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Kimberlite-indicator-mineral results derived from glacial sediments (till) in the Southern Indian Lake area of north-central Manitoba (parts of NTS 64B15, 64G1, 2, 7, 8)

By
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Manitoba

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Cover illustration: Natural exposure of till overlying bedrock at a section logged along the shoreline of Southern Indian Lake, north-central Manitoba. The till at this site was sampled for kimberlite-indicator-mineral analysis.

Abstract

Reconnaissance-scale kimberlite-indicator-mineral (KIM) sampling was undertaken in the Southern Indian Lake area of north-central Manitoba. This is the first study to investigate the diamond potential of the region using till indicator-minerals. A total of 106 KIM grains were recovered from the 0.3–0.5 mm size-fraction of nineteen 22.7 L till samples. This includes three G9 garnets, one G11 garnet, and four diamond-inclusion spinels. This open file releases the electron microprobe analyses, KIM grain counts, and sample locations. Preliminary station logs are provided for sample context. These new results confirm the presence of anomalous KIM concentrations in the Southern Indian Lake area and suggest that an unknown kimberlitic source(s) is reflected in the glacial sediments of the Southern Indian Lake area.

Please note minimum interpretation of the results is provided in this report, as its primary objective is to make this data available to the resource exploration community quickly. A more rigorous analysis of the data will follow in a subsequent report.

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Introduction

Till samples were collected at a reconnaissance-scale (1–2 samples per 100 km^2) for kimberlite-indicator-mineral (KIM) analyses, to investigate the diamond potential of the Southern Indian Lake area of north-central Manitoba. The purpose of this open file is to release the KIM data quickly to benefit the mineral exploration industry. Some field data is provided to add context for the results. Additional information regarding till composition (clast lithology and matrix geochemistry) and ice-flow history will be released as part of a later publication.

The Manitoba Geological Survey (MGS) conducted two weeks of boat-supported Quaternary geology fieldwork in the Southern Indian Lake area (parts of NTS 64B15, 64G1, 2, 7, 8) during the 2016 field season (Hodder, 2016), building on work conducted during the previous summer in the north area of the lake basin (Hodder, 2015) and previous work in the Gauer Lake to Wishart Lake area (Trommelen, 2015). The location of KIM samples collected during the 2016 field season is displayed in Figure 1.

Study location and geological setting

The study area is located in north-central Manitoba. Elevation varies from 243 to 349 m asl within the study area. The lake surface elevation of Southern Indian Lake during the 2015 and 2016 field season was approximately 260 m asl. Relief is low (≤30 m) across the study area. Natural exposures of sediment along the Southern Indian Lake shoreline are relatively rare, highly variable throughout the lake and typically expose only 1–2 m of sediment; however, exposures of up to 10 m in thickness were observed. The study area lies within a region of discontinuous permafrost (Sladen, 2011) and variable permafrost cover was encountered during fieldwork.

Bedrock geology

The study area is largely underlain by granitoid bedrock of the Chipewyan and Southern Indian domains. The south half of the study area includes supracrustal rocks of the Pukatawakan Bay and Partridge Breast Lake assemblages (Kremer, 2008b; Kremer et al., 2009a; Kremer et al., 2009b). Detailed 1:25 000 to 1:50 000 scale bedrock geology mapping has recently been completed within the study area (Kremer, 2008a; Kremer et al., 2009a; Kremer and Martins, 2014; Martins, 2015, 2016) and prospectors are encouraged to consult with these publications for further information.

Diamond potential

The Southern Indian Lake area is considered to be a prospective region for diamond exploration (e.g., Corrigan et al., 2007; Kremer et al., 2009b). The occurrence of Archean crustal inliers and the abundance of detrital and inherited zircons of Archean age in the predominantly Paleoproterozoic rocks at Southern Indian Lake (Kremer et al., 2009a, b) is potentially analogous to the Archean crust of the Sask craton that is thought to underlie regions in east-central Saskatchewan where several diamond occurrences are situated (i.e., Fort à la Corne and the Pikoo kimberlites). Reconnaissance-scale KIM sampling conducted during this project is the first to investigate the diamond potential of the region from a till indicator-mineral perspective.

Ice-flow history

At least six ice-flow phases (Figure 1) are recorded in the central and northern area of Southern Indian Lake (Hodder, 2015, 2016). Early, rare, southeast (phase I, 137–164°) and west (phase II, 268–297°) ice-flow indicators were observed, similar to observations in adjacent study areas to the east (Trommelen, 2015) and regionally (Dredge and Nixon, 1992; Kaszycki et al., 2008). These early ice-flows are followed by southward ice-flow (phase III, 178–215°). A clockwise transition is then recorded in the ice-flow data as evidenced by phase IV (205–220°) and phase V (225–253°). Phase VI (190–228°) is interpreted to represent localized deglacial ice flow.

Southwest-trending ice-flow indicators are dominant in the Southern Indian Lake area (phases IV and V). The complex ice-flow history of the area dictates that earlier ice-flow phases–westerly and southeasterly ice-flow phases–cannot be ignored and that the potential for complex palimpsest dispersal trains exists.

Methods

Till sampling

A total of 18 wave-cut shoreline exposures of Quaternary sediments were logged in detail and 19 C-horizon till samples were collected for KIM analysis (Figure 1). Till is commonly buried beneath a thick blanket of glaciolacustrine sediments in the Southern Indian Lake area, so wave-cut exposures provide easy access to the buried till. Preliminary station logs of till-sample sites are presented in Appendix 1. These station logs provide a description of the sediments, stratigraphy, and local bedrock ice-flow indicators present at the KIM sample site. More detail will be provided in an upcoming report.

Ice-flow mapping

Erosional paleo–ice-flow indicators, such as striae, grooves, chattermarks and crescentic gouges were mapped where present. Many outcrops exhibited multiple paleo–ice-flow indicators, and the relative chronology of these ice-flow phases was deciphered using the crosscutting and outcrop relationships of facets and striae (McMartin and Paulen, 2009). Clast fabrics conducted within till measured the orientation of the a-axis of 30 elongate clasts where the a:b axis ratio was greater than 1.5.

Kimberlite-indicator-mineral analysis and classification

KIM samples were analyzed by De Beers Group of Companies (De Beers) through in-kind support. KIM sample locations were withheld from De Beers to allow equal opportunity for follow-up by all interested parties. Till heavy-mineral concentrate from the <0.5 mm size-fraction was passed over a 0.3 mm aperture sieve and the <0.3 mm size-fraction discarded–leaving only the 0.3–0.5 mm size-fraction. Suspected KIM grains were then selected visually, and analyzed by electron microprobe. KIM grains were initially classified using electron

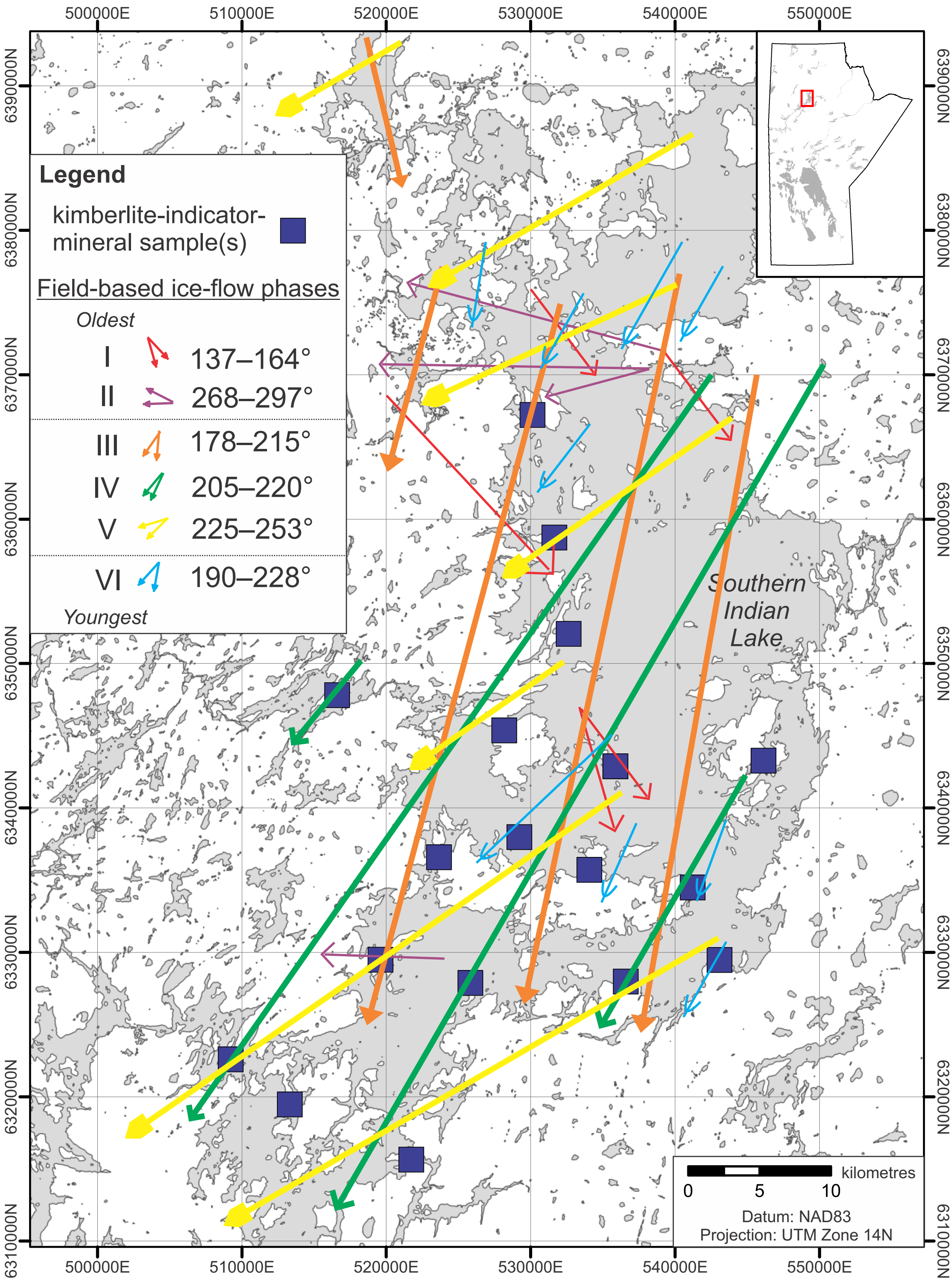

Figure 1: *Location of the study area at Southern Indian Lake, north-central Manitoba. The ice-flow history of the study area and location of till samples submitted for KIM analysis are depicted.*

microprobe results according to the method outlined by Thorleifson et al. (1994). Garnet grains were further classified according to the method outlined by Grütter et al. (2004; Figure 2). Mg-ilmenite grains were verified using the discriminate diagram proposed by Wyatt et al. (2004; Figure 2b). Diamond-inclusion spinel grains were classified according to a modified discriminate diagram of Fipke (1995; Figure 2c).

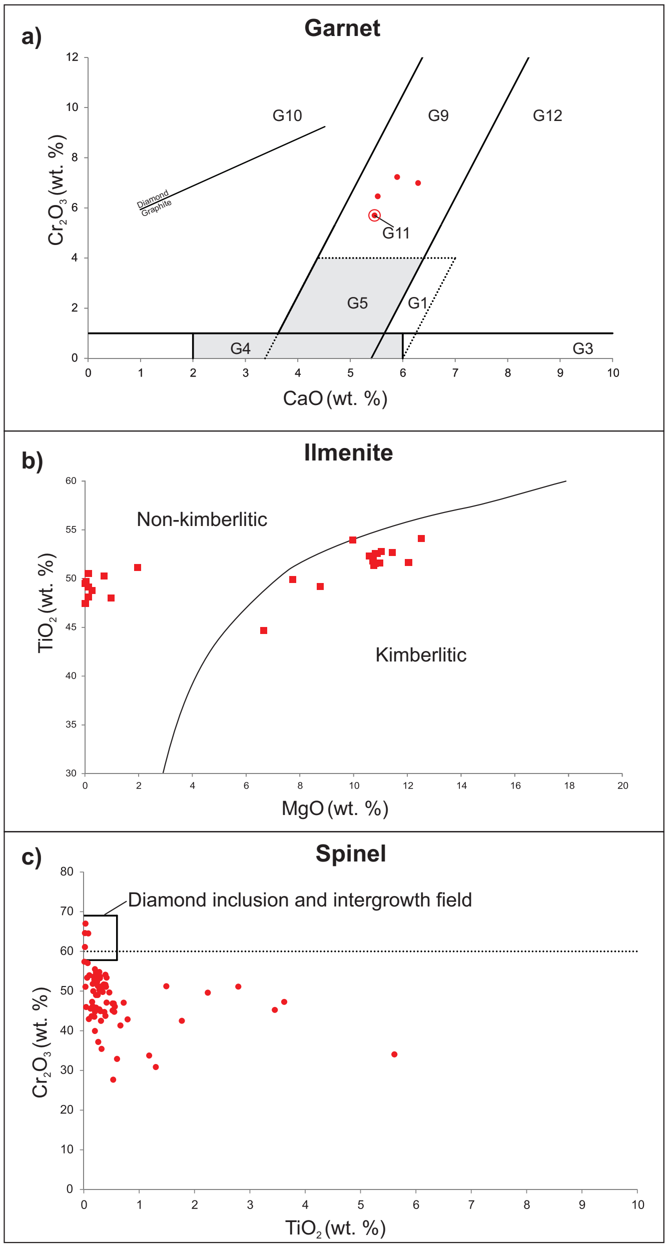

***Figure 2:** Discriminate diagrams for kimberlite-indicator-minerals: **a)** Cr_2O_3 versus CaO discriminate diagram for garnet after Grütter et al. (2004). The G5 and G4 classifications indicated by the light grey fill pattern are distinguished by Mg-number. The stippled G1 group does not overlap G4, G5, G9 or G12 categories as G1 garnet grains are distinguished by a higher TiO_2 content. G11 garnets are also classified based on a higher TiO_2 content and are differentiated from G1 garnets by a higher Cr_2O_3 content. A G11 garnet classified from this study is highlighted; **b)** TiO_2 versus MgO discriminate for ilmenite after Wyatt et al. (2004); **c)** Cr_2O_3 versus TiO_2 for chromite modified after Fipke (1995). A dashed line representing 60 wt. % Cr_2O_3 is shown for visual reference.*

Results

A total of 106 KIM grains were recovered during this study and every sample yielded at least one KIM. The visual identification, chemistry and total grain counts are presented in Appendix 2. The spatial distribution of total-KIM counts per sample (Figure 3) does not appear to show any dispersal pattern at this reconnaissance-scale level of sampling.

The majority of the KIMs recovered are Cr-spinel (77%) and Mg-ilmenite (15%). Additionally, three G9 garnets (4%), one G11 garnet (1%) and four diamond-inclusion Cr-spinels (4%) were identified. KIM results are displayed as compositional pie-charts proportionally-sized to the total number of KIMs recovered in Figure 4.

The lack of publicly available KIM data within northern Manitoba (Keller et al., 2004) inhibits comparisons of this dataset regionally. The closest dataset is to the north, between 260 and 325 km away in the Nejanilini, Kasmere and Putahow lakes areas (Böhm et al., 2008). In 2008, only minimal (<10) KIMs were recovered from 39 samples (11 L of till each) in this area of northern Manitoba near the Nunavut border. To the southeast, the closest dataset is in the Superior province (Keller et al., 2004), which is between 230 and 400 km away. To the southwest, the Pikoo kimberlites in Saskatchewan are located between 360 and 400 km away. Prospectors are encouraged to explore available public datasets to provide context to KIM results from the Southern Indian Lake area.

Conclusions

Till samples were collected at a reconnaissance-scale (1–2 samples per 100 km^2) for KIM analyses in the Southern Indian Lake area of north-central Manitoba. All 19 till samples collected contain KIMs, from which a total of 106 KIM grains were recovered from the 0.3–0.5 mm size-fraction of 22.7 L till pails. This includes three G9 garnets, one G11 garnet and four diamond-inclusion spinels.

These new results indicate the presence of anomalous KIM concentrations reflected in the glacial sediments (till) from the Southern Indian Lake area of north-central Manitoba, and suggest the presence of an unknown kimberlitic source(s).

Economic considerations

The Southern Indian Lake area has the potential to host diamond deposits. Kimberlite-indicator-mineral studies are commonly used as a successful exploration tool to investigate the diamond potential in glaciated terrains. This current reconnaissance-scale indicator-mineral study of the central area of Southern Indian Lake has provided the first dataset to assist in evaluating the diamond potential of north-central Manitoba and guide prospecting efforts in this remote area.

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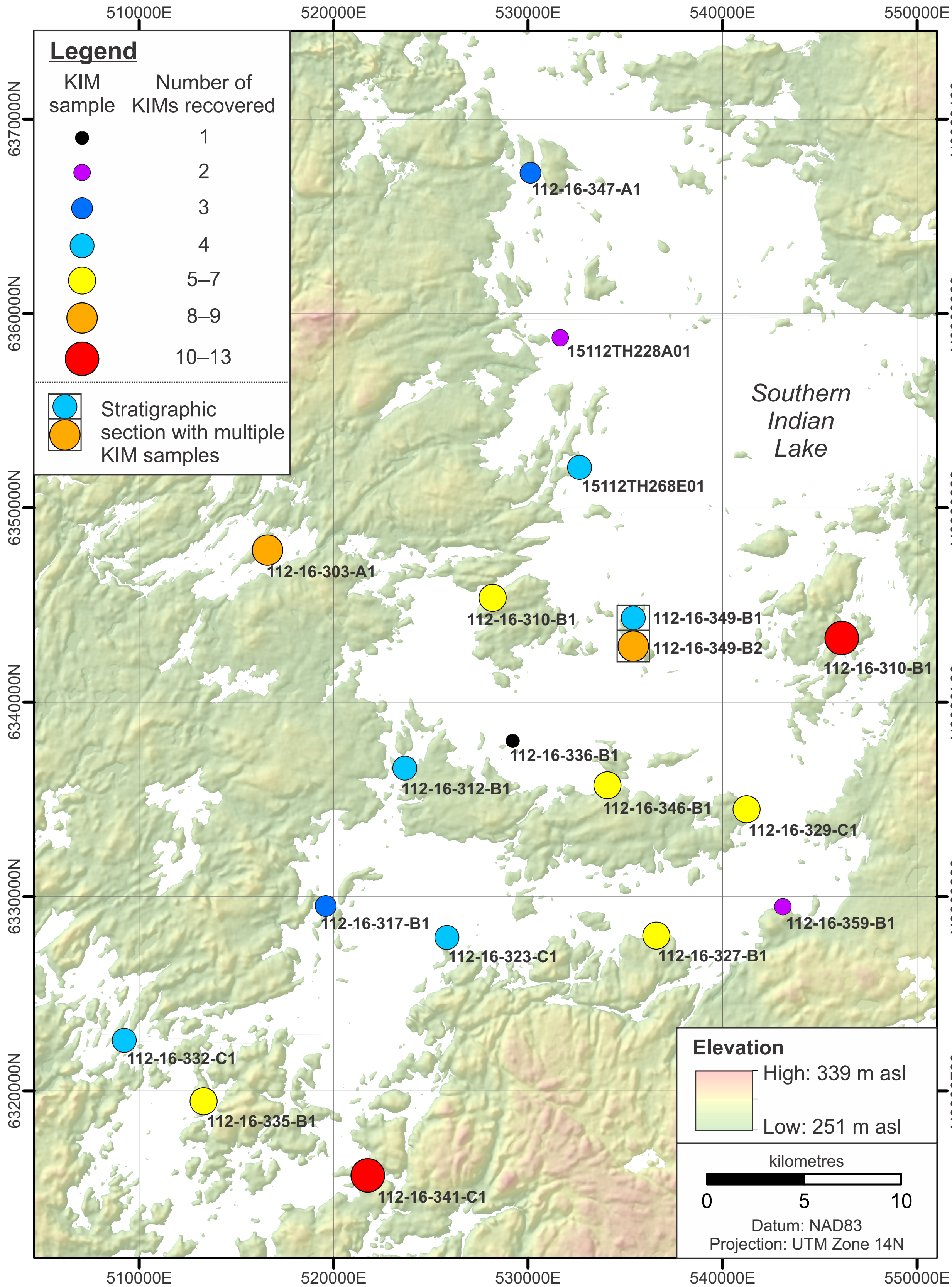

Figure 3: *KIM results displayed as proportional-sized symbols. Background hillshade image was generated using Canadian digital surface model (Natural Resources Canada, 2015).*

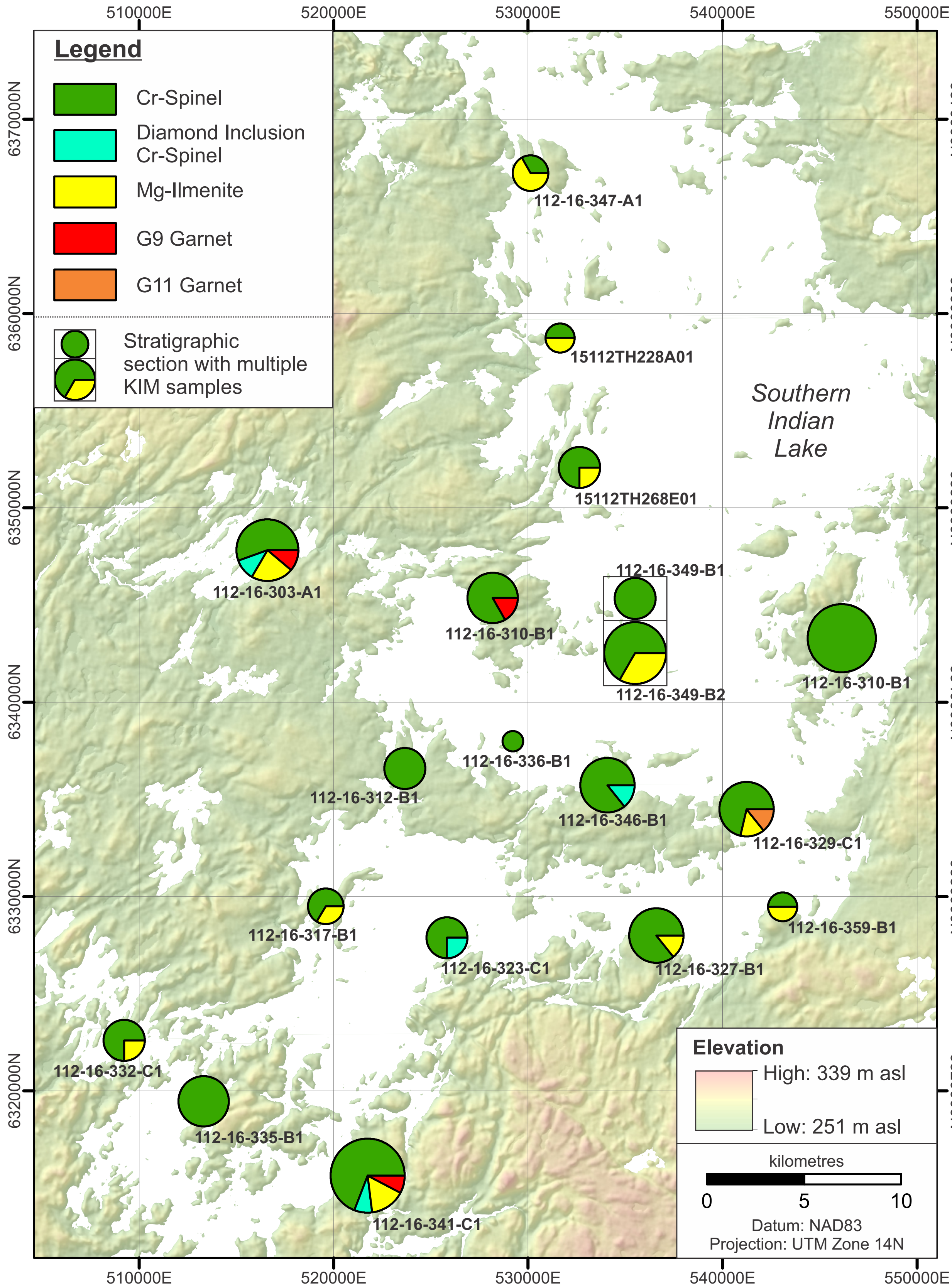

Figure 4: *KIM results displayed as proportional-sized compositional pie charts. Background hillshade image was generated using Canadian digital surface model (Natural Resources Canada, 2015).*

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