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Kimberlite-indicator-mineral results derived from glacial sediments (till) in the Kaskattama highland area of northeast Manitoba (parts of NTS 53N, O, 54B, C)



By
T.J. Hodder & S.E. Kelley

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Winnipeg, 2017; reprinted with minor revisions, July 2017

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Cover illustration: Natural exposure of Quaternary sediments along a river cut. This exposure consists of sand and gravel overlying till that was sampled for kimberlite-indicator-mineral analysis.

Abstract

Reconnaissance-scale kimberlite-indicator-mineral (KIM) sampling was undertaken in the Kaskattama highland region of northeastern Manitoba, to assess the diamond potential of the area. A total of 95 KIM grains were recovered from the 0.3–0.5 mm size-fraction of thirty 11.4 L till samples. This open file includes the electron microprobe analyses, KIM grain counts, and sample locations. Preliminary stratigraphic logs are provided where relevant. These new results confirm the presence

of anomalous KIM concentrations in the Kaskattama highland region and suggest that an unknown kimberlitic source(s) is reflected in the glacial sediments of far-northeastern Manitoba.

A minimum interpretation of the results is provided in this report, as the intent of it is to make this data available to the mineral exploration community quickly. A more rigorous analysis of the data will follow in a subsequent geological report.

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Introduction

A reconnaissance-scale till sampling survey was undertaken with the purpose of collecting samples for kimberlite-indicator-mineral (KIM) analyses, to investigate the diamond potential of the Kaskattama highland region of northeastern Manitoba. The goal of this open file is to publish 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 (including clast lithology and matrix geochemistry), ice-flow history and Quaternary stratigraphy will be released as part of a later publication.

Helicopter-supported fieldwork was undertaken by the Manitoba Geological Survey (MGS) over an eight day period during the summer of 2016 in the Kaskattama highland area (Hodder and Kelley, 2016). Thirty till samples were collected for KIM analysis from twenty sites (Figure 1). Analyses of KIMs from the till is not part of the normal scope of work by the MGS, but was made possible with the generous cooperation of the De Beers Group of Companies (De Beers). This project is also a continuation of collaborative efforts between the MGS and the University of Waterloo, to document the composition of Quaternary tills and assess the glacial stratigraphy of the Hudson Bay Lowland (HBL) and the Precambrian shield in

northeastern Manitoba (Trommelen, 2013; Trommelen et al., 2014; Kelley et al., 2015).

Previous KIM sampling was undertaken by the MGS in the HBL region of Manitoba during the 2001 and 2002 field seasons (Nielsen, 2001, 2002; Nielsen and Fedikow, 2002), with results released as part of the KIM database (Keller et al., 2004).

Study location and geological setting

The Kaskattama highland region in northeast Manitoba is a prominent topographic high that rises 130 m above the flat-lying HBL. The Kaskattama highland region is largely unexplored, primarily due to its remoteness and challenging accessibility.

Regionally, the area is believed to be underlain by Paleozoic carbonate sedimentary rocks of the Hudson Bay Basin, with Precambrian crystalline rocks mapped in the extreme southwestern portion of the field area (Manitoba Department of Mines, Natural Resources and Environment, 1979). Paleozoic bedrock outcrops in the study area were only observed along the base of the Gods River valley, northwest of the First Nation community of Shamattawa.

The postglacial Tyrrell Sea inundated the area up to an elevation of 146 m asl (marine limit) along the northern Kaskattama highland. Above marine limit, the dominant landscape

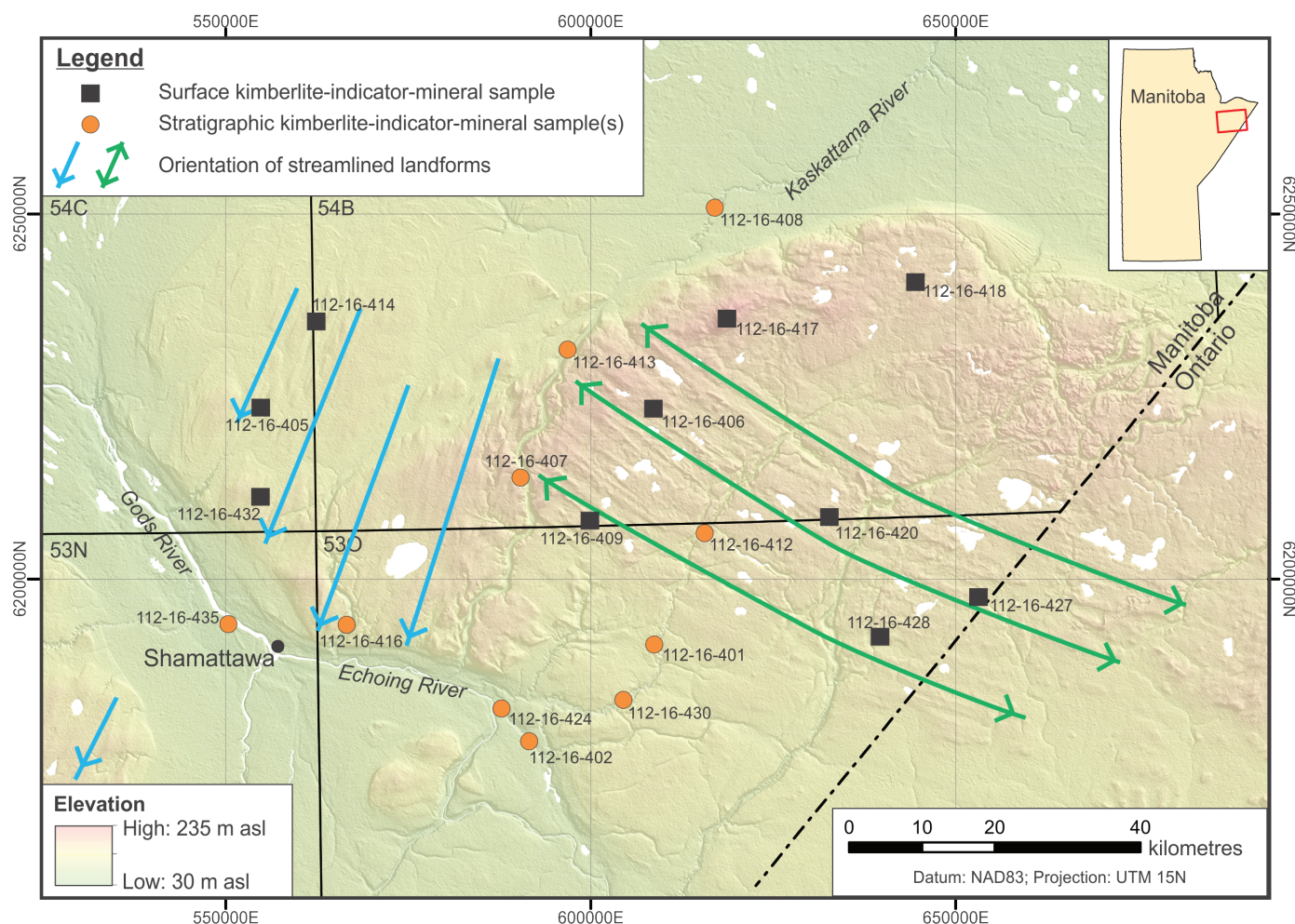


Figure 1: The Kaskattama highland area with locations of till samples submitted for KIM analysis. Background hillshade image was generated using Canadian digital surface model (Natural Resources Canada, 2015).

features include elongate till ridges, hummocky moraine and underfit valleys. The region was affected by two different glacial streamlined-landform flowsets: a southwest-trending flowset west of the highland and a northwest-southeast oriented flowset of unknown ice-flow direction on top of the highland (Figure 1).

Methods

Till sampling

A total of 36 field sites were visited over eight days to document the Quaternary stratigraphy along natural exposures and surface stations. Surface till samples were collected from C-horizon material in hand-dug pits or from mudboils. Mudboils were the preferred sampling sites, as these permafrost features bring unweathered till to the surface (McMartin and McClenaghan, 2001). Stratigraphic sections were cleared to expose fresh material and till samples collected at various intervals. A total of 30 till samples, in 11.4 L buckets, were located from 10 surface stations and 10 stratigraphic sections (Figure 1) to assess the diamond potential of the till through analysis of KIMs. Stratigraphic logs with KIM sample locations are presented in Appendix 1.

Kimberlite-indicator-mineral analysis and classification

KIM samples were analyzed by 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 was discarded, leaving only the 0.5–0.3 mm size fraction. Suspected KIM grains were then selected visually, and analyzed by electron microprobe. KIM grains were initially classified using electron 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). Diamond-inclusion spinel grains were classified according to a modified discriminate diagram of Fipke (1995; Figure 2).

Results

A total of 95 KIM grains were recovered during this study. 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 a well-defined dispersal pattern at this reconnaissance-scale level of sampling.

The majority of the KIMs are Cr-spinels (81%) and Mg-ilmenites (8%), though G9 garnets (5%) and Cr-diopsides (3%) are also present. One diamond-inclusion Cr-spinel, G11 garnet and G3 garnet were also recovered. KIM results are displayed as compositional pie-charts proportionally-sized to the total number of KIMs recovered in Figure 4. In addition to KIM grains recovered, a gold grain was recovered from one sample on top of the highland (Figure 3).

Table 1 compares the proportion of KIMs recovered during this study with similar surveys in the HBL and surrounding

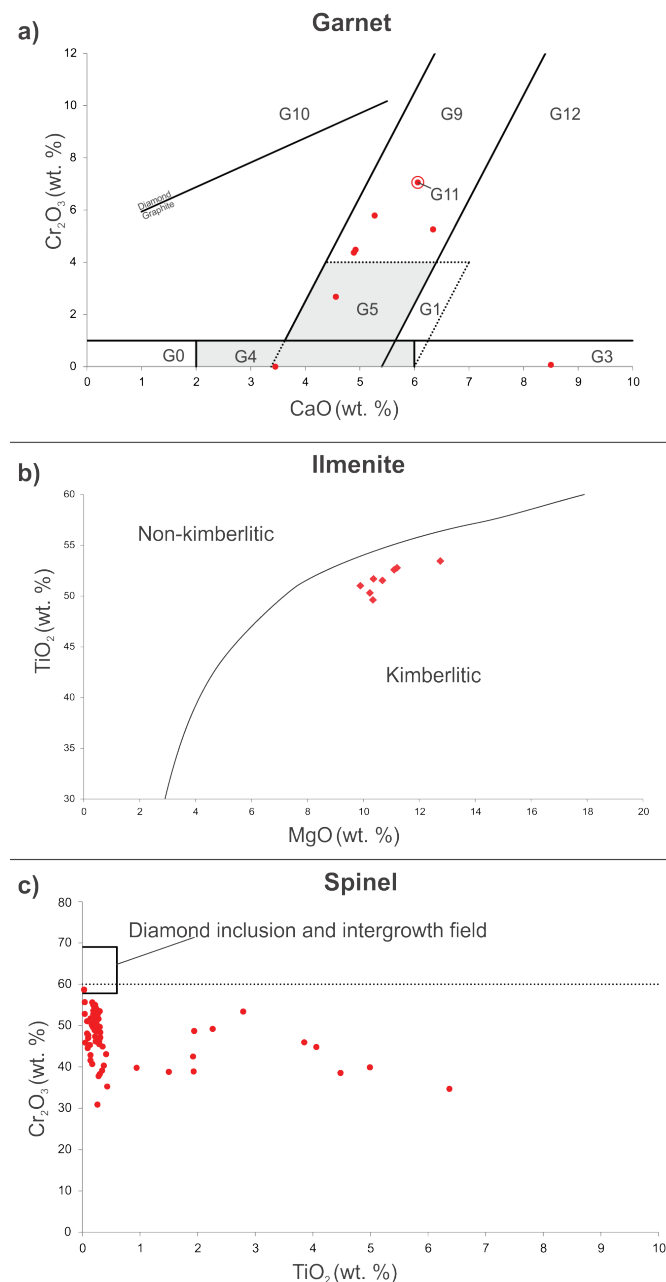


Figure 2: Discriminate diagrams for kimberlite-indicator-minerals: **a)** Cr_2O_3 versus CaO discriminate for garnet grains after Grütter et al. (2004). The G5 and G4 classifications indicated by the light grey fill pattern are distinguished by Mg-number. The stippled G1 group does not overlap G4, G5, 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 grains after Wyatt et al. (2004); **c)** Cr_2O_3 versus TiO_2 discriminate for chromite grains modified after Fipke (1995). A dashed line representing 60 wt. % Cr_2O_3 is shown for visual reference.

region. The Kaskattama study area yielded a substantially increased proportion of KIMs recovered compared to surveys in the HBL and a higher proportion than the Knee Lake area. Due to the small sample size and reconnaissance-scale design of this survey, these observations are to be taken as merely

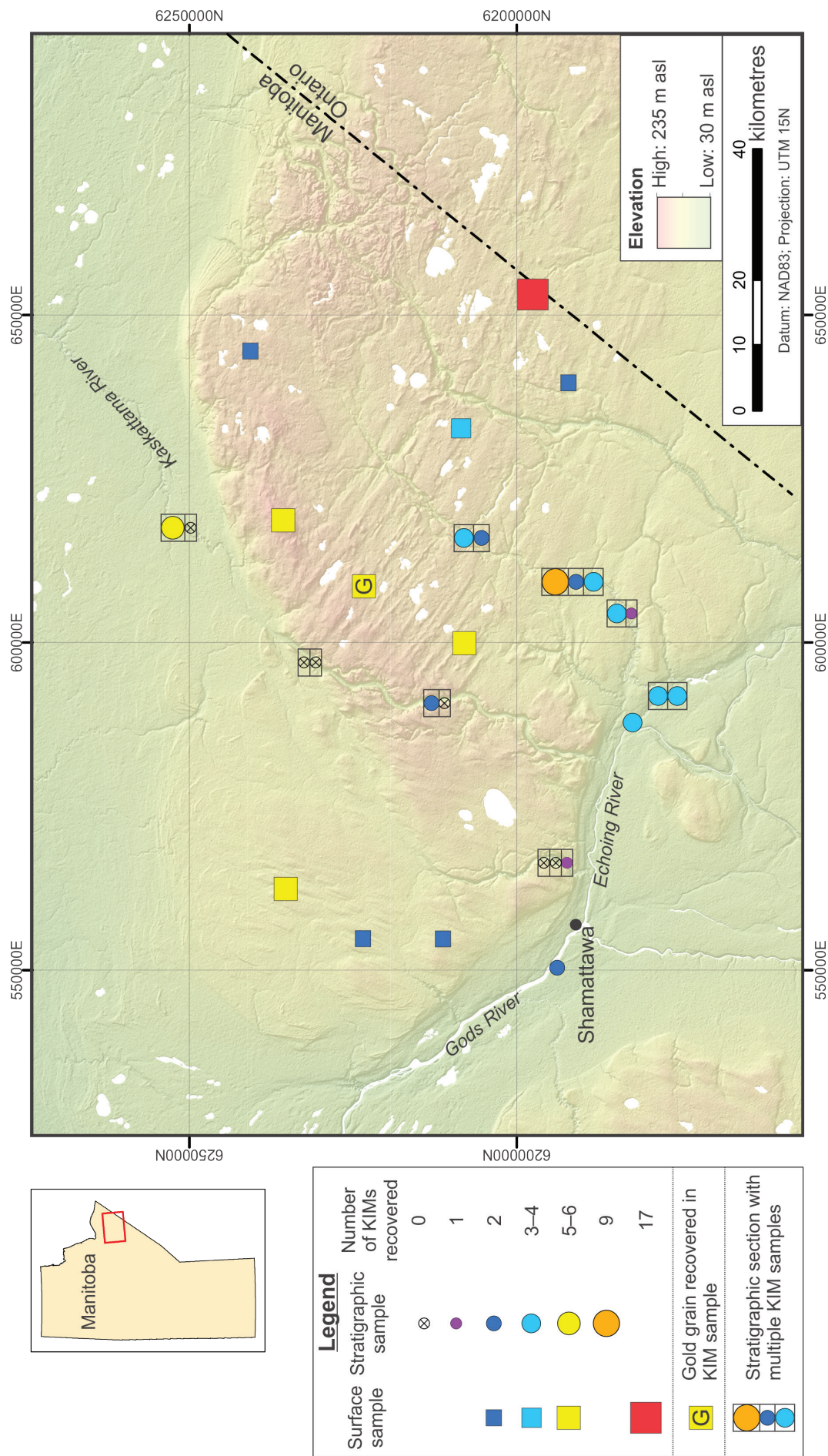


Figure 3: KIM results displayed as proportional-sized symbols. Background hillshade image was generated using Canadian digital surface model (Natural Resources Canada, 2015).

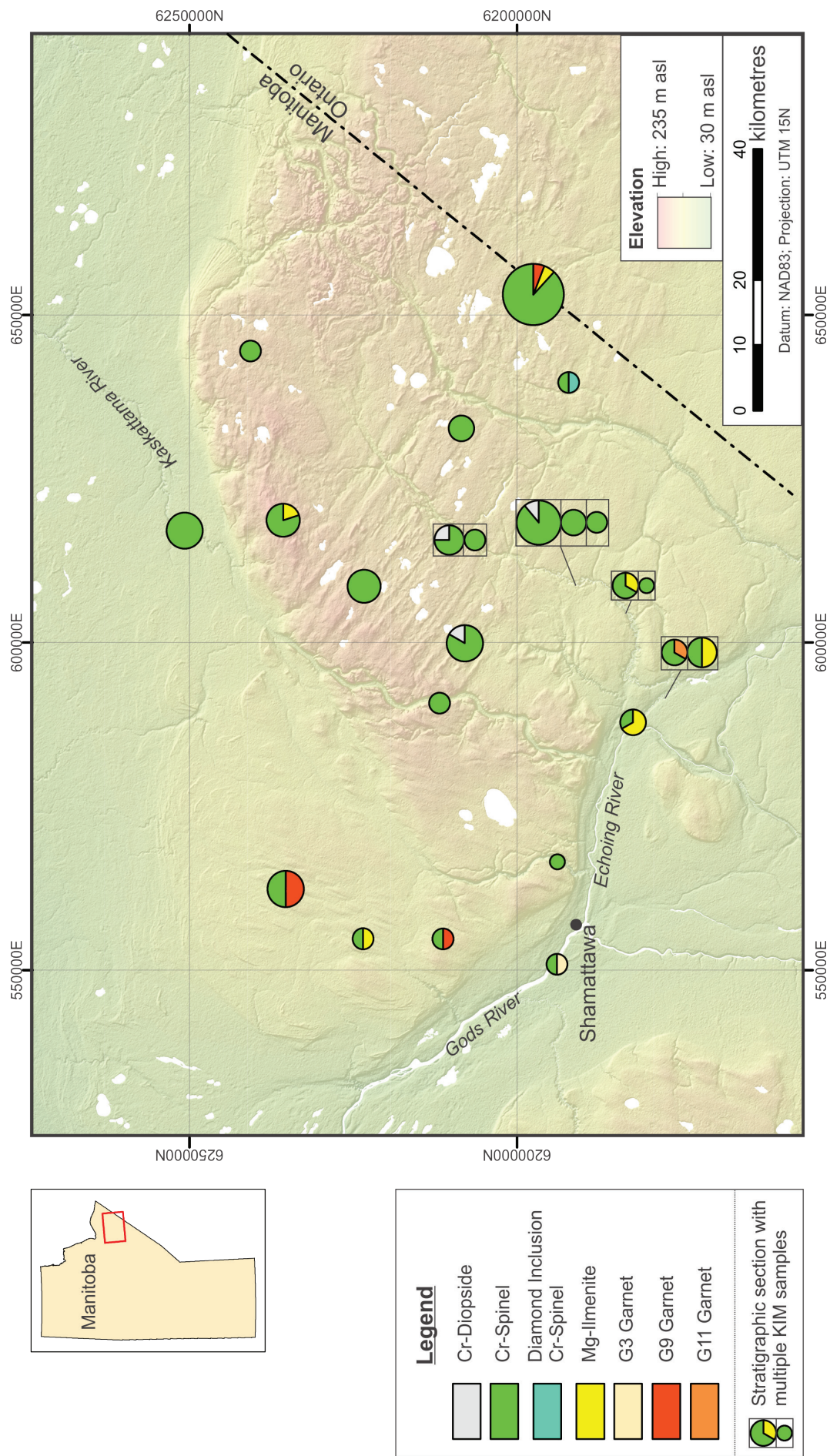


Figure 4: KIM results displayed as proportional-sized compositional pie charts. Background hillshade image was generated using Canadian digital surface model (Natural Resources Canada, 2015).

Table 1: Comparison of Kaskattama kimberlite-indicator-mineral recovery results with surrounding regions.

Study area	Number of till samples for KIMs	Sample volume (L)	Total KIMs recovered (0.3–0.5 mm)	Normalized average KIM recovery (per 11.4 L of till)
Kaskattama highland (this study)	30	11.4	95	3.2
Lower Hayes River (Nielsen and Fedikow, 2002; Keller et al., 2004)	69	11	14	0.2
Upper Hayes, Gods, Nelson, Pennycutaway rivers (Nielsen, 2002; Keller et al., 2004)	143	11	70	0.5
Knee Lake (Trommelen, 2015)	23	11.4	33	1.4
Knee Lake - Operation Superior (Trommelen, 2015)	336	11	430	1.3

insight and prospectors are encouraged to explore the datasets carefully.

Conclusions

Till samples were collected at a reconnaissance-scale for KIM analysis in the remote Kaskattama highland area of north-east Manitoba. Thirty till samples were collected, from which a total of 95 KIM grains were recovered from the 0.3–0.5 mm size-fraction of 11.4 L till pails. This includes six G9 garnet and one diamond-inclusion spinel.

These new results indicate the presence of anomalous KIM concentrations reflected in the glacial sediments (till) from the Kaskattama highland area of northeast Manitoba, and suggest the presence of an unknown kimberlitic source(s).

Economic considerations

The Kaskattama highland region of northeastern Manitoba is a remote and largely unexplored region of northern Manitoba. Results from this study provide the first publicly available reconnaissance-scale insight into the diamond potential of the region. Quaternary stratigraphy, ice-flow and till-composition data will assist in the development of a drift prospecting framework which is necessary in this region of thick drift.

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References

Fipke, C.E., Gurney, J.J. and Moore, R.O. 1995: Diamond exploration techniques emphasising indicator mineral geochemistry and Canadian examples; Geological Survey of Canada, Bulletin 423, 86 p.

Grütter, H.S., Gurney, J.J., Menzies, A.H. and Winter, F. 2004: An updated classification scheme for mantle-derived garnet, for use by diamond explorers; *Lithos*, v. 77, p. 841–857.

Hodder, T.J. and Kelley, S.E. 2016: Quaternary stratigraphy and till sampling in the Kaskattama highland region, northeastern Manitoba (parts of NTS 53N, O, 54B, C); *in* Report of Activities 2016, Manitoba Growth, Enterprise and Trade, Manitoba Geological Survey, p. 187–195.

Keller, G.R., Bogdan, D.J. and Matile, G.L.D. 2004: Manitoba Kimberlite Indicator Mineral Database (Version 3.0); Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, Open File Report OF2004-25, zipped Microsoft Access 2000 database.

Kelley, S.E., Hodder, T.J., Wang, Y., Trommelen, M.S. and Ross, M. 2015: Preliminary Quaternary geology in the Gillam area, north-eastern Manitoba – year 3 (parts of NTS 54D5–9, 11, 54C12); *in* Report of Activities 2015, Manitoba Mineral Resources, Manitoba Geological Survey, p. 131–139.

Manitoba Department of Mines, Natural Resources and Environment 1979: Geological map of Manitoba; Manitoba Department of Mines, Natural Resources and Environment, Mineral Resources Division, Geological Report 79-2, scale 1:1 000 000.

McMartin, I. and McClenaghan, M.B. 2001: Till geochemistry and sampling techniques in glaciated shield terrain: a review; *in* Drift Exploration in Glaciated Terrain, M.B. McClenaghan, P.T. Bobrowsky, G.E.M. Hall and S.J. Cook (ed.), Geological Society, Special Publication, no. 185, p. 19–43.

Munsell Color–X-Rite, Incorporated 2015: Munsell Soil Color Book; Pantone LLC, Carlstadt, New Jersey, 42 p.

Natural Resources Canada 2015: Canadian digital surface model; Natural Resources Canada, URL <<http://geogratis.gc.ca/api/en/nrcan-rncan/ess-sst/34f13db8-434b-4a37-ae38-03643433fbbb.html>> [September 2015].

Nielsen, E. 2001: Quaternary stratigraphy, till provenance and kimberlite indicator mineral surveys along the lower Hayes River; *in* Report of Activities 2001, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 121–125.

Nielsen, E. 2002: Quaternary stratigraphy and ice-flow history along the lower Nelson, Hayes, Gods and Pennycutaway rivers and implications for diamond exploration in northeastern Manitoba; *in* Report of Activities 2002, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 209–215.

Nielsen, E. and Fedikow, M.A.F. 2002: Kimberlite indicator mineral surveys, lower Hayes River; Manitoba Industry, Trade and Mines, Manitoba Geological Survey, Geological Paper GP2002-1, 39 p.

Thorleifson, L.H., Garrett, R.G. and Matile, G.L.D. 1994: Prairie kimberlite study - indicator mineral geochemistry; Geological Survey of Canada, Open File 2875, 15 p.

- Trommelen, M.S. 2013: Preliminary Quaternary geology in the Gillam area, northeastern Manitoba (parts of NTS 54D5-9, 11, 54C12); *in* Report of Activities 2013, Manitoba Mineral Resources, Manitoba Geological Survey, p. 169–182.
- Trommelen, M.S. 2015: Glacial history and till composition, Knee Lake area, northeastern Manitoba (NTS 53L14, 15, 53M1, 2); Manitoba Mineral Resources, Manitoba Geological Survey, Geoscientific Paper GP2013-3, 30 p.
- Trommelen, M.S., Wang, Y. and Ross, M. 2014: Preliminary Quaternary geology in the Gillam area, northeastern Manitoba (parts of NTS 54D5–11, 54C12) – year two; *in* Report of Activities 2014, Manitoba Mineral Resources, Manitoba Geological Survey, p. 187–195.
- Wyatt, B.A., Baumgartner, M., Anckar, E. and Grütter, H.S. 2004: Compositional classification of “kimberlitic” and “non-kimberlitic” ilmenite; *Lithos*, v. 77, p. 819–840.