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The publisher/department name in the bibliographic reference cited immediately below the title of each GS report should read **Manitoba Industry, Economic Development and Mines** instead of **Manitoba Industry, Trade and Mines**.

GS-29 Grassy Bay aeromagnetic-anomaly cluster: a potential source for the Porcupine Hills kimberlite indicator minerals in west-central Manitoba (NTS 63C13NE)

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Summary

Preliminary studies of stream-derived kimberlite indicator minerals (KIM) in the Porcupine Hills of west-central Manitoba were released in 2001 and 2002. The studies

confirmed that the north slope of the Porcupine Hills contains anomalous quantities of KIM relative to other localities along the Manitoba Escarpment. The source of the KIM appeared to be the common headwater locations of the Little Woody, Rice and Steeprock rivers, and Homestead and Little Rice creeks. The likely provenance area for these KIM was interpreted as the Fort à la Corne kimberlites in Saskatchewan, or possibly another location "north of the Porcupine Hills." Examination of aeromagnetic maps north of the Porcupine Hills in Manitoba has revealed the presence of a cluster of magnetic anomalies near Grassy Bay on Red Deer Lake, less than 20 km north of the anomalous KIM sample sites. The southeast-trending cluster consists of 'tiny' highs and lows that bear a striking resemblance, in relative magnitude and shape, to the documented aeromagnetic signatures of the Fort à la Corne kimberlites. Further work is recommended to test this hypothesis.

Introduction

The north slope of the Porcupine Hills (Fig. GS-29-1) has been shown in previous studies to be relatively anomalous in KIM compared with the Manitoba Escarpment and adjacent lowlands (Bamburak and Fedikow, 2001 and 2002). The likely provenance area for these KIM was interpreted as the Fort à la Corne kimberlites in Saskatchewan, or possibly another location "north of the Porcupine Hills." As a result, the area immediately to the north of the anomalous area has been examined to see if there are any geophysical signatures that would suggest the presence of kimberlite intrusions.

Previous work

Bamburak and Fedikow (2001, 2002) reported on the details of previous work on kimberlite mineral investigations by government and industry in the southern portions of the Prairie Provinces. According to Fowler (1985, 1987), no KIM were found in the 91 till and glaciolacustrine samples collected from the southern Porcupine Hills and Westlake



Figure GS-29-1: Location of the Porcupine Hills study area in relation to Fort à la Corne, Saskatchewan.



Plain (south of Dawson Bay and west of Swan Lake; Fig. GS-29-1). A dispersion train of five G10 garnets was interpreted, in the Prairie kimberlite study, by Thorliefson and Garrett (1993) to be from a source near the south end of Lake Winnipegosis. Thorleifson et al. (1994) also documented a dispersion train of chrome spinels with its apex near the south end of Lake Winnipegosis.

Porcupine Hills, north slope

Bamburak and Fedikow (2001, 2002) reported on 58 stream sand and gravel samples from the Porcupine Hills and immediate vicinity. The source area of the KIM found in the samples was interpreted as being the common headwater locations of the Little Woody, Rice and Steeprock rivers, and Homestead and Little Rice creeks on the north slope of the Porcupine Hills (Fig. GS-29-2). Almost 80% of the indicators in the -0.5 to +0.3 mm size fraction were from these streams, and these indicators included a G9 garnet, a G11 garnet and a diamond-inclusion spinel. In the 2002 study, one Mg-ilmenite grain in the -2.0 to +1.0 mm size fraction was also recovered from the Rice River stream-bed sample.

Bamburak and Fedikow (2002) concluded that, because the Swan River Formation bedrock samples did not show any KIM, the overlying glacial till likely contained the KIM. This conclusion is supported by KIM found in a till sample (KIM-92-5T) collected north of Westgate, Manitoba (Fig. GS-29-2) for the Prairie kimberlite study (Thorliefson and Garrett, 1993). The Westgate till sample contained 13 chrome-diopside grains (Table GS-29-1).

Thorliefson and Garrett (1993) reported that a total of 776 chrome-diopside grains was recovered from the 816 till samples processed in the Prairie kimberlite study. The maximum number of chrome-diopside grains collected at a single site in the Prairie study was 14 grains (in southern Saskatchewan). Therefore, the 13 chrome-diopside grains recovered from the Westgate till sample is relatively anomalous when compared with adjacent till samples. It should be noted that sites immediately to the west of the Westgate till sample showed relatively low quantities of KIM. This



Figure GS-29-2: Stream-sediment sample locations, Porcupine Hills-Red Deer Lake area.

Field ID	Grain size (mm)	Chrome diopside (% Cr ₂ O ₃)	Na ₂ O (%)	K ₂ O (%)	CaO (%)	FeO (%)	MgO (%)	Al ₂ O ₃ (%)	MnO (%)	TiO ₂ (%)	Cr ₂ O ₃ (%)	SiO ₂ (%)	Total (%)
KIM-92-5-T	0.25-0.50	0.5-1.0	0.75	0	23.09	3.16	15.43	3	0	0	0.59	52.9	98.93
KIM-92-5-T	0.25-0.50	0.5-1.0	0.78	0	22.65	3.46	15.75	1.7	0.03	0.03	1	52.99	98.4
KIM-92-5-T	0.25-0.50	0.5-1.0	0.78	0	22.85	3.47	15.93	1.77	0.03	0.04	0.55	53.24	98.64
KIM-92-5-T	0.25-0.50	0.5-1.0	0.81	0	22.71	3.58	15.78	1.67	0.03	0.05	0.6	53.43	98.65
KIM-92-5-T	0.25-0.50	0.5-1.0	0.67	0	22.91	3.8	15.65	1.73	0.04	0.02	0.62	53.11	98.56
KIM-92-5-T	0.25-0.50	0.5-1.0	0.7	0	21.89	3.84	16.27	2.28	0.02	0.03	0.57	53.17	98.76
KIM-92-5-T	0.25-0.50	0.5-1.0	0.67	0	23.54	2.71	16.03	1.31	0	0	0.85	53.94	99.05
KIM-92-5-T	0.25-0.50	0.5-1.0	0.58	0	23.45	4.01	16.05	0.92	0.13	0.06	0.55	53.44	99.19
KIM-92-5-T	0.50-2.00	>1.0	0.78	0	22.59	2.89	16.32	1.85	0.08	0.22	1.03	54.43	100.17
KIM-92-5-T	0.25-0.50	>1.0	0.55	0	23.61	2.91	15.99	1.75	0	0	1.04	53.01	98.86
KIM-92-5-T	0.25-0.50	>1.0	0.27	0	18.38	4.95	18.68	3.46	0.04	0.16	1.05	52.15	99.12
KIM-92-5-T	0.25-0.50	>1.0	0.93	0	22.63	2.78	15.65	1.95	0	0.08	1.27	53.39	98.67
KIM-92-5-T	0.25-0.50	>1.0	0.65	0	22.94	3.53	15.33	2.16	0.03	0.16	1.15	51.52	97.46

Table GS-29-1: Kimberlite indicator mineral chemistry of the Westgate till sample.

reduces the possibility that the Porcupine Hills KIM were transported by easterly flowing Cretaceous river systems (possibly glacially reworked) from Fort à la Corne, 280 km to the west-northwest.

The presence of anomalous KIM in the streams draining the north slope of the Porcupine Hills and within the till north of the hills suggests that the KIM have a local provenance a short distance to the north, possibly near Red Deer Lake.

Fort à la Corne kimberlite belt

Geological setting

The Fort à la Corne kimberlite belt strikes northwest and extends for a distance of 50 km in central Saskatchewan. It contains more than 73 kimberlite bodies, ranging from 2.7 to 250 ha in surface area (Robertson, 2003).

The kimberlites at Fort à la Corne are situated beneath 120 m of unconsolidated glacial overburden. About 96 million years ago, they were emplaced in a sequence of Cretaceous shale and sandstone (up to 170 m thick) that overlies approximately 440 m of Cambro-Ordovician dolomitic carbonate rocks (Lehnert-Thiel et al., 1992). The entire package lies unconformably on metamorphic Precambrian basement rocks that are interpreted to be of Proterozoic age. These rocks form part of the Glennie Domain within the Reindeer Zone of the 1.8 Ga Trans-Hudson Orogen. The Glennie Domain consists of Paleoproterozoic island-arc volcanogenic successions separated by reworked Archean granitoid and granitic gneiss (Robertson, 2003).

According to Gent (1991), the emplacement of kimberlite bodies along zones of crustal weakness between subcratonic Archean blocks and internal faults was the result of crustal hinging or arching of the eastern margin of the Western Canada Sedimentary Basin, induced by the Laramide Orogeny. This included dextral wrenching–induced arching and faulting.

Aeromagnetic expression

The thick overburden cover in the Fort à la Corne area has rendered heavy-mineral till sampling ineffective (Robertson, 2003). This is evident in the results of the Prairie kimberlite study, which shows very low quantities of KIM in samples collected south of Fort à la Corne (Thorliefson and Garrett, 1993). Companies exploring for kimberlite intrusions at Fort à la Corne have relied on magnetic and gravity surveys (Robertson, 2003).

According to Robertson (2003), the kimberlite bodies were first recognized from their magnetic signatures (Fig. GS-29-3) on Geological Survey of Canada aeromagnetic map 7743G (Geological Survey of Canada, 1971). Eight magnetic highs, thought to be caused by kimberlite bodies, had amplitudes ranging from 50 to 80 nT, but locally up to 140 nT (Lehnert-Thiel et al., 1992).

A magnetic profile across anomaly 140/141 is shown in Figure GS-29-4. The profile was modelled for this report using MAG2DC for Windows (Cooper, 2000). Readings at 0.3 km intervals were measured along the profile from aeromagnetic map 7743G (Geological Survey of Canada, 1971). The susceptibilities of the kimberlite and granite



Figure GS-29-3: Kimberlite aeromagnetic anomalies in the Fort à la Corne area (from Geological Survey of Canada, 1971).



Figure GS-29-4: Magnetic profile across kimberlite anomaly 140/141 in the Fort à la Corne area (modelled from published data).

gneiss are within the measured range. The depth to the top of the postulated kimberlite body is consistent with drillhole data in the general vicinity.

Grassy Bay aeromagnetic anomaly cluster

Examination of aeromagnetic maps north of the Porcupine Hills in Manitoba has revealed the presence of a cluster of magnetic anomalies northwest and southwest of Grassy Bay on Red Deer Lake (Fig. GS-29-5), less than 20 km north of the anomalous KIM stream-sample sites and the Westgate till-sample location.



Figure GS-29-5: Grassy Bay aeromagnetic-anomaly cluster (from Geological Survey of Canada, 1992).

Geological setting

The Grassy Bay aeromagnetic-anomaly cluster is situated within the Precambrian Trans-Hudson Orogen. The Precambrian basement is overlain by 400 m of Phanerozoic sedimentary rocks (Bezys and Conley, 1998). Most of the anomalies occur within the outcrop belt of the Devonian Souris River Formation. Southwest of Grassy Bay, the carbonate beds are overlain by the Cretaceous Swan River Formation. According to Manitoba Geological Survey drillholes M-7-99 and M-8-99 (Bamburak and Bezys, 1999), the Paleozoic strata near Westgate are overlain by about 60 m of Cretaceous sand and shale (possibly ice thrusted), which are covered by approximately 20 m of glacial till.

Aeromagnetic expression

The southeast-trending Grassy Bay aeromagnetic-anomaly cluster (Fig. GS-29-5) consists of 'tiny' highs and lows. There is a striking similarity in relative magnitude and shape of the Grassy Bay cluster to the aeromagnetic signature of the Fort à la Corne kimberlites (Fig. GS-29-3).

Aeromagnetic anomaly A (Fig. GS-29-5) was modelled for this report using MAG2DC for Windows (Cooper, 2000). Readings at 0.3 km intervals were measured across the anomaly. The resulting model is shown in Figure GS-29-6. There is a good fit, in terms of relative amplitude and shape, between the profiles of anomaly A of the Grassy Bay cluster and kimberlite anomaly 140/141 of the Fort à la Corne cluster. The wider profile of anomaly A probably reflects its greater depth of burial than the source at Fort à la Corne and its location adjacent to Precambrian bedrock with higher magnetic susceptibility.

Conclusions

Stream samples collected along the north slope of the Porcupine Hills contain anomalous quantities of KIM relative to other localities along the Manitoba Escarpment. The source of the KIM appears to be the common headwater locations of the Little Woody, Rice and Steeprock rivers, and Homestead and Little Rice creeks.

The Westgate till sample (KIM-92-5T) in the Prairie kimberlite study was collected midway between the stream headwaters and the Grassy Bay aeromagnetic-anomaly cluster. The Westgate sample contained 13 chrome-diopside grains, which is relatively anomalous when compared with adjacent till samples from the Prairie study.

The southeast-trending Grassy Bay (Red Deer Lake) aeromagnetic-anomaly cluster consists of 'tiny' highs and lows that bear a striking resemblance, in relative magnitude and shape, to the documented aeromagnetic signatures of the Fort à la Corne kimberlites.

Ground magnetometer surveys and drilling are recommended to test this hypothesis.

Economic considerations

Historically, the lowland areas to the north and east of the Porcupine Hills have seen some of the earliest mining operations in the province, namely salt recovered from brine springs during the days of the fur trade. Local residents have also explored the hills for metallic-mineral occurrences over the years. Until the 1990s, the Mafeking quarries provided high-calcium limestone for production of Portland cement in Regina, Saskatchewan. Over the past 80 years, numerous mining companies have conducted exploration programs for base and precious metals, as well as for petroleum traps and oil shales along the trend of a buried major crustal suture, the Superior Boundary Zone.

Exploration for kimberlite in west-central Manitoba is in its infancy, with only limited work being done to date. The discovery of a kimberlite field in west-central Manitoba would have a profound positive impact on the local economy due to increased exploration. The impact is potentially huge if diamondiferous kimberlites are found.



Figure GS-29-6: Magnetic profile across aeromagnetic anomaly A of the Grassy Bay cluster.

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References

- Bamburak, J.D. and Bezys, R.K. 1999: Industrial minerals investigations and corehole drilling program 1999; *in* Report of Activities 1999, Manitoba Industry, Trade and Mines, Geological Services, p. 116–119.
- 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. and CD-ROM.
- Bamburak, J.D. and Fedikow, M.A.F. 2002: Kimberlite indicator minerals from west-central Manitoba 2002 update (NTS 63C and 63K); *in* Report of Activities 2002; Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 287–294.
- Bezys, R.K. and Conley, G.G. 1998: The Precambrian in Manitoba; Manitoba Energy and Mines, Stratigraphic Map Series, OPC-1, scale 1:2 000 000.
- Cooper, G.R.J. 2000: MAG2DC for Windows user's manual (version 2.10); Geophysical Department, University of the Witwatersrand, Johannesburg 2050, South Africa.
- Fowler, J.A. 1985: Report on the examination of Manitoba Department of Energy and Mines, Mineral Resources Division, Geological Services Branch samples; Monopros Limited, May 14, 1985, 18 p.
- Fowler, J.A. 1987: Report on the examination of samples from the Manitoba Department of Energy and Mines, Mineral Resources Division, Geological Services Branch samples; Monopros Limited, September 1987, 12 p.
- Gent, M.R. 1991: Diamond exploration in Saskatchewan (abstract); Canadian Institute of Mining and Metallurgy, 93rd Annual General Meeting, May 1991, Vancouver, Program and Abstracts.
- Geological Survey of Canada 1971: Prince Albert, Saskatchewan (NTS 73H); Saskatchewan Department of Mineral Resources–Geological Survey of Canada, Geological Survey of Canada, Geophysical Series Map 7743G, scale 1:250 000.
- Geological Survey of Canada 1992: Aeromagnetic total field map, Swan Lake–Duck Mountain, Saskatchewan/Manitoba (NTS 63 C/NW), Geological Survey of Canada, Open File 2494, Map 1, scale 1:100 000.
- Lehnert-Thiel, K., Loewer, R., Orr, R.G. and Robertshaw, P. 1992: Diamond-bearing kimberlites in Saskatchewan, Canada: the Fort à la Corne case history; Exploration and Mining Geology, v. 1, no. 4, p. 391–403.
- Robertson, R. 2003: Fort à la Corne JV produces biggest diamond yet; Northern Miner June 23, 2003, p. B1, B6-8.
- Thorleifson, L.H. and Garrett, R.G. 1993: Prairie kimberlite study till matrix geochemistry and preliminary indicator mineral data; Geological Survey of Canada, Open File 2745, one 3.5" diskette containing 25 ASCII files.
- Thorleifson, L.H., Garrett, R.G. and Matile, G. 1994: Prairie kimberlite study indicator mineral geochemistry; Geological Survey of Canada, Open File 2875, one 3.5" diskette containing 12 ASCII files.