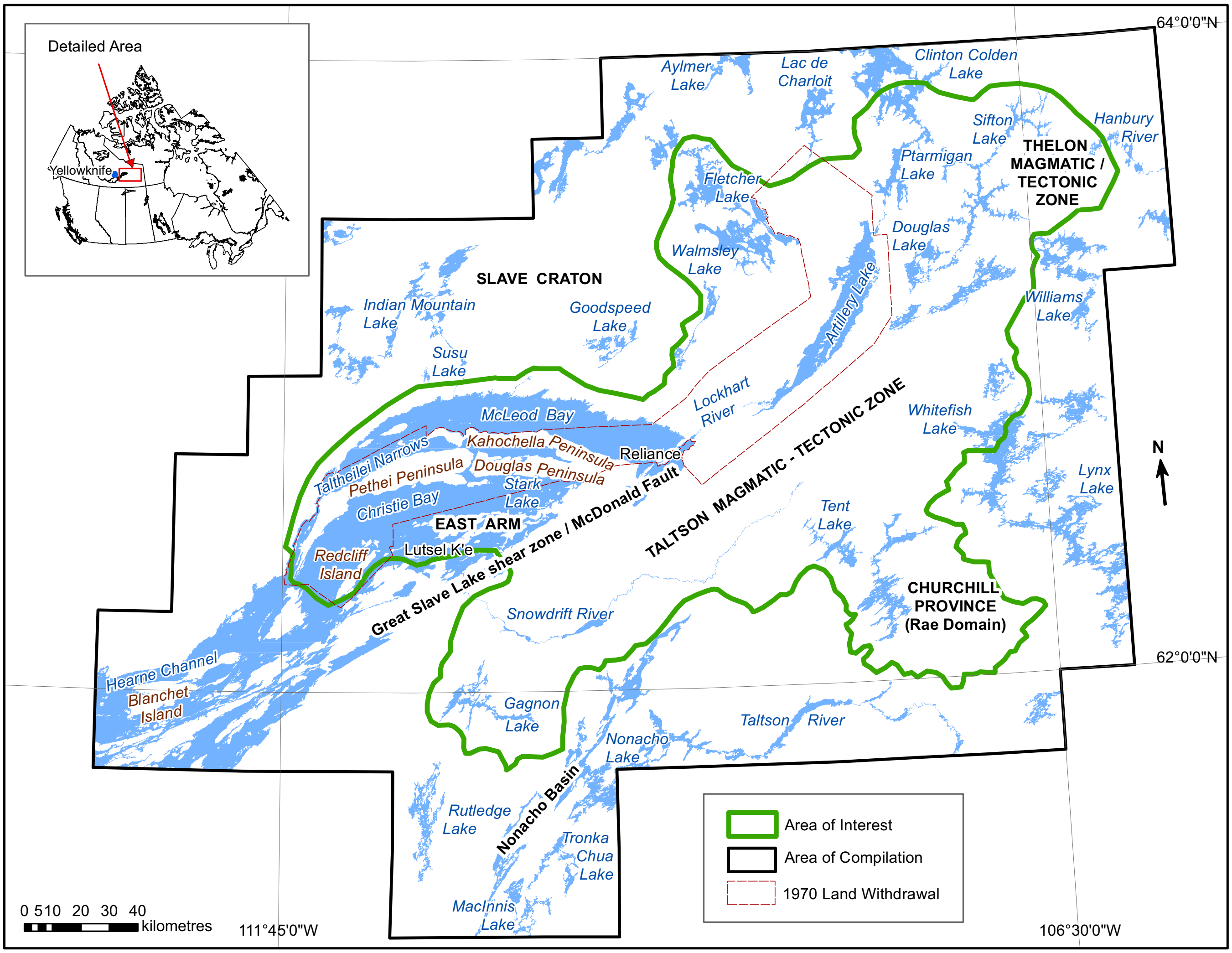

Figure 1. Map showing Area of Compilation (AOC) and Area of Interest (AOI) for the currently proposed park. The location of an earlier AOI (1970 land withdrawal) is also shown.

stations were installed in a northwest-trending linear array, crossing Artillery Lake and approximately bisecting the AOC. Data were collected from these stations between July 2008 and June 2010. Though not conclusive, interpretation of the data suggests that the mantle lithosphere, which is presumed to be the source of the diamondiferous kimberlite of Gahcho Kué, underlies all of the AOI.

4. Quaternary Geology. Data obtained from fieldwork resulted in an updated surficial materials map, a till geochemistry database, an indicator mineral database, and a more comprehensive understanding of glacial and fluvial flow directions.
5. GIS Database Compilation and Resource Potential Modelling. A GIS-based procedure has been systematically applied to assess the mineral potential in the AOI as well as the expanded AOC. Thirteen mineral-deposit types were selected as being the most likely to occur in the area.

For each deposit type, a resource potential model was developed and applied, based on geological, structural, geochemical, mineralogical, and geophysical evidence that has been captured in a digital database as raster maps. The spatial data were assembled by compiling knowledge from existing maps and mineral-occurrence databases. A new database of mineral occurrences (deposits, drilled showings or prospects, and showings; n=499) was compiled and classified according to the different mineral-deposit types; this database provided key information for evaluating mineral potential. In addition, fieldwork during 2008 and 2009 resulted in new geochemical and mineralogical data from till and esker samples, updated the geological maps, and supplementary information from selected mineral occurrences.

The raster evidence maps that constitute the assessment guides for each deposit type were combined using a scoring and weighting system, fine-tuned by experts in each deposit type under consideration. A "knowledge-driven" weighted-overlay approach was applied

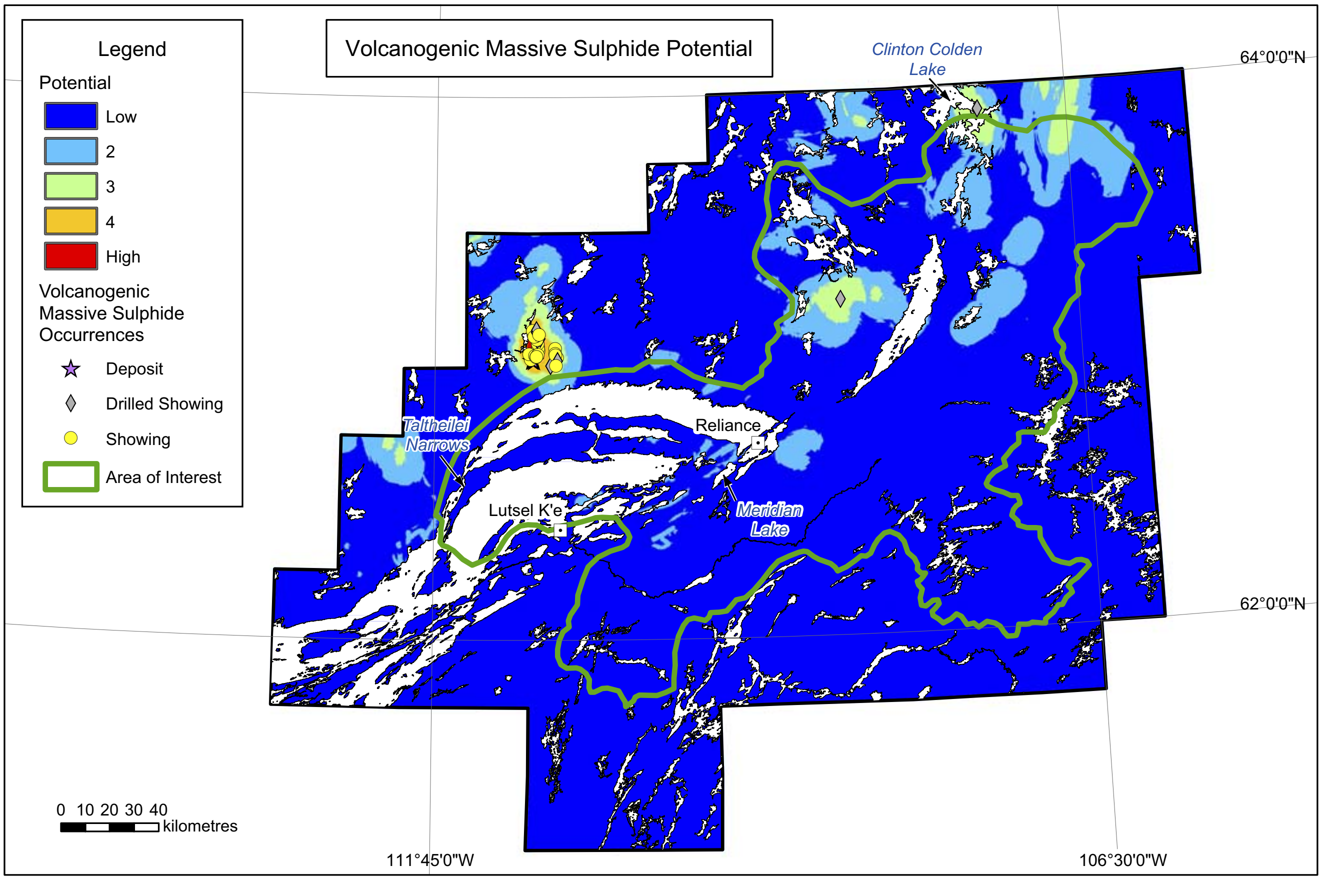

Figure 2. Map showing the modelled potential for volcanogenic massive sulphide occurrences.

(as opposed to a "data-driven" approach that uses a statistical prediction method) yielding a mineral potential map for each of the thirteen deposit types. The resulting predictive maps rated mineral potential as scores ranging from 1 to 5, which correlates to 1 representing low potential; 2, low-to-moderate; 3, moderate; 4, moderate-to-high; and 5 representing high potential.

ASSESSMENT RESULTS

1. **Volcanogenic massive sulphide deposits**
The Indian Mountain Belt includes areas rated as having both high and moderate-to-high potential (scores of 5 and 4) for volcanogenic massive sulphide (VMS) deposits, with several deposits and numerous prospects and showings. These prospective areas lie entirely outside the AOI, although the zone with moderate-to-high potential (score = 4) extends close to the northern boundary of the AOI. In the vicinity of Clinton-Colden Lake, an area with two zones that also have moderate-to-high VMS potential (score = 4) straddles the AOI boundary; a drilled showing falls within this area, just north of the AOI boundary. (Fig. 2)

2. **Kimberlite-hosted diamonds**
A relatively large area with high and moderate-to-high potential (scores of 5 and 4) is located west of Walmsley Lake, straddling the AOI boundary. Although no occurrences in this area fall within the AOI, three drilled showings are just outside the AOI boundary. The deposits and prospects that comprise Gahcho Kué lie between 4 and 5 km outside the AOI. A relatively small zone lies about 40 km northwest of Gahcho Kué, near the boundary of the AOC; this zone has a moderate-to-high diamond potential (score = 4) and includes a drilled showing. (Fig. 3)

2. **Peraluminous granite-pegmatite rare metals.** An area north of Hearne Channel, which is well west of the AOI, has high and moderate-to-high potential (scores of 4 and 5). This is an area with deposits, prospects, and showings. (Fig. 4)

3. **Peralkaline-syenite rare-metals**
Mineral potential ratings of high and moderate-to-high (scores of 4 and 5) occur in an area also northwest of the Hearne Channel (Thor Lake), but further west than the area with granite-pegmatite rare-metal potential. This prospective zone includes deposits (Nechalacho Project) but is also well outside the AOI. (Fig. 5)

4. **Lode gold**
There are three areas with moderate-to-high potential (a score of 4) for lode gold near the northern

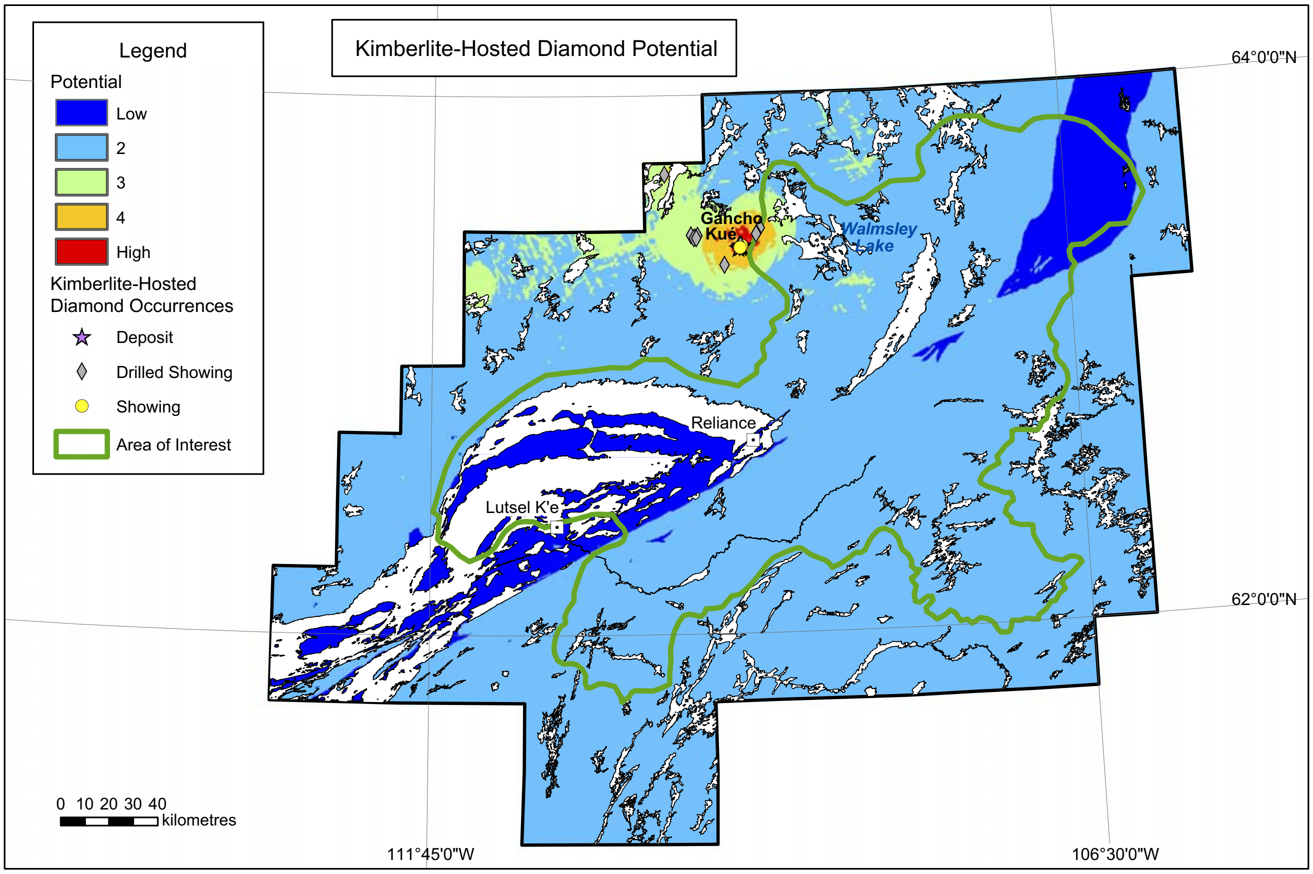

Figure 3. Map showing the modelled potential for kimberlite-hosted diamond occurrences.

boundary of the AOI. An area just west of Ptarmigan Lake lies entirely within the AOI, and an area near Fletcher Lake lies mostly within the AOI. The third area lies about 6 km outside the northern boundary of the AOI. Although there are no lode gold occurrences in these areas, they are regarded as prospective because of favourable evidence from mineral grain counts and from geochemical analyses of till samples, as well as the presence of favourable rock types (Fig. 6).

5. **Vein-hosted uranium**
There are many occurrences of vein-hosted uranium mineralization in the Area of Compilation. A large area south of the AOI (Nonacho Lake, Tronka Chua Lake, and MacInnis Lake areas) has high and moderate-to-high potential (scores of 5 and 4), with one deposit being located in this zone. There are two relatively small areas that have moderate-to-high potential (score = 4) for this deposit type within the AOI, but these are near the AOI boundary, close to Tent Lake. The larger of these areas has several prospective zones, one of which includes a showing. (Fig. 7)

6. **Sandstone-hosted uranium**
Several areas within the AOI have moderate potential (score = 3) but none have moderate-to-high or high potential (score = 4 or 5). These areas are generally proximal to the McDonald Fault system and extend from near Wilson Island west of the AOI through a central zone that straddles the AOI boundary east of Lutsel K’e to a zone near Reliance in the east. Twenty-three of the forty sandstone-hosted uranium occurrences are located in these zones. Another area with moderate potential, which is largely within the AOI, includes a zone proximal to Taltheilei Narrows and extends across several islands in McLeod Bay. No occurrences are known there (Fig. 8).

8. **Mississippi Valley-type lead-zinc**
Although a number of veins of Mississippi Valley-type (MVT) are found in the Artillery Lake area, mineralization potential never exceeds moderate (score = 3). The areas of moderate potential include a significant portion of the Artillery Lake area and an area near Reliance (Fig. 9).

9. **Vein-hosted copper**
There are many vein-hosted Cu prospects and showings within the AOC and there is an area of mineralization near Meridian Lake that has moderate-to-high potential (score = 4). This area includes 14 occurrences (4 drilled showings and 10 showings). Eight of these (3 drilled showings and 5

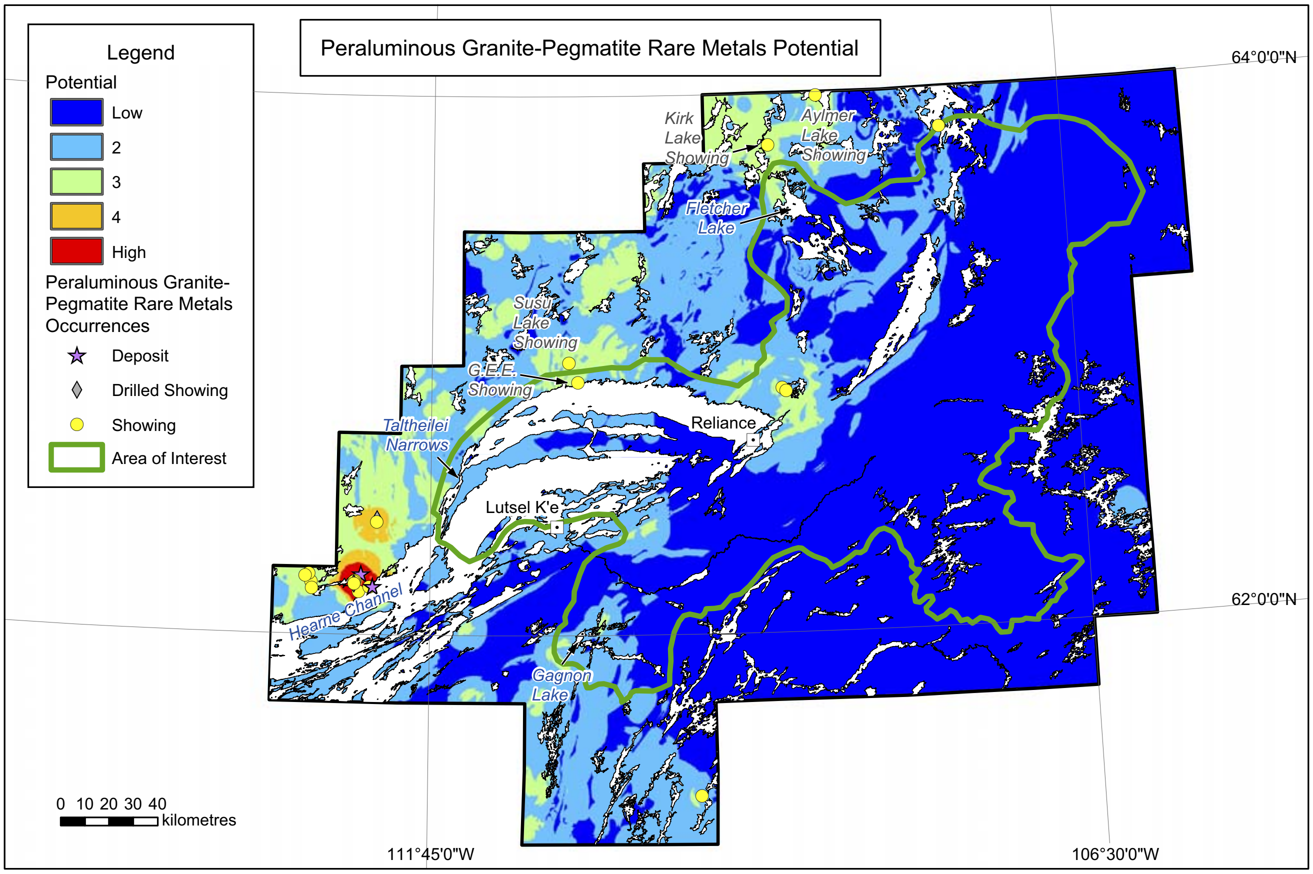

Figure 4. Map showing the modelled potential for peraluminus granite-pegmatite rare metal occurrences.

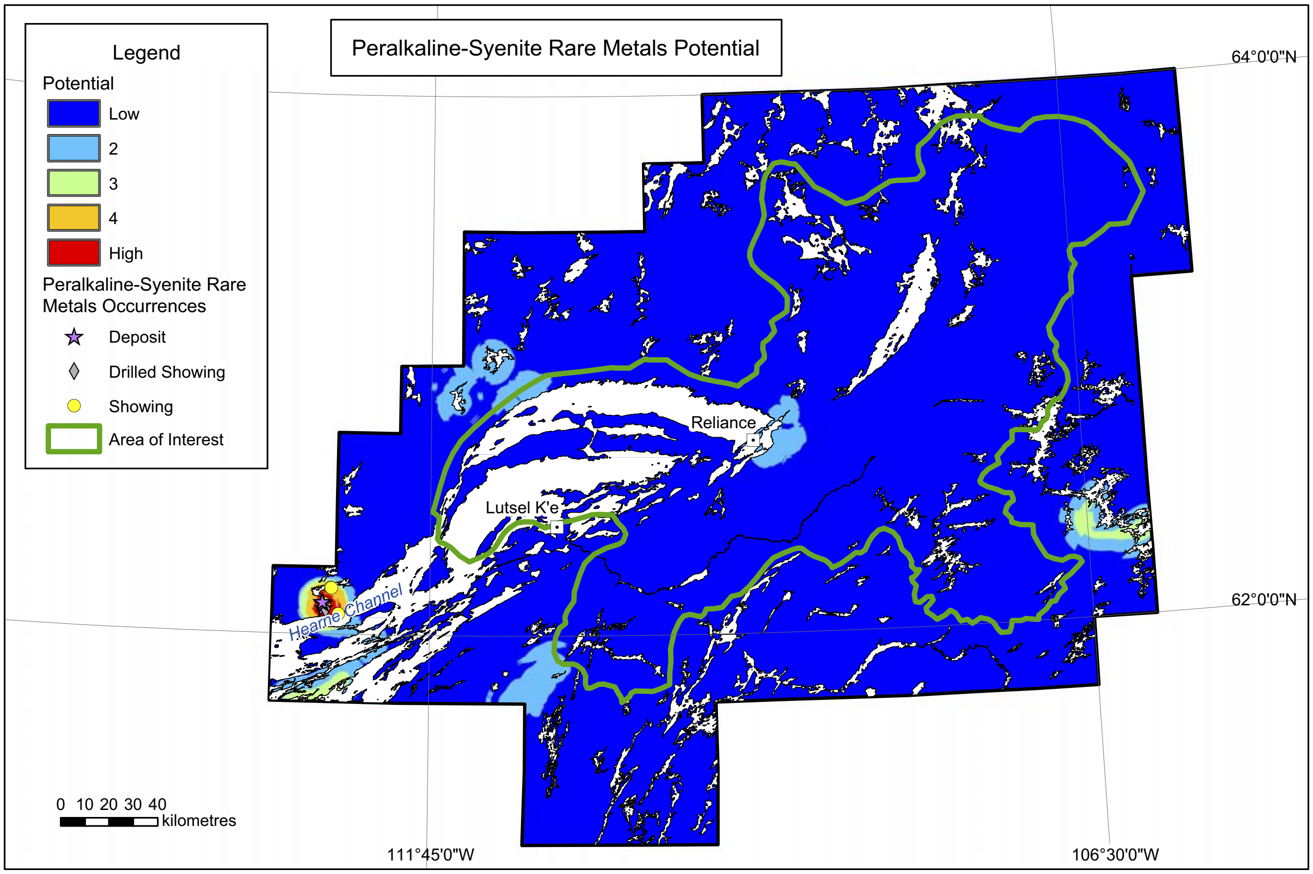

Figure 5. Map showing the modelled potential for peralkaline syenite rare metal occurrences.

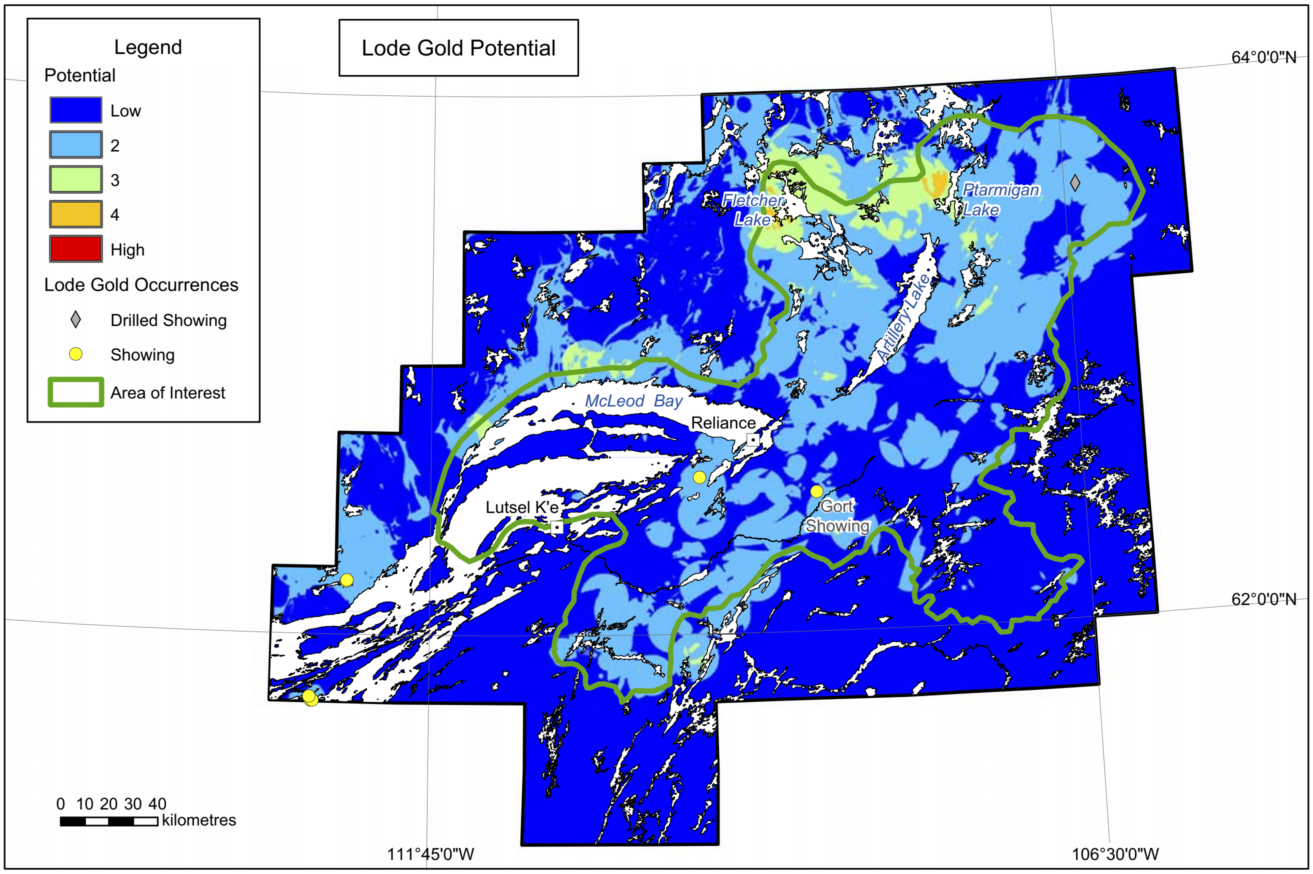

Figure 6. Map showing the modelled potential for lode gold occurrences.

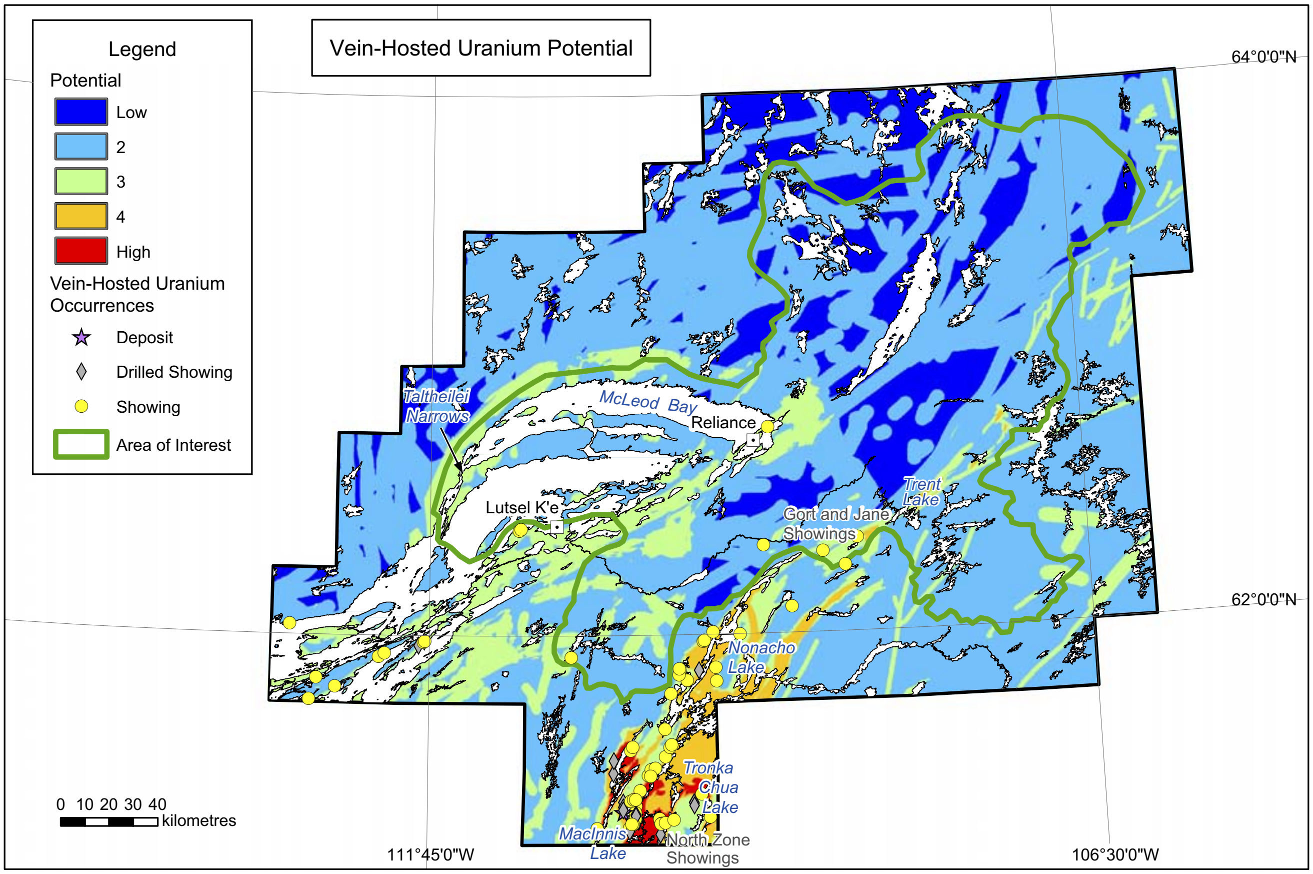

Figure 7. Map showing the modelled potential for vein-hosted uranium occurrences.

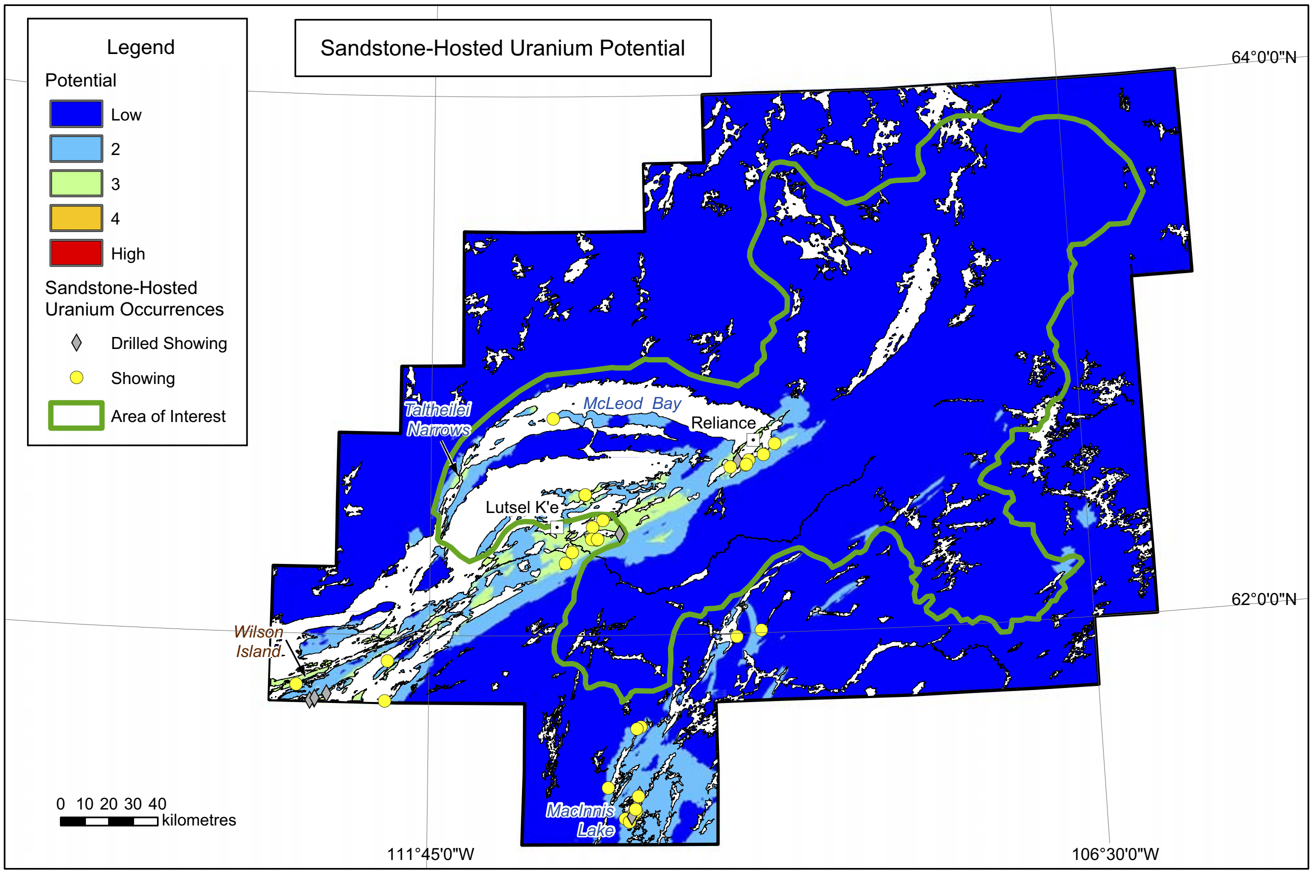

Figure 8. Map showing the modelled potential for sandstone-hosted uranium occurrences.

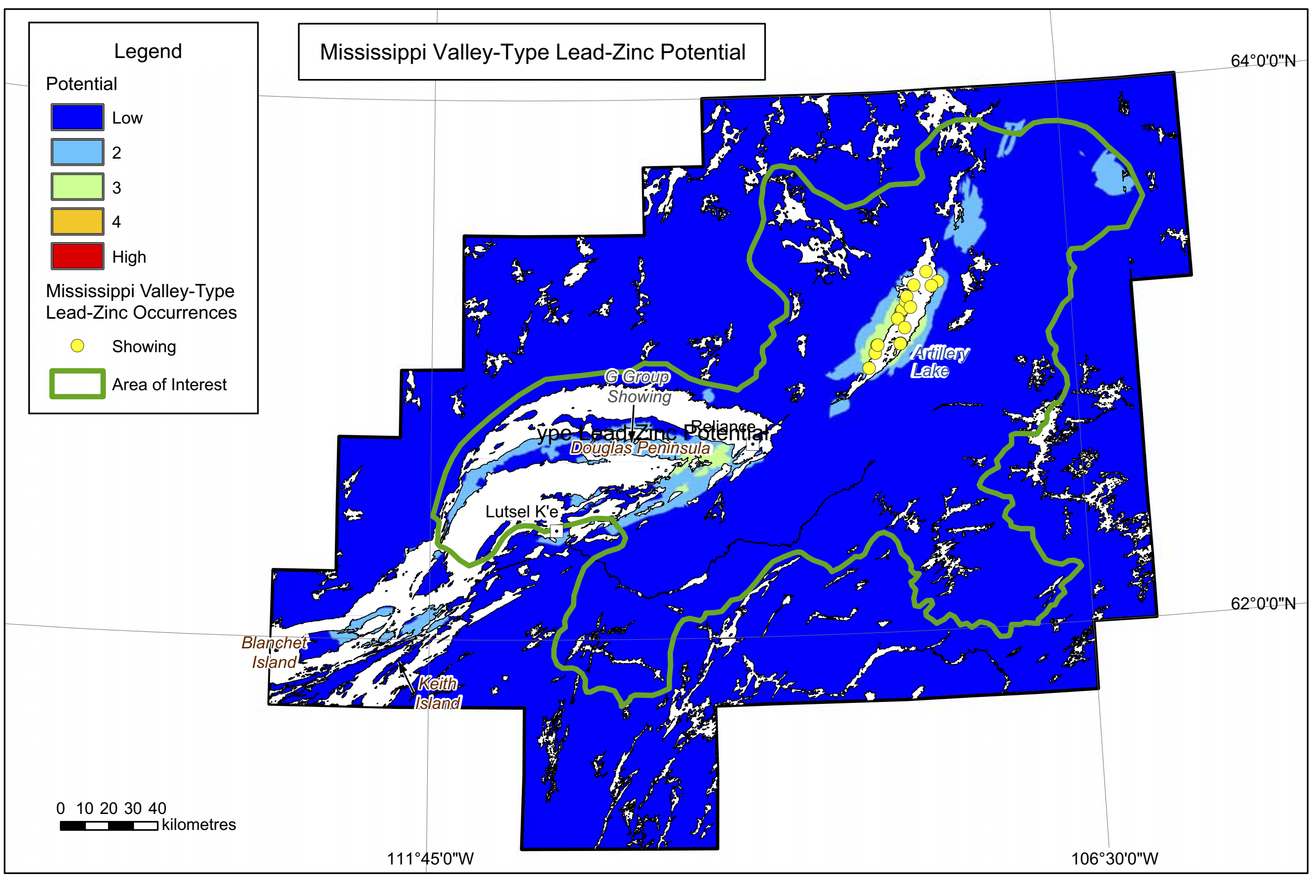

Figure 9. Map showing the modelled potential for Mississippi Valley-type occurrences.

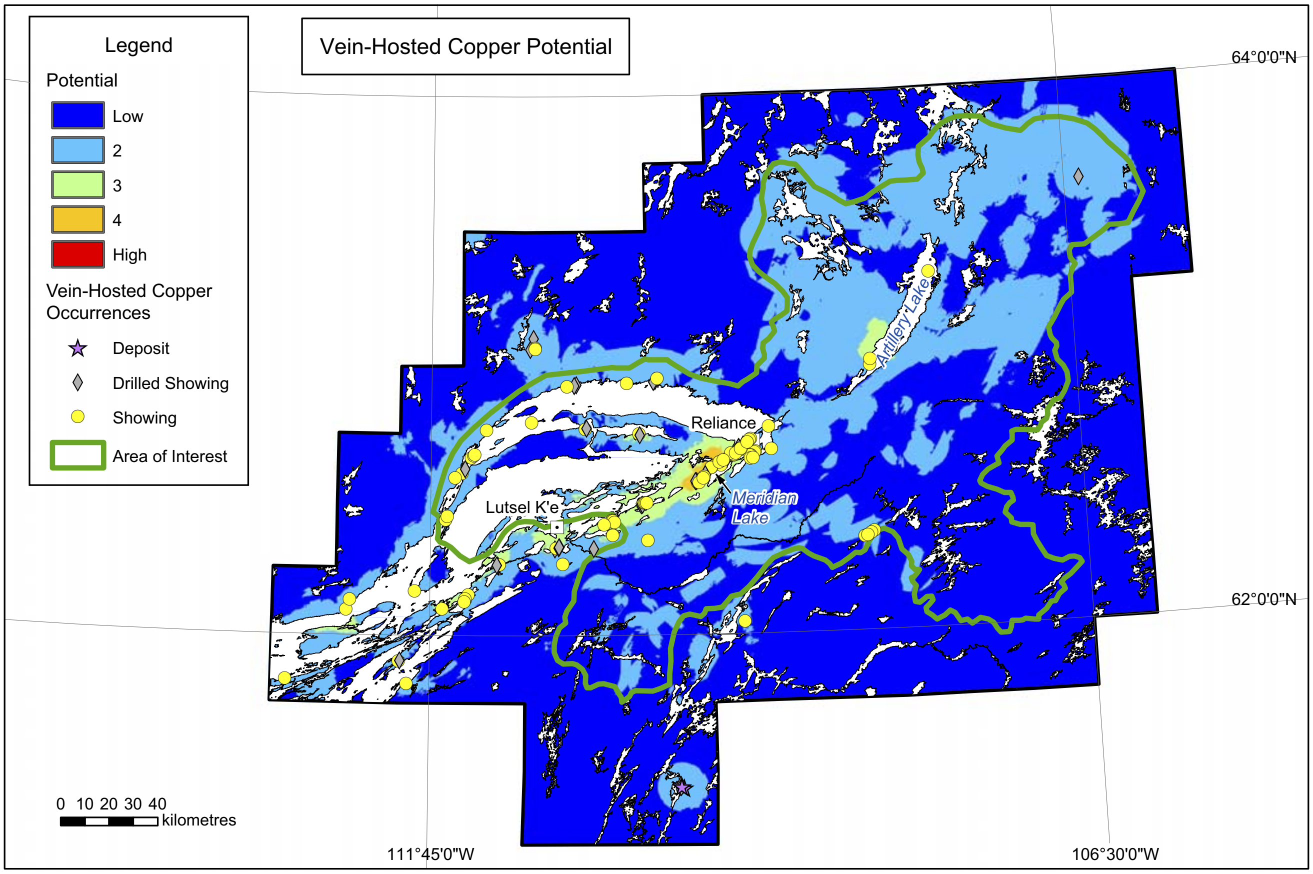

Figure 10. Map showing the modelled potential for vein-hosted copper occurrences.

showings) are auriferous (Fig. 10).

10. **Iron oxide-copper-gold**
An area comprising two zone of moderate-to-high potential (score = 4) straddles the AOI boundary near Lutsel K'e. The larger patch zone includes 5 occurrences (4 drilled showings and 1 showing) that are very near the AOI boundary (Fig. 11).

11. **Magmatic nickel-copper sulphides**
Mineral potential for this deposit type did not exceed moderate (scores ≤ 3) in the AOC. However, south of the AOI, there is a curvilinear cluster of 21 occurrences (9 drilled showings and 12 showings) that approaches the AOI boundary; within this cluster, there is a small area of moderate potential (score = 3) where 3 drilled showings and 3 showings are located (Fig. 12).

12. **Chromite**
No chromite occurrences or layered mafic to ultramafic intrusions, which are diagnostic host rocks for chromite deposits, have been mapped in the AOC. Nevertheless, mineral grain counts indicate that these types of host rocks probably are present in the eastern part of the AOI, and have not yet been identified in outcrop. An extensive area of moderate potential (score = 3) is found north of Whitefish Lake, some of which is inside the AOI boundary (Fig. 13).

13. **Sedimentary exhalative**
Although no sedimentary exhalative (Sedex) mineralization has been identified within the AOC, the mineral-potential model suggests moderate-to-high potential (score = 4) for this important deposit type in an area that straddles the AOI boundary near Lutsel K'e and extends to Reliance (well within the AOI). Seven of the eight occurrences (veins of barite and barite-sulphide, which may reflect Sedex prospectivity) occur within this area (Fig. 14).

The results of this study indicate that there are areas near the boundary of the Area of Interest (AOI) for the proposed park where the mineral potential is moderate-to-high or high (scores or 4 or 5, respectively). These key areas along the northern boundary of the AOI have very elevated potential for diamond and/or gold occurrences (Figs. 3 and 6). Some consideration should also be given to the areas near Lutsel K'e, along the Murky Channel Fault and McDonald Fault systems where the potential for IOCG, and/or Sedex, and/or vein-hosted copper occurrences is assessed as moderate-to-high (score = 4).

Hydrocarbon Potential

The possibility of petroleum accumulations can be dismissed unequivocally for the large areas of Archean to Paleoproterozoic igneous and intensely metamor-

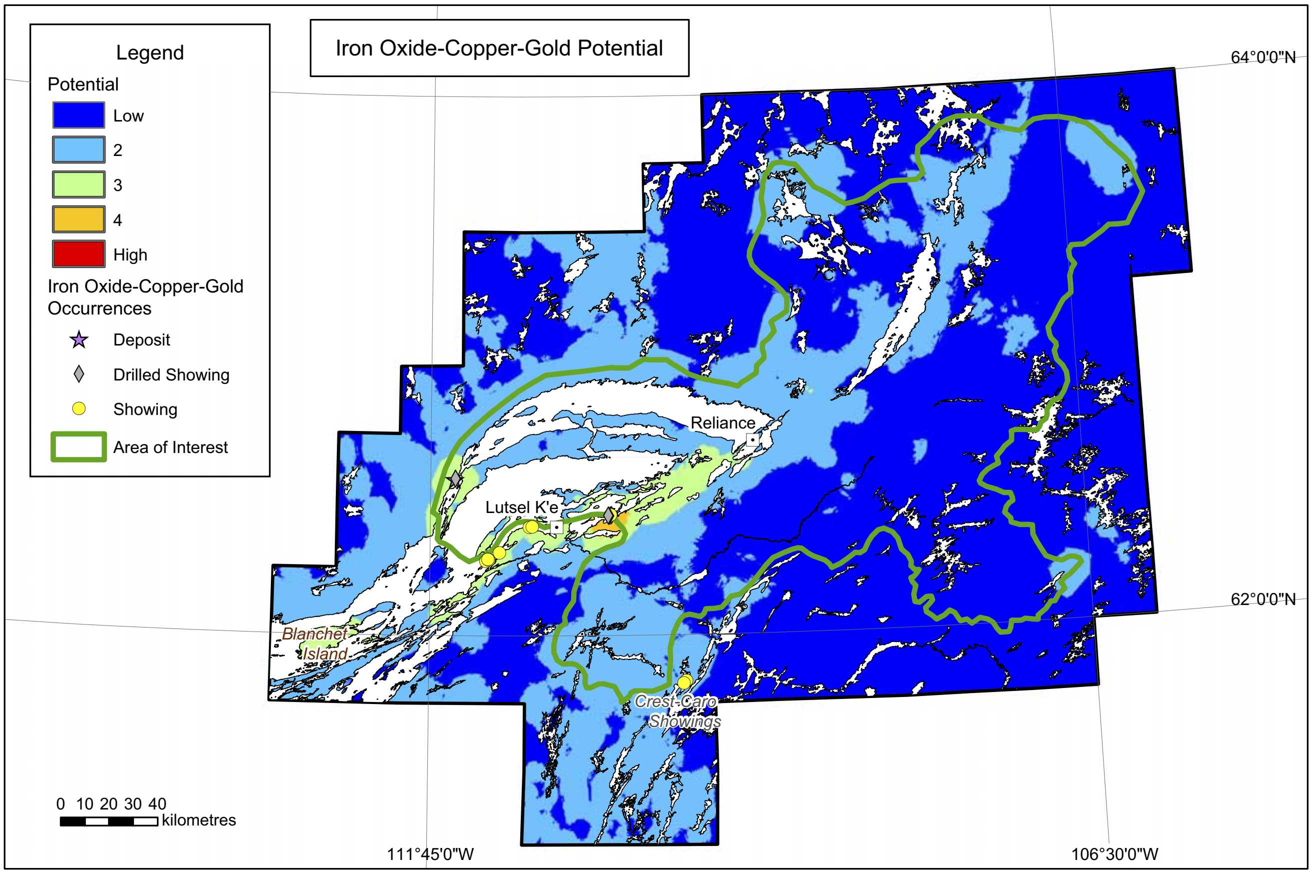

Figure 11. Map showing the modelled potential for iron oxide-copper-gold (IOCG) occurrences.

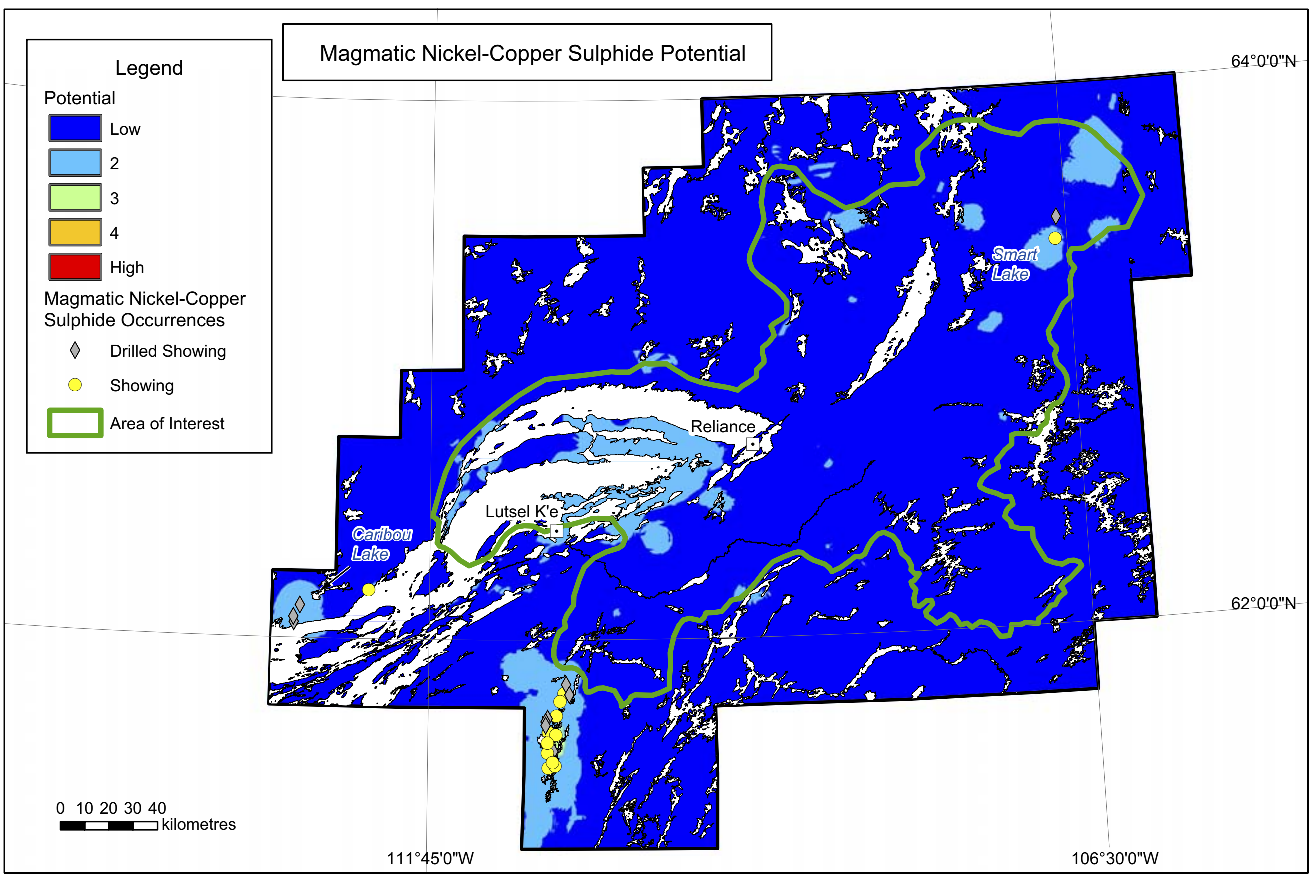

Figure 12. Map showing the modelled potential for magmatic nickel-copper sulphide occurrences.

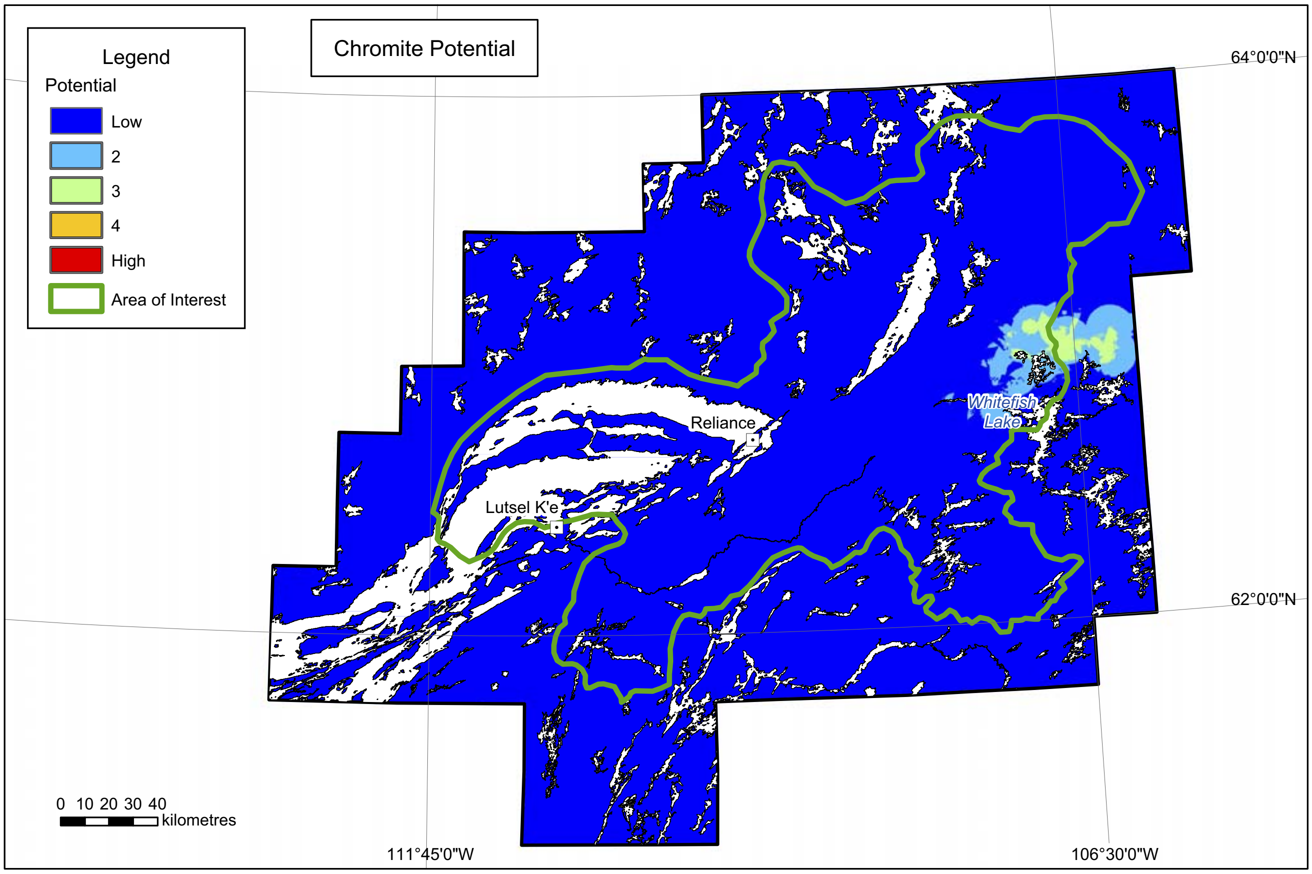

Figure 13. Map showing the modelled potential for chromite occurrences.

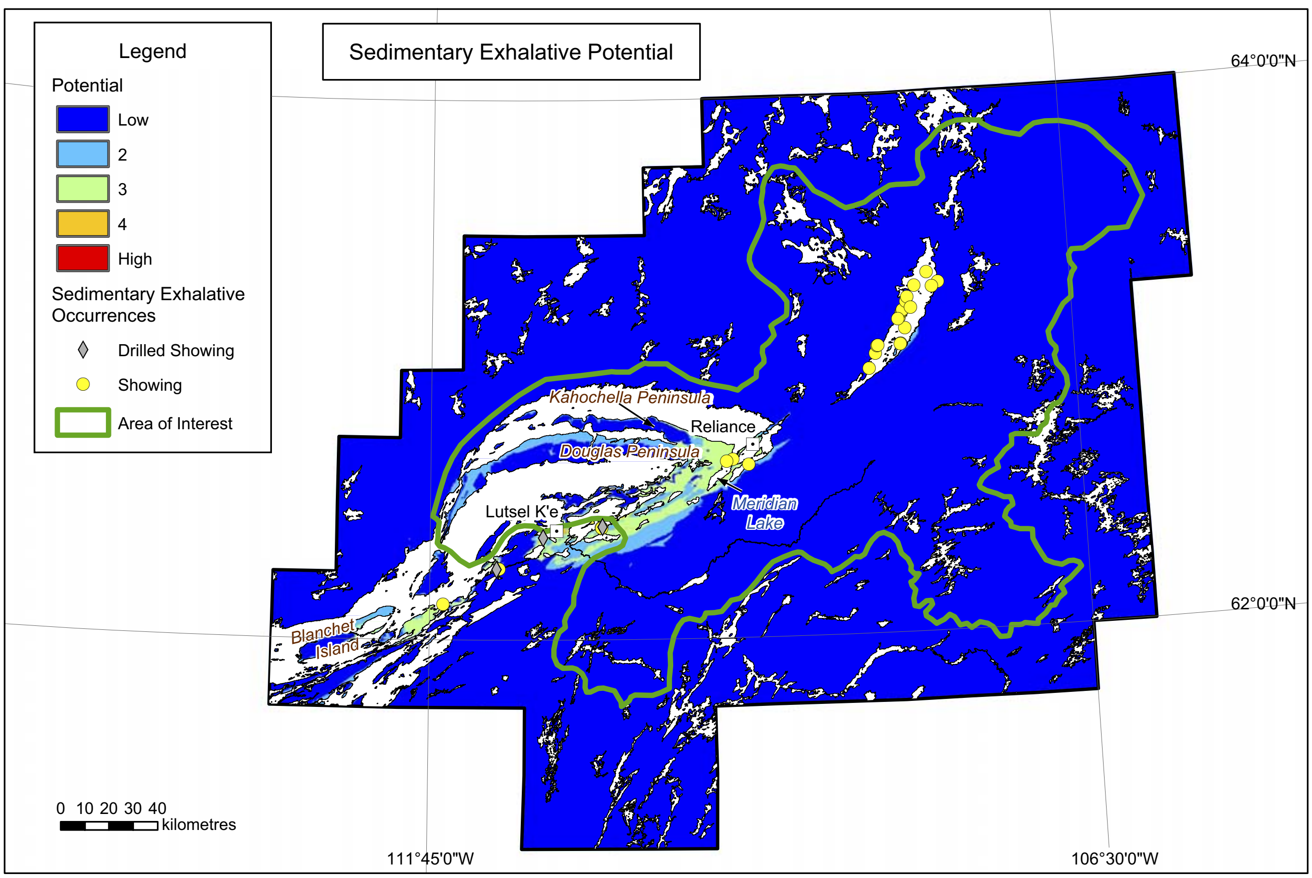

Figure 14. Map showing the modelled potential for sedimentary exhalative (Sedex) occurrences.

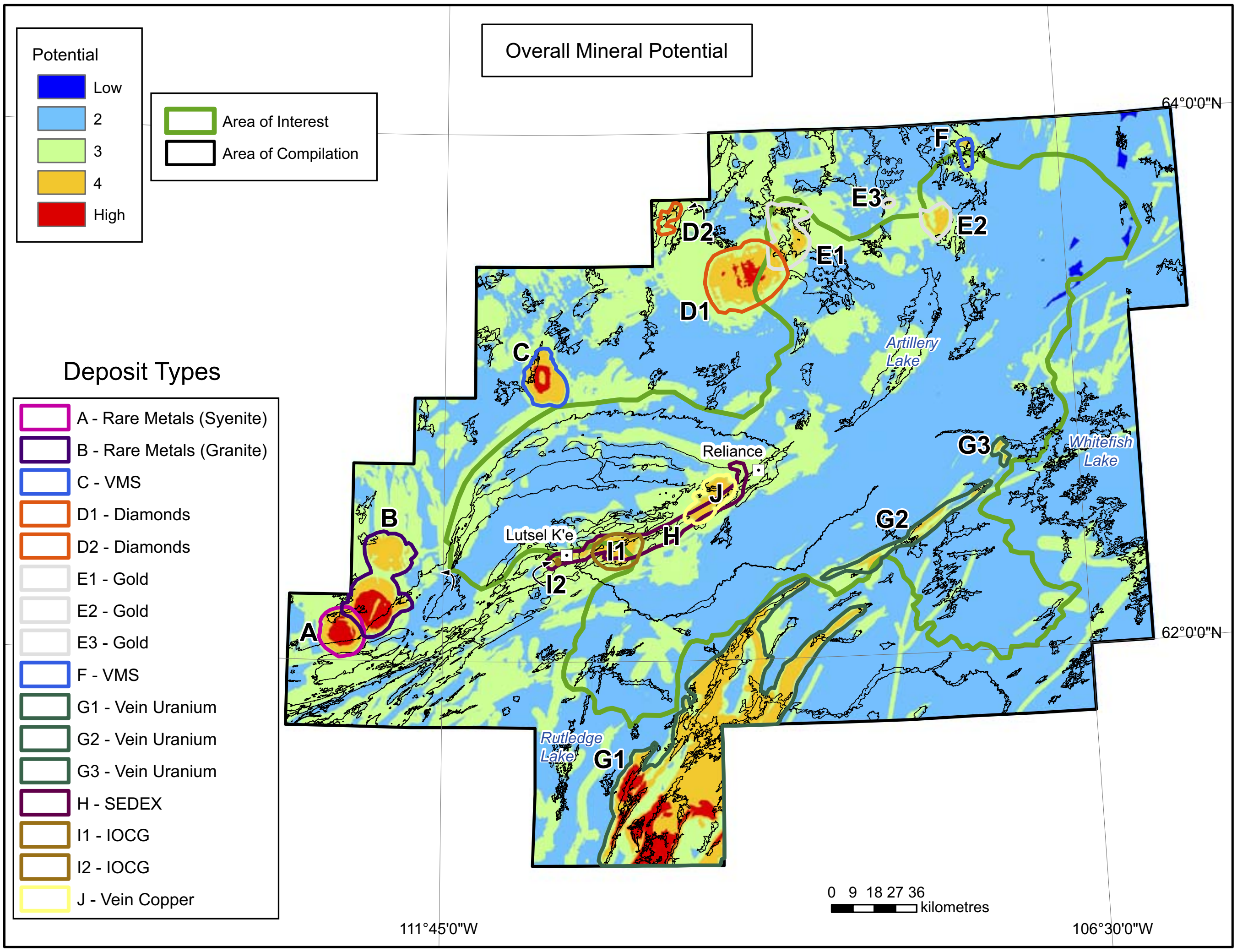

Figure 15. Overall mineral potential summary map in the Area of Compilation for the proposed Thaidene Nene park reserve.

phosed bedrock exposed across Slave Craton, the Taltson magmatic-tectonic zone, and the northwest Churchill Terrane, which covers most of the Area of Interest. For the remaining portions of the AOI, the unmetamorphosed Paleoproterozoic East Arm fold and thrust belt in the southwestern portion of the proposed park, there is also little possibility of unconventional oil and gas accumulation and preservation.

Composite Resource Potential

An overall mineral-potential map was created by identifying areas (or spatial 'patches') where mineral potential was rated as moderate-to-high or high (scores of 4 or 5, respectively) for any of the thirteen deposit types being examined and combining the results. This combined map was then annotated and interpreted in order to summarize which type(s) of deposits are predicted in each patch. (Fig. 15)

Caveats

The results of this mineral and energy resource assessment are based on the best geoscience information currently available. They reflect the present knowledge of the geology and mineral deposit models known or thought to be important in the AOI for the proposed Thaidene Nene national park. The GIS-modelling approach employed in this study was effective for managing the large amount of spatial data that were interpreted, for documenting the methodology, and for ensuring reproducible results. However, it should be noted that geological knowledge is not static; it is continually being refined and expanded. In addition, the GIS model was "expert" driven, which introduces some subjectivity. As a result, there will always be uncertainties associated with resource potential analysis that can only be lessened through renewed investigations using the most current knowledge as future land use issues arise.

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