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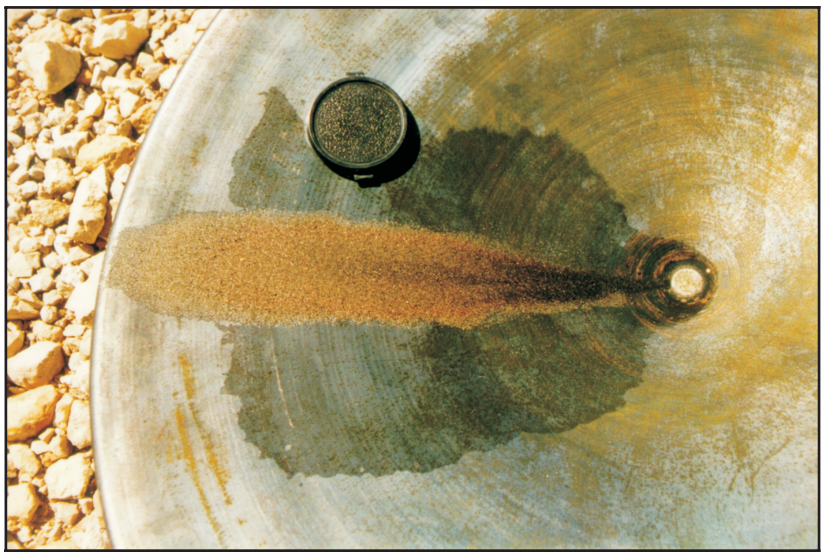
Kimberlite indicator minerals from west-central Manitoba (NTS 62N, 63C, 63K)



By
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OPEN FILE REPORT

Manitoba
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Cover:
Heavy minerals captured by gold panning of typical sand sample from a stream draining the Porcupine Hills.

Georeference:
NTS area(s): 62N, 63C, 63K

Keywords:
bars
Cretaceous
garnet
geochemistry
ilmenite
kimberlite
Manitoba
mineralogy
Porcupine Hills
spinel

Suggested reference:
Bamburak, J.D. and Fedikow, M.A.F. 2001: Kimberlite indicator minerals from west-central Manitoba (NTS 62N, 63C, 63K); Manitoba Industry, Trade and Mines, Manitoba Geological Survey, Open File Report OF2001-3, 11 p. + CD-ROM.

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Kimberlite indicator minerals from west-central Manitoba (NTS 62N, 63C, 63K)

by J.D. Bamburak and M.A.F. Fedikow
Winnipeg, 2001

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TABLE OF CONTENTS

FIGURES

TABLES

CD-ROM

Accompanying CD-ROM has Excel and PDF files for tables 1 to 6.

ABSTRACT

Sand and gravel samples, collected from a variety of depositional environments in west-central Manitoba from 1997 to 2000, were assessed for kimberlite indicator minerals (KIMs). The majority of samples originated from sand bars in streams flowing off the Porcupine Hills. Kimberlite indicator minerals were identified in streams draining the north slope of the Hills, and these include a G9 garnet and a diamond-inclusion spinel in the –1.0 to +0.5 mm grain-size range. A Cretaceous bedrock provenance for the indicators is suggested, based on the absence of KIMs in tills in the immediate vicinity. Approximately 80% of the KIMs in the –0.5 to +0.3 mm size fraction occur in the sand bars of the Little Woody and Rice rivers, and Homestead and Little Rice creeks. Each of these drainages has a common headwater location.

INTRODUCTION

Forty-four sand and gravel samples were analyzed for kimberlite indicator minerals (KIMs). The samples had been collected from a variety of environments in west-central Manitoba (Fig. 1) over the period 1997 to 2000.

Thirty-nine samples were taken at the downstream end of sand bars within streams flowing from the Porcupine Hills (Fig. 2). One sample was collected from a salt spring east of the Porcupine Hills. Two samples were from sand bars within streams on the flanks of Duck Mountain (Fig. 1), and another was taken near the base of a deep gravel pit southeast of Duck Mountain. One sample was dug from garnet-rich beach sand on Clearwater Lake, northeast of The Pas.

PREVIOUS WORK

Porcupine Hills–Duck Mountain–Westlake Plain Area

In May 1985, Monopros Ltd. reported on the results of the examination of 91 mineral-concentrate samples from the southern Porcupine Hills and Westlake Plain (south of Dawson Bay and west of Swan Lake) for KIMs and diamonds (Fowler, 1985). The concentrates were prepared by the former Geological Services Branch (now the Manitoba Geological Survey) from 25 kg till and glaciolacustrine-sediment samples (SL-83, SL-84 and PR-85) collected by the Branch from 1983 to 1985 for Mississippi Valley–type (MVT) Pb-Zn mineralization studies (Nielsen, 1989, Fig. 39). Fowler (1985, 1987) reported that neither KIMs nor diamonds were found in any of the 91 samples.

In 1992, the Geological Survey of Canada conducted a regional study (at a sampling density of one sample per 800 km^2) in the southern portions of the Prairie Provinces. The Prairie Kimberlite Study determined that five of the twelve G10 garnets found in the 816 till samples were from the Westlake Plain and the area immediately down-ice of it. A source near Oliver Lake at the north end of Lake Manitoba was interpreted from drumlinoid ridges and flutes by Thorleifson and Garrett (1993). A similar dispersion train of chrome spinel, with its apex near the south end of Lake Winnipegosis, was documented by Thorleifson et al. (1994). Matile and Nielsen (1996) recognized another dispersion train of chrome diopside extending south and southwest from the Wekusko Lake area in northern Manitoba.

In 1994, Matile and Nielsen (1996) sampled 182 sites for KIMs within 1 km^2 target cells contained within a 100 km^2 cell grid in the Westlake Plain. A 70 kg and a 3 kg split bulk till sample was collected at each site. The 70 kg portion was processed at the Saskatchewan Research Council for KIMs, with 1046 selected grains analyzed by electron microprobe at the University of Manitoba. The 3 kg split was to be chemically analyzed.

Clearwater Lake Area

In 1982, McCabe (1982, Fig. GS-14-2) indicated the presence of highly garnetiferous sand at three locations along the northwest shoreline of Clearwater Lake. The garnet sand beach deposits were not examined for KIMs.

GEOLOGY

The samples for this study were collected at the eastern edge of the Western Canada Sedimentary Basin. The basin contains an assemblage of Phanerozoic sedimentary rocks ranging in age from Cambrian to Recent (Fig. 3). Underlying this portion of the basin is a basement comprising Precambrian igneous, sedimentary and metamorphic rocks. The boundary between the Archean Superior Province to the east and the younger Proterozoic Trans-Hudson Orogen to the west underlies or is close to the study area.

Porcupine Hills–Duck Mountain–Westlake Plain Area

The base of the Phanerozoic assemblage within the Porcupine Hills–Duck Mountain–Westlake Plain area consists of Devonian carbonate rocks (Fig. 3). Mesozoic shale with minor carbonate, and sand units of Cretaceous age overlie the Devonian beds in the Porcupine Hills and Duck Mountain. Pleistocene and Recent sediments usually form a thin veneer over these older sedimentary rocks. All of the above geological terranes contributed to the sediments sampled in the streams and flowing down the slopes of the Porcupine Hills and Duck Mountain.

The Paleozoic and Mesozoic bedrock was described in detail by Norris et al. (1982) and McNeil and Caldwell (1981), respectively. Details of the Pleistocene and Recent sediments were presented by Nielsen (1989).

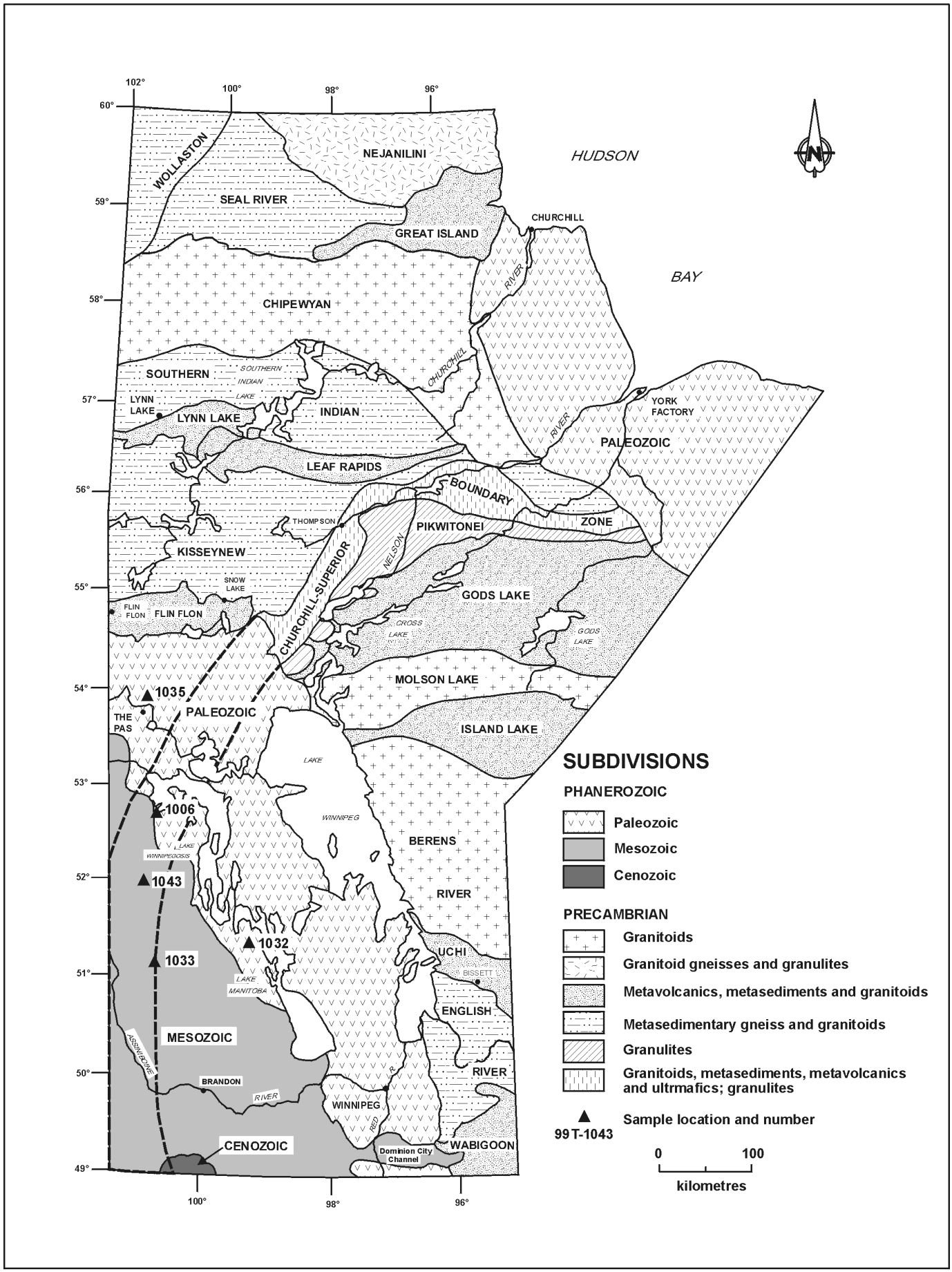


Figure 1: Location map and regional geological setting.

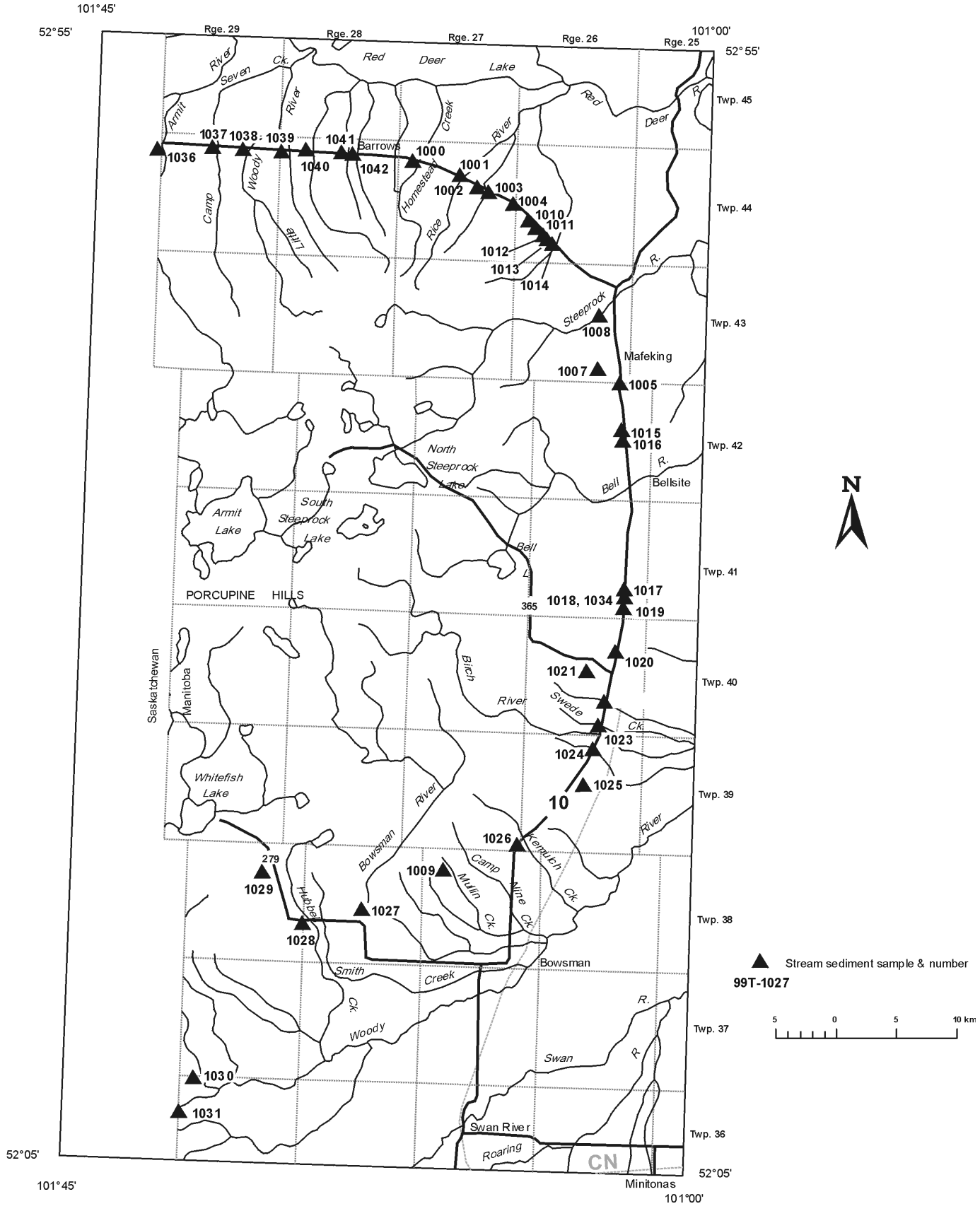
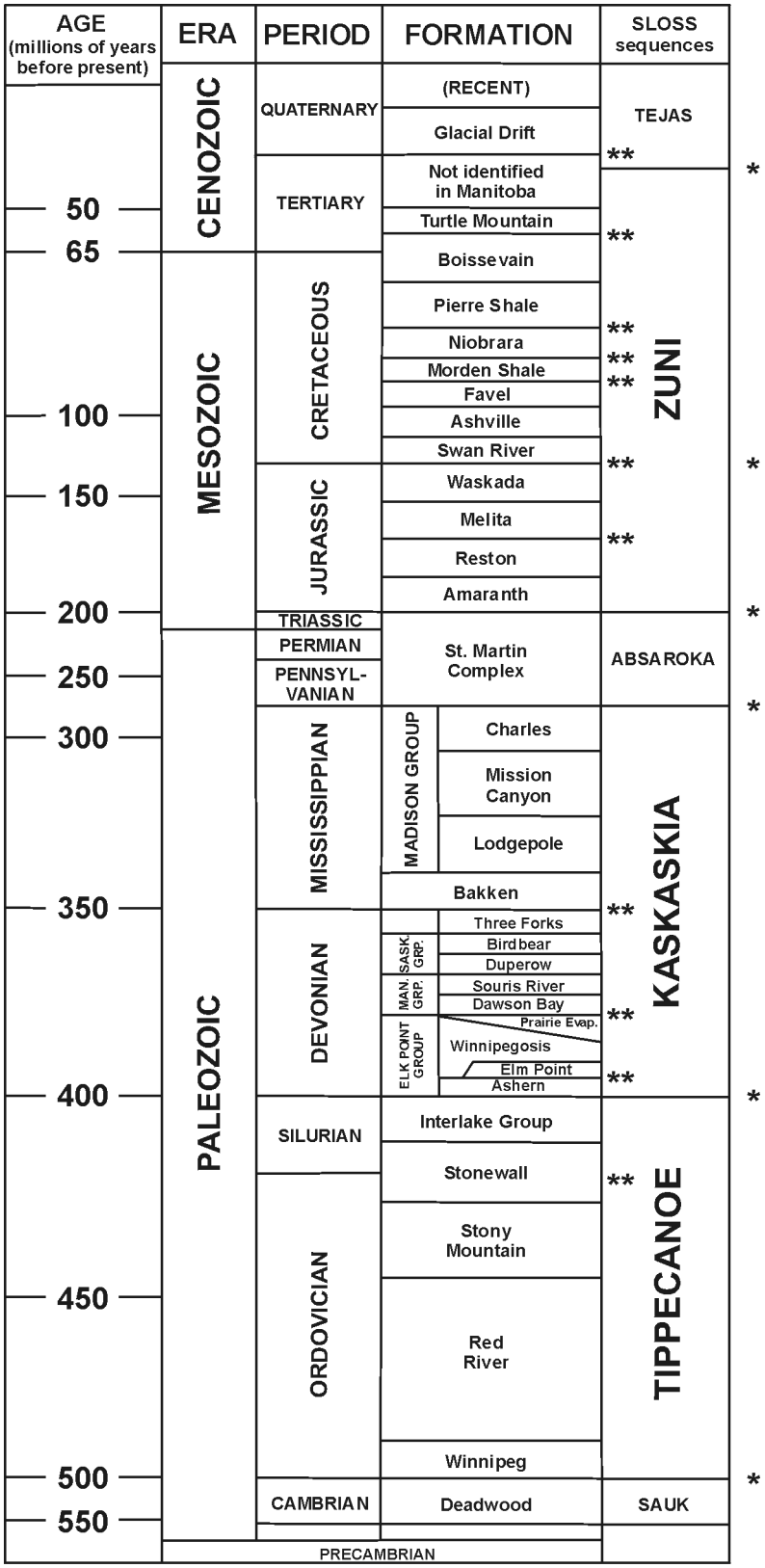


Figure 2: Sample locations in the Porcupine Hills and vicinity.



Footnote: * Potential major karst events

** Potential minor karst events

Figure 3: Stratigraphic column.

Clearwater Lake Area

In the vicinity of the highly garnetiferous Clearwater Lake beaches, northeast of The Pas, the carbonate bedrock is of Late Ordovician age (Bannatyne, 1988). The formations represented are the Upper Stony Mountain and/or Stonewall formations. The underlying Precambrian is exposed approximately 60 km to the north.

McCabe (1982) investigated the carbonate bedrock, northeast of the garnet sand beaches, and concluded that there was no evidence of brecciation, anomalous dips or unusual rock types to suggest the presence of a meteorite impact structure.

SAMPLE COLLECTION, PREPARATION AND ANALYSIS

During the summer of 1997, 5 kg samples of sand and fine gravel were collected at the downstream end of sand bars within 39 streams flowing from the Porcupine Hills (Table 1). These samples were collected as part of the investigations of the Prairie-type microdisseminated mineralization in west-central Manitoba (Bamburak et al., 1997). Five additional 5 kg sediment samples from other environments and outside the Porcupine Hills (Fig. 1) were also collected. These samples were from:

1) German Lake salt spring, along the Pelican Rapids Road east of the Porcupine Hills (99T-1006);

2) East Favel River, southeast of Minitonas on the north slope of Duck Mountain (99T-1043);

3) Sulphur Spring Creek, north of Grandview on the south slope of Duck Mountain (99T-1033);

4) Fishing River gravel pit, north of Sifton, southeast of Duck Mountain (99T-1032); and

5) Clearwater Lake beach (northwest shoreline), northeast of The Pas (99T-1035).

The samples were washed to remove organic materials and coarse sieved to remove pebbles. They were shipped to Monopros Ltd. for processing, at the end of the 2000 sampling program. According to Fedikow et al. (2000), processing by Monopros would include screening the 5 kg samples at 2.0 mm, with the oversize discarded except for a representative aliquot of the –5.6 to +2.0 mm fraction, which was used for pebble counts. The –2.0 mm size fraction was passed over a 0.3 mm aperture sieve and the –0.3 mm size fraction discarded. The –2.0 to +0.3 mm fraction was concentrated by gravity separation, dried in ovens and further sieved into –2.0 to +1.0 mm, –1.0 to +0.5 mm and –0.5 to +0.3 mm size fractions, which were packaged, labelled and shipped to Monopros laboratories for further treatment.

These three size fractions were individually separated using the heavy liquid bromoform (specific gravity = 2.86). The heavy fractions that sank through the bromoform were washed and sorted for KIMs. Indicator minerals were analyzed by microprobe (Fedikow et al., 2000).

VISUAL MINERALOGY AND MINERAL CHEMISTRY

No KIMs were found in the –2.0 to +1.0 mm size fraction. The KIM abundances for the –1.0 to +0.5 mm and the –0.5 to +0.3 mm size fractions are listed in Tables 2 and 3, respectively. The following abbreviations appear in the tables:

TFND	Total number of kimberlitic indicator-mineral grains
TGA	Total number of kimberlitic garnet grains
ROK	Number of garnet grains with remnants of kelyphite (surface-texture feature) preserved as a crust around the grain
OTH	Number of other kimberlitic garnet grains
TIL	Total number of ilmenite grains
PM	Number of ilmenite grains with perovskite mantle (surface-texture feature)
OTH	Number of other ilmenite grains
TCD	Total number of chrome-diopside grains
ROS	Number of chrome-diopside grains with remnants of original surface (texture feature)
OTH	Number of other chrome-diopside grains
TSP	Total number of chrome-spinel (chromite) grains

The chemistry of picked KIMs, analyzed by microprobe and classified for the –1.0 to +0.5 mm and –0.5 to +0.3 mm size fractions, are listed in Tables 4 and 5, respectively. The –1.0 to +0.5 mm size fraction has ten KIMs comprising eight chrome spinels and two magnesian ilmenites. The –0.5 to +0.3 mm size fraction has one each of G10 (99T-1035), G9 (99T-1040) and G11 (99T-1028) garnets, as well as a diamond-inclusion spinel in 99T-1001.

CONCLUSIONS

The source of the KIMs within the streams draining the Porcupine Hills is presently unknown. The following possibilities have to be considered:

1) The KIMs may have originated from the exposed Precambrian Shield, to the north and east, and were transported into the study area by glaciers.

   a) As noted earlier, Matile and Nielsen (1996) recognized a chrome-diopside dispersion train extending south and south-west

Table 1: West-central Manitoba sediment samples.

Sample no.	Location	NTS	Zone	Easting	Northing	ls-sec-tp-rge
99T-1000	Homestead Creek bridge	63C/14SW	NAD 27 14U	340750	5855110	15-30-44-27W
99T-1001	Rice River bridge	63C/14SW	NAD 27 14U	344530	5854090	04-27-44-27W
99T-1002	Centre Rice Creek culvert	63C/14SW	NAD 27 14U	346140	5853140	12-23-44-27W
99T-1003	Cement Culvert Creek (Little Rice)	63C/14SW	NAD 27 14U	346980	5852670	07-23-44-27W
99T-1004	(Little) Rice Creek bridge	63C/14SW	NAD 27 14U	348850	5851760	15-13-44-27W
99T-1005	Smith (Morgan) Creek bridge	63C/11NE	NAD 27 14U	358070	5837000	14-35-42-26W
99T-1006	German Lake salt spring	63C/15SW	NAD 27 14U	372630	5846460	03-04-44-24W
99T-1007	Mafeking Creek ford	63C/11NE	NAD 27 14U	356010	5838400	11-02-43-26W
99T-1008	Steeprock River old crossing	63C/11NE	NAD 27 14U	356110	5842530	06-23-43-26W
99T-1009	Mudlen Creek discovery	63C/06SW	NAD 27 14U	343410	5796870	13-29-38-27W
99T-1010	Baden West Creek bridge	63C/14SE	NAD 27 14U	350190	5850360	02-18-44-26W
99T-1011	Baden East Creek (south of hamlet)	63C/14SE	NAD 27 14U	350200	5849850	10-07-44-26W
99T-1012	Sting Creek	63C/14SE	NAD 27 14U	351620	5848880	03-08-44-26W
99T-1013	Beaver Dam Creek	63C/14SE	NAD 27 14U	352110	5848310	16-05-44-26W
99T-1014	77 Creek	63C/14SE	NAD 27 14U	353270	5847450	07-04-44-26W
99T-1015	Raven Creek	63C/11NE	NAD 27 14U	358020	5833170	10-23-42-26W
99T-1016	Nowhere Creek	63C/11SE	NAD 27 14U	358100	5832020	15-14-42-26W
99T-1017	Dry Creek	63C/11SE	NAD 27 14U	358120	5821610	08-14-41-26W
99T-1018	Glade Creek	63C/11SE	NAD 27 14U	358120	5821230	01-14-41-26W
99T-1019	Post Creek	63C/11SE	NAD 27 14U	358050	5819370	01-11-41-26W
99T-1020	Unnamed creek	63C/06NE	NAD 27 14U	357320	5815050	06-26-40-26W
99T-1021	Steeprock Road Creek	63C/06NE	NAD 27 14U	355150	5813340	05-22-40-26W
99T-1022	Turnoff Creek	63C/06NE	NAD 27 14U	356400	5811010	16-10-40-26W
99T-1023	Rusty Creek	63C/06NE	NAD 27 14U	355960	5809010	10-03-40-26W
99T-1024	Birch River (Primrose wayside park)	63C/06NE	NAD 27 14U	355670	5807090	07-34-39-26W
99T-1025	Iron Creek	63C/06SE	NAD 27 14U	353860	5804420	11-21-39-26W
99T-1026	Kematch River	63C/06SE	NAD 27 14U	349370	5799250	08-01-39-27W
99T-1027	Bowsman River	63C/06SW	NAD 27 14U	336640	5793750	16-16-38-28W
99T-1028	Hubbell Creek	63C/06SW	NAD 27 14U	331860	5792560	04-18-38-28W
99T-1029	Trout Creek	63C/04NE	NAD 27 14U	328200	5786210	16-22-37-29W
99T-1030	Woody Creek	63C/04NE	NAD 27 14U	322750	5779910	16-31-36-29W
99T-1031	Hart Creek	63C/04SE	NAD 27 14U	321450	5777200	05-30-36-29W
99T-1032	Fishing River gravel pit	62N/08NE	NAD 83 14U	425200	5699233	06-33-28-19W
99T-1033	Sulphur Spring Creek bridge	62N/07SE	NAD 27 14U	381750	5689700	01-36-27-24W
99T-1034	New Creek	63C/11SE	NAD 83 14U	358127	5821407	07-14-41-26W
99T-1035	Clearwater Lake	63K/03SE	NAD 83 14U	355759	5992666	16-35-58-26W
99T-1036	Armit River (Saskatchewan)	63C/13SE	NAD 27 14U	319590	5856300	02-36-44-30W
99T-1037	Camp Seven Creek	63C/13SE	NAD 27 14U	324190	5856370	07-33-44-29W
99T-1038	Woody Creek (Little Woody River)	63C/13SE	NAD 27 14U	326710	5856230	04-35-44-29W
99T-1039	Railway Pier Creek bridge	63C/13SE	NAD 27 14U	330030	5856050	04-31-44-28W
99T-1040	Turnoff Creek bridge	63C/14SW	NAD 27 14U	331840	5855960	04-32-44-28W
99T-1041	Barrows West Creek bridge	63C/14SW	NAD 27 14U	334920	5856050	05-34-44-28W
99T-1042	Whisky Creek bridge	63C/14SW	NAD 27 14U	335710	5855980	02-34-44-28W
99T-1043	East Favel River	63C/03SE	NAD 27 14U	360750	5765700	14-19-35-25W

from Wekusko Lake in northern Manitoba (230 km to the north-northeast).

b) Also, a major exploration effort based upon KIMs is underway on the Shield in the Knee Lake area, 500 km to the east-northeast (Fedikow and Nielsen, 2000).

c) However, KIMs were absent in tills capping the southern Porcupine Hills and in tills within the northern part of the Westlake Plain (Fowler, 1985, 1987).

2) The KIMs may have been derived from kimberlitic intrusions within the Western Canada Sedimentary Basin.

a) In Saskatchewan, Cretaceous diamond-bearing kimberlites have been found at Fort à la Corne (280 km to the west-northwest). The KIMs would have been transported into the study area by Cretaceous river systems (possibly glacially reworked).

b) Bezys et al. (1996) identified accretionary lapilli within a possible Cretaceous channel fill near Easterville, 100 km to the east-northeast. Although the samples were not kimberlitic, nearby hydrothermal volcanic activity was inferred and the potential for associated kimberlite intrusions cannot be ruled out.

The results of the KIM analysis are summarized in Table 6. Half of the ten kimberlite indicators in the –1.0 to +0.5 mm grain-size range (including a G9 garnet and a diamond-inclusion spinel) are found in streams draining the north slope of the Porcupine Hills, shown in Figure 2 from 99T-1038 to 99T-1004. Further, almost 80% of the indicators in the –0.5 to +0.3 size fraction are from the same streams. It should be noted that the headwaters of the Little Woody and Rice rivers and of Homestead and Little Rice creeks are located close to one other, suggesting a Cretaceous bedrock provenance for the KIMs. Whether they are locally derived or have been transported is open to speculation. The lack of grains with surface-texture features (Tables 2 and 3) may indicate that the KIMs have travelled some distance.

Table 2: Visual mineralogy, –1.0 to +0.5 mm size fraction. See text for explanation of abbreviations.

Sample no.	TFND	TGA	ROK	OTH	TIL	PM	OTH	TCD	ROS	OTH	TSP
99T-1000	1	0	0	0	0	0	0	0	0	0	1
99T-1001	0	0	0	0	0	0	0	0	0	0	0
99T-1002	1	0	0	0	1	0	1	0	0	0	0
99T-1003	0	0	0	0	0	0	0	0	0	0	0
99T-1004	1	0	0	0	0	0	0	0	0	0	1
99T-1005	0	0	0	0	0	0	0	0	0	0	0
99T-1006	0	0	0	0	0	0	0	0	0	0	0
99T-1007	0	0	0	0	0	0	0	0	0	0	0
99T-1008	0	0	0	0	0	0	0	0	0	0	0
99T-1009	0	0	0	0	0	0	0	0	0	0	0
99T-1010	0	0	0	0	0	0	0	0	0	0	0
99T-1011	0	0	0	0	0	0	0	0	0	0	0
99T-1012	0	0	0	0	0	0	0	0	0	0	0
99T-1013	0	0	0	0	0	0	0	0	0	0	0
99T-1014	0	0	0	0	0	0	0	0	0	0	0
99T-1015	0	0	0	0	0	0	0	0	0	0	0
99T-1016	0	0	0	0	0	0	0	0	0	0	0
99T-1017	0	0	0	0	0	0	0	0	0	0	0
99T-1018	0	0	0	0	0	0	0	0	0	0	0
99T-1019	2	0	0	0	0	0	0	0	0	0	2
99T-1020	0	0	0	0	0	0	0	0	0	0	0
99T-1021	0	0	0	0	0	0	0	0	0	0	0
99T-1022	0	0	0	0	0	0	0	0	0	0	0
99T-1023	0	0	0	0	0	0	0	0	0	0	0
99T-1024	1	0	0	0	0	0	0	0	0	0	1
99T-1025	0	0	0	0	0	0	0	0	0	0	0
99T-1026	0	0	0	0	0	0	0	0	0	0	0
99T-1027	1	0	0	0	1	0	1	0	0	0	0
99T-1028	0	0	0	0	0	0	0	0	0	0	0
99T-1029	1	0	0	0	0	0	0	0	0	0	1
99T-1030	0	0	0	0	0	0	0	0	0	0	0
99T-1031	0	0	0	0	0	0	0	0	0	0	0
99T-1032	0	0	0	0	0	0	0	0	0	0	0
99T-1033	0	0	0	0	0	0	0	0	0	0	0
99T-1034	0	0	0	0	0	0	0	0	0	0	0
99T-1035	0	0	0	0	0	0	0	0	0	0	0
99T-1036	0	0	0	0	0	0	0	0	0	0	0
99T-1037	0	0	0	0	0	0	0	0	0	0	0
99T-1038	0	0	0	0	0	0	0	0	0	0	0
99T-1039	1	0	0	0	0	0	0	0	0	0	1
99T-1040	0	0	0	0	0	0	0	0	0	0	0
99T-1041	1	0	0	0	0	0	0	0	0	0	1
99T-1042	0	0	0	0	0	0	0	0	0	0	0
99T-1043	0	0	0	0	0	0	0	0	0	0	0

ACKNOWLEDGMENTS

Birch Mountain Resources Ltd. supported the field costs associated with the collection of the stream samples in 1997, as part of the investigations of the Prairie-type microdisseminated mineralization in west-central Manitoba. J.A. Fowler of Monopros Ltd. is gratefully acknowledged for sample preparation and analysis. Ric Syme is thanked for reviewing the manuscript.

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Table 3: Visual mineralogy, –0.5 to +0.3 mm size fraction. See text for explanation of abbreviations.

Sample no.	TFND	TGA	ROK	OTH	TIL	PM	OTH	TCD	ROS	OTH	TSP
99T-1000	27	0	0	0	1	0	1	1	0	1	25
99T-1001	12	0	0	0	0	0	0	0	0	0	12
99T-1002	1	0	0	0	0	0	0	0	0	0	1
99T-1003	4	0	0	0	0	0	0	0	0	0	4
99T-1004	5	0	0	0	1	0	1	0	0	0	4
99T-1005	0	0	0	0	0	0	0	0	0	0	0
99T-1006	0	0	0	0	0	0	0	0	0	0	0
99T-1007	1	0	0	0	0	0	0	0	0	0	1
99T-1008	0	0	0	0	0	0	0	0	0	0	0
99T-1009	0	0	0	0	0	0	0	0	0	0	0
99T-1010	0	0	0	0	0	0	0	0	0	0	0
99T-1011	0	0	0	0	0	0	0	0	0	0	0
99T-1012	0	0	0	0	0	0	0	0	0	0	0
99T-1013	0	0	0	0	0	0	0	0	0	0	0
99T-1014	0	0	0	0	0	0	0	0	0	0	0
99T-1015	2	0	0	0	0	0	0	0	0	0	2
99T-1016	1	0	0	0	0	0	0	0	0	0	1
99T-1017	0	0	0	0	0	0	0	0	0	0	0
99T-1018	0	0	0	0	0	0	0	0	0	0	0
99T-1019	1	0	0	0	0	0	0	0	0	0	1
99T-1020	4	0	0	0	0	0	0	0	0	0	4
99T-1021	0	0	0	0	0	0	0	0	0	0	0
99T-1022	2	0	0	0	0	0	0	0	0	0	2
99T-1023	0	0	0	0	0	0	0	0	0	0	0
99T-1024	0	0	0	0	0	0	0	0	0	0	0
99T-1025	0	0	0	0	0	0	0	0	0	0	0
99T-1026	0	0	0	0	0	0	0	0	0	0	0
99T-1027	0	0	0	0	0	0	0	0	0	0	0
99T-1028	4	1	0	1	0	0	0	0	0	0	3
99T-1029	0	0	0	0	0	0	0	0	0	0	0
99T-1030	0	0	0	0	0	0	0	0	0	0	0
99T-1031	0	0	0	0	0	0	0	0	0	0	0
99T-1032	0	0	0	0	0	0	0	0	0	0	0
99T-1033	0	0	0	0	0	0	0	0	0	0	0
99T-1034	2	0	0	0	0	0	0	0	0	0	2
99T-1035	1	1	0	1	0	0	0	0	0	0	0
99T-1036	0	0	0	0	0	0	0	0	0	0	0
99T-1037	0	0	0	0	0	0	0	0	0	0	0
99T-1038	3	0	0	0	0	0	0	0	0	0	3
99T-1039	11	0	0	0	0	0	0	0	0	0	11
99T-1040	7	1	0	1	1	0	1	0	0	0	5
99T-1041	0	0	0	0	0	0	0	0	0	0	0
99T-1042	0	0	0	0	0	0	0	0	0	0	0
99T-1043	1	0	0	0	0	0	0	0	0	0	1

Table 4: Mineral chemistry, –1.0 to +0.5 size fraction

Sample no.	MnO	Na_2O	Al_2O_3	FeO	SiO_2	TiO_2	CaO	Cr_2O_3	MgO	Total	Classification
99T-1002	0.37	0.1	0.22	36.81	0.01	48.2	0.01	3.21	8.99	97.92	Mg-ilmenite
99T-1027	0.22	0	0.39	39	0.03	48.88	0.03	0.12	9.5	98.16	Mg-ilmenite
99T-1000	0.28	0.3	24.93	32.89	0.03	0.39	0.01	30.9	9.48	99.2	Cr-spinel
99T-1004	0.34	0	19.52	26.42	0	0.29	0.02	43.31	10.21	100.1	Cr-spinel
99T-1019	0.21	0.1	17.02	16.37	0.03	0.16	0	51.68	13.43	98.99	Cr-spinel
99T-1019	0.36	0	11.27	25.2	0	0.71	0	55.12	8.02	100.69	Cr-spinel
99T-1024	0.23	0	16.83	14.61	0.04	0.24	0.01	53.82	15.06	100.84	Cr-spinel
99T-1029	0.03	0	16.88	23.06	0.09	0.79	0	45.71	13.04	99.59	Cr-spinel
99T-1039	0.25	0	17.56	33.18	0.01	0.95	0	39.84	8.7	100.49	Cr-spinel
99T-1041	1.36	0	9.17	42.02	0.01	0.8	0	45.18	0.49	99.03	Cr-spinel

Table 5: Mineral chemistry, –0.5 to +0.3 size fraction

Sample no.	MnO	Na_2O	Al_2O_3	FeO	SiO_2	TiO_2	CaO	Cr_2O_3	MgO	Total	Classification
99T-1000	0.06	1.18	1.75	2.51	54.09	0.03	22.43	1.48	15.8	99.33	Chrome diopside
99T-1028	0.22	0.05	16.99	6.54	42.63	0.97	6.02	6.63	19.79	99.85	Titanian Cr-pyrope (G11)
99T-1035	0.53	0.01	20.61	8.24	42.63	0.15	4.2	4.93	19.64	100.95	Non-titanian Cr-pyrope (G10)
99T-1040	0.38	0.04	19.39	7.68	43.36	0.19	5.63	4.59	19.3	100.54	Non-titanian Cr-pyrope (G9)
99T-1000	0.38	0.06	0.5	37.69	0	49.99	0.04	0.23	10.24	99.13	Mg-ilmenite
99T-1004	0.45	0	0.54	37.5	0.02	49.39	0.02	0.6	10.55	99.06	Mg-ilmenite
99T-1040	0.41	0	0.37	42.38	0	48.93	0	0	6.85	98.94	Mg-ilmenite
99T-1000	0.81	0	13.15	38.36	0	6.01	0	38.46	3.26	100.04	Cr-spinel
99T-1000	0.44	0	10.82	32.52	0	0.43	0	47.18	8.15	99.54	Cr-spinel
99T-1000	1.45	0	0.01	48.32	0	49.04	0	0	0.32	99.14	Ilmenite
99T-1000	0.23	0	0.44	37.3	0.09	51.01	0.07	0.04	10.04	99.21	Mg-ilmenite
99T-1000	0.58	0	7.9	45.41	0	0.65	0	40.2	3.82	98.56	Cr-spinel
99T-1000	0.25	0	16.66	17.38	0	0.13	0	51.97	14.62	101.03	Cr-spinel
99T-1000	0.69	0	16.98	40.22	0	0.45	0	39.92	1.3	99.57	Ilmenite
99T-1000	0.35	0.18	11.59	34.52	0.06	0.38	0	45.58	6.43	99.1	Cr-spinel
99T-1000	0.27	0	7.88	26.87	0.02	3.06	0	46.42	14.02	98.54	Cr-spinel
99T-1000	1.06	0.03	0.92	55.35	0.04	0.76	0	37.68	1.7	97.55	Ilmenite
99T-1000	0.33	0.04	10.46	36.19	0	4.3	0	37.22	9.34	97.89	Cr-spinel
99T-1000	0.37	0	9.8	32.12	0.06	3.4	0	43.23	10.06	99.05	Cr-spinel
99T-1000	0.53	0	19.89	22.25	0.04	0.26	0	47.8	10.3	101.07	Cr-spinel
99T-1000	0.13	0.06	9.63	34.66	0.1	6.41	0	35.96	11.31	98.25	Cr-spinel
99T-1000	0.32	0	13.47	34.49	0	0.29	0	42.51	7.6	98.68	Cr-spinel
99T-1000	0.23	0	8.81	25.99	0	1.93	0	51.81	10.65	99.42	Cr-spinel
99T-1000	0.6	0	8.07	23.31	0	0.18	0.03	57.77	10.22	100.18	Cr-spinel
99T-1000	0.46	0	12.53	37.58	0	0.38	0	41.37	6.59	98.92	Cr-spinel
99T-1000	0.85	0	6.19	45.47	0	0.06	0	47.26	0.43	100.26	Ilmenite
99T-1000	0.3	0	17.99	29.88	0	0.37	0	43.95	6.7	99.19	Cr-spinel
99T-1000	0.2	0.06	15.74	17.76	0.03	0.17	0.12	55.73	10.96	100.78	Cr-spinel
99T-1000	0.18	0	18.15	14.57	0	0.15	0	52.94	14.58	100.57	Cr-spinel
99T-1000	0.46	0	16.38	29.35	0.38	0.27	0.03	46.68	7.13	100.69	Cr-spinel
99T-1000	0.22	0	16.81	31.44	0	0.44	0	43.3	7.81	100.02	Cr-spinel
99T-1000	0.61	0.07	19.31	37.65	0	1.12	0	37.51	2.74	99.02	Cr-spinel
99T-1001	0.4	0.13	15.91	27.04	0	0.4	0.02	49.49	7.04	100.44	Cr-spinel
99T-1001	0.28	0.09	10.59	35.21	0.02	0.38	0.03	46.91	5.69	99.2	Cr-spinel
99T-1001	0.25	0.11	16.21	25.74	0	0.36	0	49.68	7.85	100.19	Cr-spinel
99T-1001	0.22	0.17	27.25	37.87	0	0.09	0	30.66	3.83	100.09	Cr-spinel
99T-1001	0.12	0.04	16	25.02	0.02	0.25	0	49.36	8.64	99.45	Cr-spinel
99T-1001	0.2	0	10.36	11.93	0.13	0.08	0	61.31	15.84	99.84	Diamond inclusion Cr-spinel
99T-1001	0.36	0	19.18	16.37	0	0.17	0	49.93	13.65	99.65	Cr-spinel
99T-1001	0.23	0.04	14.81	23.66	0	0.04	0	51.74	8.85	99.38	Cr-spinel
99T-1001	0.32	0.02	6.41	28.2	0.04	0	0	58.6	5.79	99.39	Cr-spinel
99T-1001	0.29	0	11.44	29.99	0	0	0.01	53.16	3.58	98.48	Cr-spinel
99T-1001	0.22	0	7.46	28.69	0.08	3.55	0	45.87	12.31	98.17	Cr-spinel
99T-1001	0.37	0	10.09	35.65	0	0.18	0	46.46	5.07	97.83	Cr-spinel
99T-1002	0.31	0.06	17.22	22.66	0	0.12	0	46.96	13.2	100.53	Cr-spinel
99T-1003	0.4	0	13.87	45.7	0	0.78	0	33.7	3.14	97.6	Cr-spinel
99T-1003	0.25	0.08	12.04	20.83	0.06	0.54	0	55.04	11.25	100.11	Cr-spinel
99T-1003	0.24	0	25.5	28.21	0	0.11	0	36.19	8.51	98.76	Cr-spinel
99T-1003	0.16	0	9.05	26.49	0.08	3.11	0.01	47.35	12.56	98.81	Cr-spinel
99T-1004	0.17	0	7.77	29.26	0.12	4.95	0	39.06	16.2	97.53	Cr-spinel
99T-1004	0.36	0	10.17	38.56	0.08	0.39	0	45.02	5.38	99.97	Cr-spinel
99T-1004	0.16	0.02	17.29	27.8	0	0.23	0	47.06	6.35	98.91	Cr-spinel
99T-1004	0.45	0.04	18.63	17.91	0.06	0.16	0	49.57	11.84	98.65	Cr-spinel
99T-1007	0.18	0	20.9	23.76	0.06	0.23	0	43.44	11.02	99.59	Cr-spinel
99T-1015	0.11	0	16.13	22.64	0	0.49	0	47.58	12.56	99.51	Cr-spinel
99T-1015	0.02	0.02	18.59	14	0	0.19	0	52.28	15.55	100.64	Cr-spinel
99T-1016	0.79	0	3.36	21.98	0	0	0	66.23	7.27	99.63	Cr-spinel
99T-1019	0.13	0.26	10.74	31.69	0.06	4.42	0	41.66	10.64	99.6	Cr-spinel
99T-1020	0.97	0	10.99	43.24	0	0.51	0	39.26	3.51	98.49	Cr-spinel
99T-1020	0.39	0	18.15	26.13	0.04	0.4	0	47.63	6.7	99.44	Cr-spinel
99T-1020	0.45	0.05	10	35.73	0	0.42	0	47.27	5.08	99.01	Cr-spinel
99T-1020	1.09	0	11.5	44.6	0	0.32	0	39.62	0.74	97.86	Cr-spinel
99T-1022	0.16	0.06	16.72	15.79	0.04	0.1	0	54.15	13.65	100.67	Cr-spinel
99T-1022	0.04	0.04	15.89	14.13	0	0.23	0	54.48	14.58	99.37	Cr-spinel
99T-1028	0.22	0	17.7	27.08	0.02	0.91	0	48.19	6.89	101.01	Cr-spinel
99T-1028	0.42	0.06	14.41	27.17	0.27	0.21	0.01	47.55	9.79	99.88	Cr-spinel
99T-1028	0.23	0.02	10.01	34.44	0	6.53	0.01	35.42	10.9	97.55	Cr-spinel
99T-1034	0.23	0.02	32.62	25.72	0	0.06	0	31.3	10.61	100.56	Cr-spinel
99T-1034	0.22	0	8.51	23.35	0	3.2	0	52.73	12.56	100.58	Cr-spinel

Table 5: Mineral chemistry, –0.5 to +0.3 size fraction (Con't)

Sample no.	MnO	Na_2O	Al_2O_3	FeO	SiO_2	TiO_2	CaO	Cr_2O_3	MgO	Total	Classification
99T-1038	0.21	0	5.32	19.39	0	0.11	0	64.48	10.71	100.22	Cr-spinel
99T-1038	0.4	0	0.01	49.35	0.06	50.08	0.02	0.08	0.75	100.76	Ilmenite
99T-1038	0.22	0.05	10.82	40.76	0	0.17	0	44.41	1.52	97.95	Cr-spinel
99T-1039	0.34	0.02	1.35	40.13	0.11	0	0	50.4	6.22	98.59	Cr-spinel
99T-1039	0.43	0	8.55	34.48	0	0.28	0.01	50.99	6.09	100.82	Cr-spinel
99T-1039	0.32	0.15	17.55	25.16	0	0.18	0.01	47.49	8.96	99.8	Cr-spinel
99T-1039	18.98	0	20.82	21.21	36.37	0.14	2.27	0	0.35	100.15	Cr-spinel
99T-1039	1.07	0	9.72	35.83	0.02	0.33	0	48.55	3.16	98.67	Cr-spinel
99T-1039	0.22	0	16.73	20.94	0.17	0.24	0	49.91	12.02	100.22	Cr-spinel
99T-1039	0.94	0.19	1.32	70.07	0.02	0.65	0.07	21.48	1.34	96.08	Cr-spinel
99T-1039	0.51	0	3.23	49.53	0	0.74	0	40.51	3.14	97.65	Cr-spinel
99T-1039	0.35	0.06	15.55	22.94	0.04	0.12	0	51.02	10.73	100.81	Cr-spinel
99T-1039	0.29	0	17.14	28.32	0	0.65	0	44	9.82	100.22	Cr-spinel
99T-1039	0.26	0.06	9.88	33.32	0	5.81	0	38.38	11.49	99.21	Cr-spinel
99T-1040	0.33	0.12	25.22	30.74	0	0.28	0	35.71	7.48	99.88	Cr-spinel
99T-1040	0.34	0.22	16.71	34.13	0	0.32	0	40.79	6.74	99.24	Cr-spinel
99T-1040	0.4	0.06	9.02	25.79	0	3.75	0	45.69	14.9	99.6	Cr-spinel
99T-1040	0.28	0.02	10.42	34.33	0	4.32	0	39.32	10.33	99.04	Cr-spinel
99T-1040	0.01	0	28.94	12.34	0.18	0	0	41.43	17.92	100.81	Cr-spinel
99T-1043	0.2	0	33.24	16.29	0.13	1.44	0.07	31.66	15.28	98.31	Cr-spinel

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Table 6: Kimberlite indicator-mineral summary.[1]

Sample no. Porcupine Hills (clockwise)	Location	Kimberlite indicator grain size	
		-1.0 to +0.5 mm	-0.5 to +0.3 mm
99T-1036	Armit River (Saskatchewan)	0	0
99T-1037	Camp Seven Creek	0	0
99T-1038	**Woody Creek (Little Woody River)**	**0**	**3**
99T-1039	**Railway Pier Creek bridge**	**1**	**11**
99T-1040	**Turnoff Creek bridge**	**0**	**7**
99T-1041	**Barrows West Creek bridge**	**1**	**0**
99T-1042	Whisky Creek bridge	0	0
99T-1000	**Homestead Creek bridge**	**1**	**27**
99T-1001	**Rice River bridge**	**0**	**12**
99T-1002	**Centre Rice Creek culvert**	**1**	**1**
99T-1003	**Cement Culvert Creek (Little Rice)**	**0**	**4**
99T-1004	**(Little) Rice Creek bridge**	**1**	**5**
99T-1010	Baden West Creek bridge	0	0
99T-1011	Baden East Creek (south of hamlet)	0	0
99T-1012	Sting Creek	0	0
99T-1013	Beaver Dam Creek	0	0
99T-1014	77 Creek	0	0
99T-1008	Steeprock River old crossing	0	0
99T-1007	**Mafeking Creek ford**	**0**	**1**
99T-1005	Smith (Morgan) Creek bridge	0	0
99T-1015	**Raven Creek**	**0**	**2**
99T-1016	**Nowhere Creek**	**0**	**1**
99T-1017	Dry Creek	0	0
99T-1018	Glade Creek	0	0
99T-1034	**New Creek**	**0**	**2**
99T-1019	**Post Creek**	**2**	**1**
99T-1020	**Unnamed creek**	**0**	**4**
99T-1021	Steeprock Road Creek	0	0
99T-1022	**Turnoff Creek**	**0**	**2**
99T-1023	Rusty Creek	0	0
99T-1024	**Birch River (Primrose wayside park)**	**1**	**0**
99T-1025	Iron Creek	0	0
99T-1026	Kematch River	0	0
99T-1009	Mudlen Creek discovery	0	0
99T-1027	**Bowsman River**	**1**	**0**
99T-1028	**Hubbell Creek**	**0**	**4**
99T-1029	**Trout Creek**	**1**	**0**
99T-1030	Woody Creek	0	0
99T-1031	Hart Creek	0	0
External Sites			
99T-1006	German Lake salt spring	0	0
99T-1043	**East Favel River**	**0**	**1**
99T-1032	Fishing River gravel pit	0	0
99T-1033	Sulphur Spring Creek bridge	0	0
99T-1035	**Clearwater Lake**	**0**	**1**

[1] Samples containing kimberlite-indicator grains are in bold.