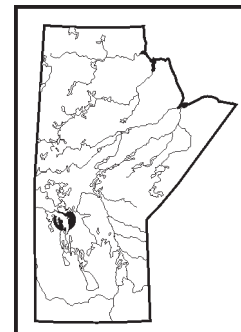


**GS-26 A possible new Mississippi Valley–type mineral occurrence
near Pemmican Island in the north basin of Lake Winnipegosis,
Manitoba (NTS 63B12 and 13, 63C9 and 16)
by J.D. Bamburak and K. Klyne¹**



Bamburak, J.D. and Klyne, K. 2004: A possible new Mississippi Valley–type mineral occurrence near Pemmican Island in the north basin of Lake Winnipegosis, Manitoba (NTS 63B12 and 13, 63C9 and 16); *in* Report of Activities 2004, Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, p. 266–278.

Summary

Manitoba has been investigated for over 30 years by government and mining company geologists interested in finding Mississippi Valley–type (MVT) Pb–Zn mineralization. A joint study by Klyne Exploration and the Manitoba Geological Survey, underway since 2001, has focused on the MVT potential of the north basin of Lake Winnipegosis, near the northeast end of Pemmican Island. Drilling in 2004 intersected 15 cm of sulphide-bearing dolomite, grading 4.59% Zn, 0.41% Pb, 0.014% Cu, 10.4% Fe and 14.05% S, at a depth of about 15 m below lake level. The mineralization is situated

- within dolomite of the Cedar Lake Formation (Silurian Interlake Group);
- below the argillaceous Devonian Ashern Formation and the pre–Middle Devonian unconformity, with associated karst development;
- adjacent to the faulted eastern margin of the buried Precambrian Superior Boundary Zone;
- on the southwest flank of the Precambrian Severn Arch;
- near the edge of the composite Elk Point–Williston sedimentary basin; and
- on the southeast limb of the Moose Lake Syncline.

Introduction

The study area is located in the north basin of Lake Winnipegosis, which is defined, for the purpose of this report, as that part of the lake situated north of Birch Island and extending westward to include Dawson Bay, as depicted in Figure GS-26-1.

As documented by Gale and Conley (2000), the potential for Mississippi Valley–type (MVT) Pb–Zn mineral occurrences within Paleozoic carbonate rocks of Manitoba has been suggested by many geologists over the past 30 years. Various companies (Gulf Minerals Canada Limited, Husky Oil Limited, Canadian Nickel Company, Limited, and Cominco Ltd.) have attempted to search for Paleozoic MVT Pb–Zn deposits in the province (Bamburak et al., 2000). Fedikow et al. (1998) discussed the potential for sediment-hosted disseminated sulphide deposits (Au, PGE and base metals).

Geological setting

Jackson and Beales (1967) stated that the most striking structural features associated with Pb–Zn orebodies are that the mineralization occurs near the margin of sedimentary basins and at the edge of major synclines. Further, Anderson and Macqueen (1982) commented that MVT deposits tend to be found on arches between basins.

The study area, in west-central Manitoba, is situated within the Paleozoic outcrop belt, on the northeast margin of the composite Elk Point–Williston sedimentary basin (600 km southwest of the Severn Arch axis) and on the southeast limb of the Moose Lake Syncline (Figure GS-26-2). The latter is also coincident with the Precambrian Superior Boundary Zone (SBZ), as depicted by McCabe (1967).

Most of the eastern portion of the north basin of Lake Winnipegosis is located within the Silurian outcrop belt (Figure GS-26-3). The Interlake Group (Table GS-26-1) occupies this portion of the outcrop belt. The Silurian beds were exposed to a major erosional event before deposition of the overlying Middle Devonian Ashern Formation.

The western portion of the north basin of Lake Winnipegosis is underlain by the Devonian outcrop belt (Figure GS-26-3), which includes the Ashern, Winnipegosis and Dawson Bay formations (Table GS-26-1). The Prairie Evaporite above the Winnipegosis Formation has been removed through salt solution and the overlying beds have collapsed onto the Winnipegosis Formation (Norris et al., 1982).

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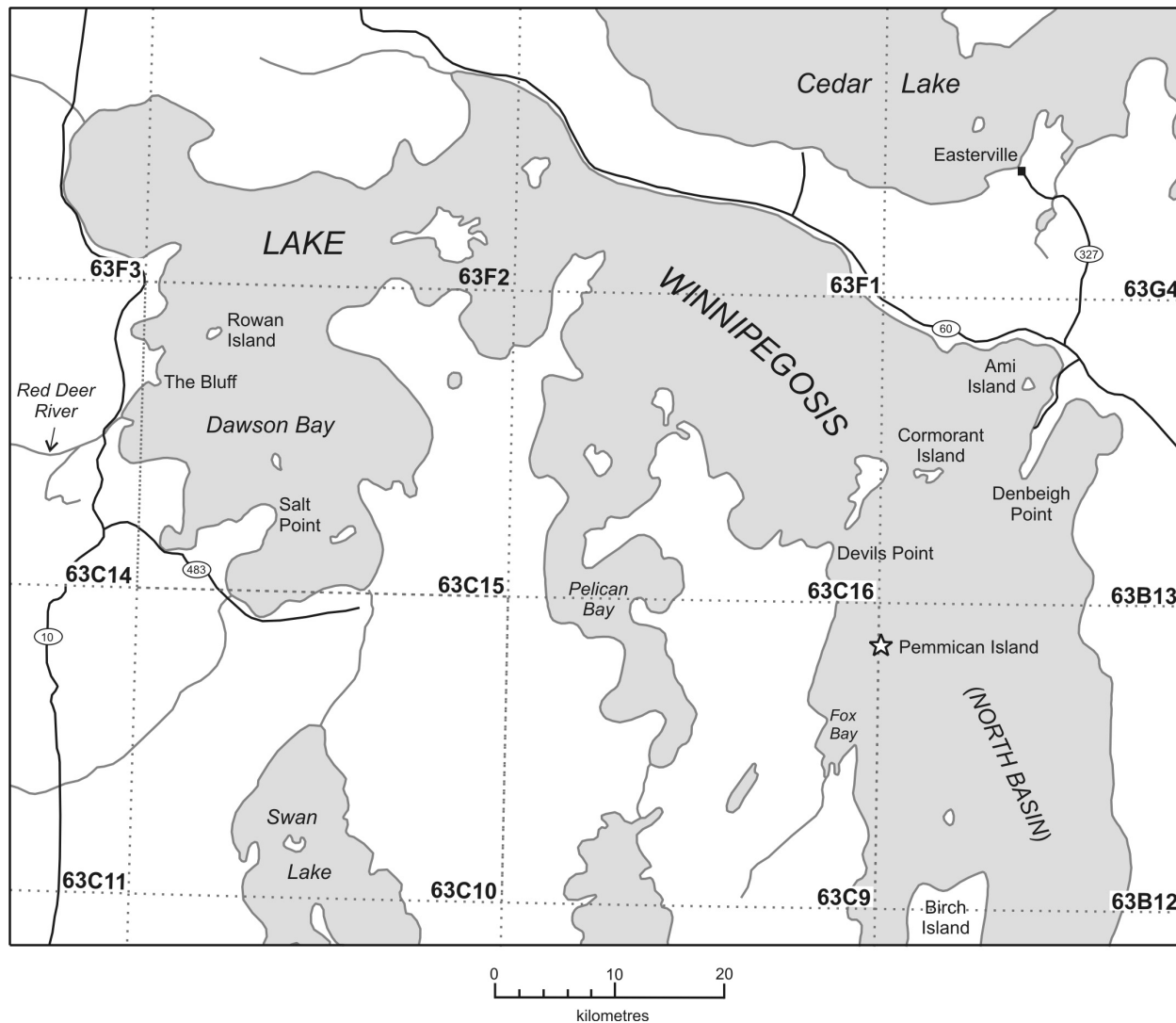


Figure GS-26-1: North basin of Lake Winnipegosis, showing location of Pemmican Island.

Previous investigations

Geological Survey of Canada (1889–1964)

In 1889, J. B. Tyrrell documented the presence of nodules of marcasite and fragments of lignite, associated with white sandstone at Pemmican Island (Figure GS-26-1). He interpreted this to be a Cretaceous “outlier of Dakota sandstone deposited in a hollow of the Devonian rocks” (Tyrrell, 1892). Similar concretions were also described on Ami Island, Devils Point and Cormorant Island (Figure GS-26-1) by Tyrrell (1890). On Ami Island, he noted “small rounded masses of white sandstone holding nodules of Marcasite.” Tyrrell also speculated that the nodules or concretions had been ice-pushed from the bottom of Lake Winnipegosis.

In 1964, A.W. Norris and M. Oullet noted “numerous loose fragments of iron sulphide” on the northeast shore of Pemmican Island (Figure GS-26-1), 0.32 km northwest of the east tip of the island (Norris et al., 1982). They recognized argillaceous dolomite of the Lower Member of the Devonian Winnipegosis Formation (Table GS-26-1) in a cliff on the island, and also believed that the underlying Devonian Ashern Formation was present near the edge of the lake.

Manitoba Geological Survey (1950–2002)

Baillie (1951) could not find any evidence that the Ashern Formation was present at the base of Pemmican Island; however, a sample of Ashern Formation from Pemmican Island, provided by R. Chartrand of The Pas, was tested for brick making by Bannatyne (1970).

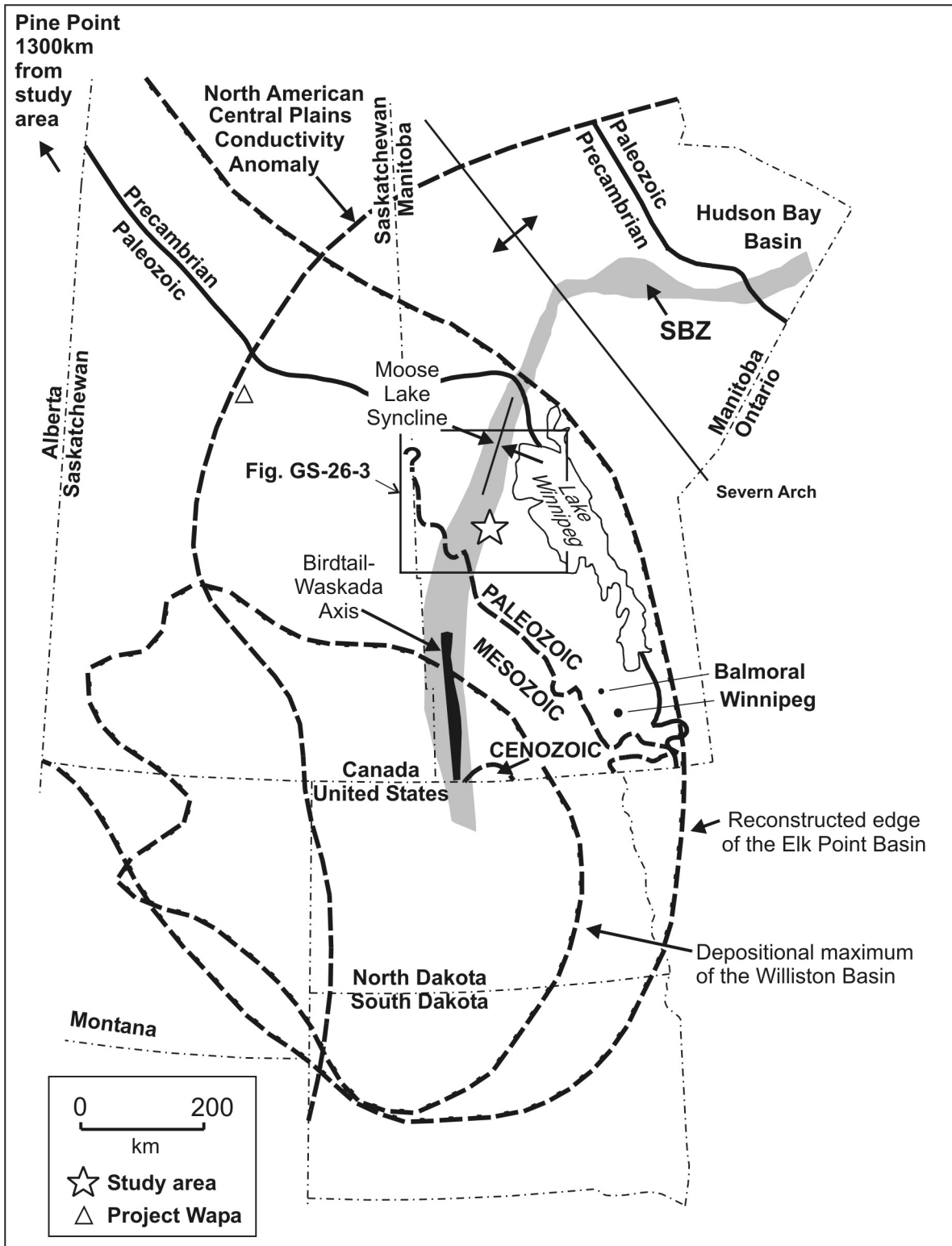


Figure GS-26-2: Major structural features and geology of the Williston and Elk Point basins, Manitoba and vicinity (modified from Fedikow et al., 2004).

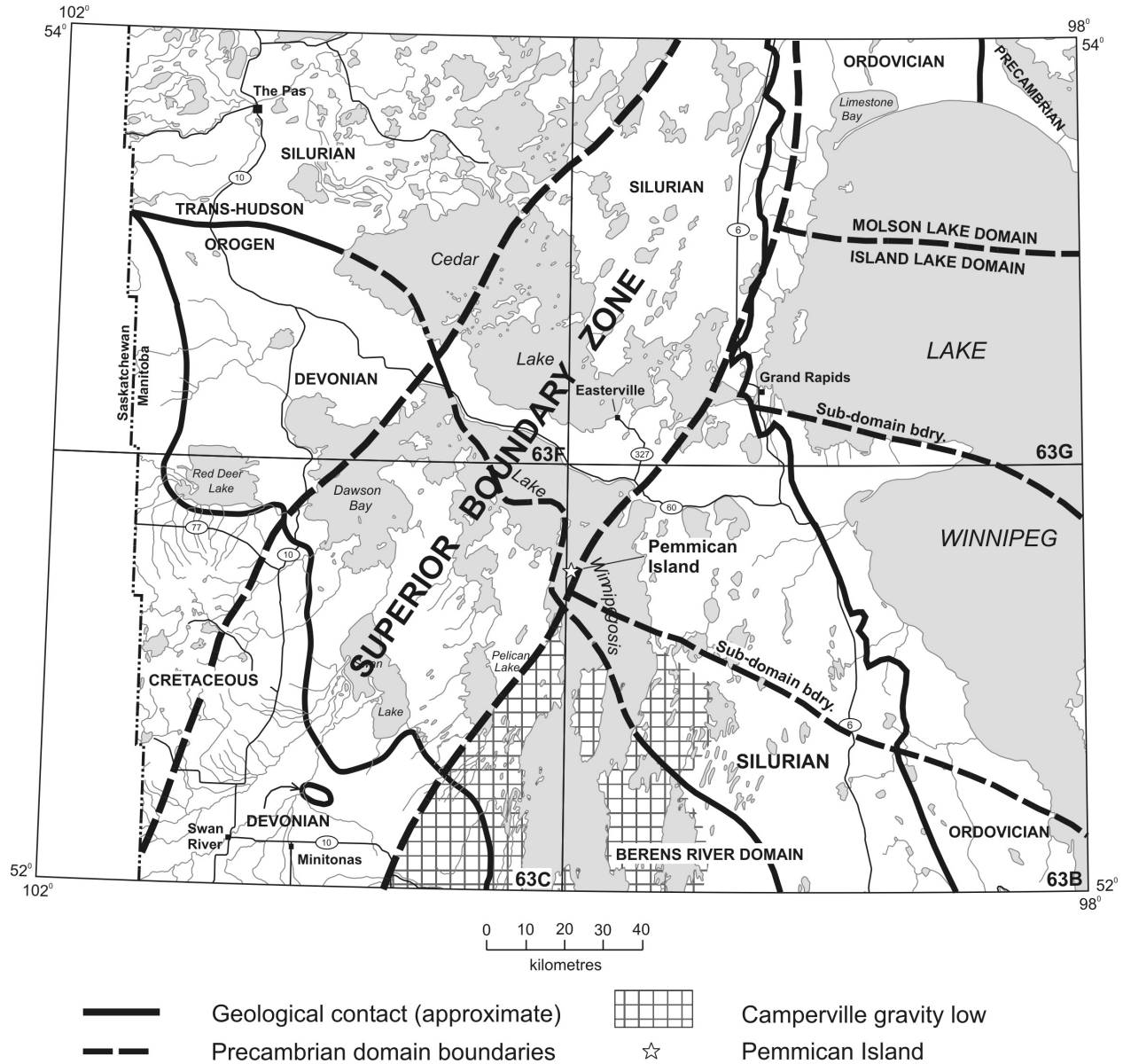


Figure GS-26-3: Geological setting of Pemmican Island in the north basin of Lake Winnipegosis. Precambrian domain boundaries after Pilkington and Thomas (2001).

In 1969, a small well-rounded pebble of almost pure galena was found in the NE ¼, Sec. 26, Twp. 14, Rge. 1, E 1st Mer., near the town of Balmoral (Figure GS-26-2), 250 km southeast of Pemmican Island and 35 km northeast of Winnipeg. McCabe (1969) suggested that the pebble might have been glacially transported from a site, possibly in Manitoba, similar to the Phanerozoic Pine Point deposit in the Northwest Territories. In response to the discovery of the pebble, the Manitoba Geological Survey carried out two lines of investigation:

- Detailed geochemical sampling of about 6300 department drillcore samples from the Paleozoic outcrop belt of southwestern Manitoba was carried out from 1980 to 1985 (Gale and Conley, 2000).
- Three hundred and seventy-two backhoe pits were dug and sampled for overburden and Quaternary stratigraphic analysis and heavy-mineral study, extending in the up-ice direction from where the galena erratic was found (Nielsen, 1989).

Gale and Conley (2000) reported that the maximum Pb concentration (200 ppm) in the drillcore samples was obtained from the Winnipegosis Formation (Table GS-26-1). The highest Zn (740 ppm) and Ni (120 ppm) values were from the Red River Formation. The maximum Cu value was 710 ppm from the St. Martin Complex, and the maximum F

Table GS-26-1: Generalized stratigraphic section for southern Manitoba, with asterisks showing times of karst events (McRitchie, 1991).

ERA	PERIOD	FORMATION	MEMBER	MAXIMUM THICKNESS (m)	BASIC LITHOLOGY	
CENOZOIC	QUATERNARY	(Recent)			Top soil, dune sands, lake clays, peat	
		Glacial Drift		140	Clay, sand, gravel, boulders, till	
	TERTIARY					
MESOZOIC	CRETACEOUS	Boissevain	Peace Garden Goodlands	160	Shale, clay, sand, lignite	
		Pierre Shale (First White Specks)	Coulter	400	Grey shales, non-calcareous, local ironstone, bentonitic, carbonaceous	
			Odanah			
			Millwood			
			Pembina			
		Niobrara	Gammon Ferruginous	75	Grey speckled shale, calcareous, bentonitic	
		Morden Shale		55	Dark grey shale, non-calcareous, concretions, local sand and silt	
	Favel (Second White Specks)	Assiniboine Keld	45	Grey shale with calcareous specks, bands of limestone and bentonite		
	ASHVILLE	Belle Fourche Shale	80	Dark grey shale, non-calcareous, silty, Newcastle (sand zone)-quartz sandstone		
		Westgate				
		Newcastle Skull Creek				
	Swan River		150	Sandstone and sand, quartzose, pyritic shale, non-calcareous		
	JURASSIC	Waskada		60	Banded green shale and calcareous sandstone, bands of limestone, varicoloured shale	
		Melita		145		
		Reston		45	Limestone, buff, and grey shales	
Amaranth		Evaporite	55	White anhydrite and/or gypsum and banded dolomite and shale		
TRIASSIC		Red Beds	45	Red shale to siltstone, dolomitic		
PALEOZOIC	PERMIAN	St. Martin Complex		265(+)	Carbonate breccia, trachyandesite (crypto-explosion structure?)	
	PENNSYLVANIAN					
	MISSISSIPPIAN	Madison Group	Charles		20	Massive anhydrite and dolomite
			Mission Canyon	MC-5	120	Light buff limestone, oolitic, fossiliferous, fragmental, cherty, bands of shale and anhydrite
				MC-4		
		MC-3				
		MC-2				
	Lodgepole	Flossie Lake Whitewater Lake Virde Scallion Daly Upper Middle Lower	185	Limestone and argillaceous limestone, light brown and reddish mottled, zones of shale, oolitic, crinoidal and cherty limestone		
	Bakken		20	Two black shale zones separated by siltstone		
	DEVONIAN	Qu'Appelle Group	Three Forks		55	Red siltstone and shale, dolomitic
			Birdbear		40	Limestone and dolomite, yellow-grey, fossiliferous, porous, some anhydrite
		SASK. GROUP	Duperow		120	Limestone and dolomite, argillaceous and anhydritic in places
			Souris River (First Red)		90	Cyclical shale, limestone and dolomite, anhydritic
			Dawson Bay (Second Red)		50	Limestone and dolomite, porous, anhydritic, local red and green shale
		ELK PT. GROUP	Winnipegosis	Prairie Evap.	120	Halite, potash and anhydrite, interbedded dolomite
Elm Point				75	Dolomite, yellow brown, reefy	
Ashern	☆		12	Dolomite and shale, brick red		
SILURIAN	Interlake Group	☆	110	Dolomite, yellow buff, fossiliferous, several argillaceous marker beds		
ORDOVICIAN	Stonewall	t-marker zone Williams Guntton	25	Dolomite, sparsely fossiliferous, t-marker defines Ordovician-Silurian boundary		
	Stony Mountain	Penitentiary	45	Dolomite, yellow buff Dolomite, dusky yellow, fossiliferous, red shale, green fossiliferous limestone bands (Gunn)		
		Gunn				
	Red River	Fort Garry	170	Dolomitic limestone and dolomite, mottled (Tyndall Stone within Selkirk)		
		Selkirk				
Cat Head						
Winnipeg	Dog Head	65	Green shale, waxy, interbedded sandstone Sand, sandstone and quartzose			
	Upper Unit Lower Unit					
CAMBRIAN	Deadwood		25	Black to green grey sand, waxy, glauconitic siltstone and shale		
PRECAMBRIAN					Metamorphic and crystalline rock	

* Potential major karst event ** Potential minor karst event

☆ Cedar Lake Formation host rock for mineralization

value was 1100 ppm from the Ashern Formation. The maximum Fe value (5.7%) was from the Dawson Bay Formation. Gale and Conley also reported that the heavy-mineral investigation of Nielsen's samples did not show any sphalerite or galena and that "systematic geochemical anomalies" were not identified.

In 2001, a 203.3 m corehole (M-1-01) was drilled by the Manitoba Geological Survey on the west shore of Denbeigh Point (Figure GS-26-1), 25 km northeast of Pemmican Island (Bezys and Bamburak, 2001). The hole was drilled to provide a continuous stratigraphic corehole for detailed geochemical sampling to compare with the results of Gale and Conley (2000). Analytical results from the sampling are described in the 'Denbeigh Point corehole M-1-01 analyses' section.

Bamburak et al. (2002) described the results of geochemical sampling of rounded Fe-sulphide concretions and angular Fe-sulphide slabs (with dolomite clasts), found along the waterline of Pemmican Island in 2001 and 2002. Maximum analytical values from all samples were 62.2% Fe, 36.4% S, 1.18% Ni, 0.76% Zn, 3670 ppm As, 1100 ppm Pb and 813 ppm Co. It was also noted that the sample containing 1100 ppm Pb also had 1700 ppm Zn. A Thompson-type nickel anomaly in the Precambrian basement was believed to account for the high Ni value. McRitchie (1995) and Hosain and Bamburak (2002) documented the results of exploration for Thompson-type mineralization within the buried southwestern extension of the Thompson Nickel Belt.

Cominco Ltd. (1970–1971)

In 1970, Cominco Ltd. conducted a geological and geochemical program in the vicinity of Easterville and Denbeigh Point (Figure GS-26-1) to locate Pb-Zn mineralization. Cominco was attracted to the north basin of Lake Winnipegosis by the reported occurrence of "massive botryoidal marcasite" on an island near Denbeigh Point. The occurrence "was considered as encouragement with regard to Pb-Zn mineralization in the Paleozoic section." In October of the same year, however, Cominco reported that, "Despite the fact that islands and the shoreline around Denbeigh Point were intensively searched, no evidence was found of marcasite mineralization, in either float or outcrop", and further work on the MVT potential of the area was not recommended (Assessment File 91785, Manitoba Industry, Economic Development and Mines, Winnipeg).

Husky Oil Limited (1970–1971)

Husky Oil Limited hired Questor Surveys Limited to conduct a combined INPUT airborne electromagnetic and magnetic survey in the Dawson Bay area in 1970. As a result of the survey, Husky drilled four mineral exploration coreholes southeast of Red Deer Lake (Figure GS-26-1) in 1971 (A.F. 91776, 92239). Although intense brecciation was noted in all holes by McCabe and Bannatyne (1971), no significant mineralization was found and no further work was recommended (A.F. 91776).

Gulf Minerals Canada Limited (1975–1976)

In 1975 and 1976, Gulf Minerals Canada Limited conducted a systematic search for base metal deposits along the rim of the Western Canada Sedimentary Basin by examining oilwell cuttings. As a result of finding anomalous values of Pb and Zn in the cuttings, Gulf decided to focus on the vicinity of Minitonas (Figure GS-26-3; A.F. 92192). Additional criteria for the selection of the Minitonas area by Gulf were

- the projected trend of the SBZ beneath Paleozoic and Mesozoic cover from aeromagnetic data;
- the distribution of Winnipegosis Formation (Table GS-26-1) reefs;
- post-Devonian solution of the Prairie Evaporite and probable collapse structures;
- the Silurian Interlake Group unconformity with the overlying Middle Devonian Ashern Formation, and the possible development of karst topography; and
- the presence of circular structures on the Earth Resources Technology Satellite mosaic (A.F. 92116).

During November 1975, Gulf Minerals conducted a four-hole drilling program on the claims. Pyrite was found as fillings in fractures and vugs, and occasionally associated with fossils. A small crystal of sphalerite was noted at 429.2 m in hole 13-10-36-26W1.

A total of 1481.3 m of core were analyzed for Cu, Pb and Zn, over 3 m lengths. A sandy and shaly bed in the Interlake Group (Table GS-26-1) returned the maximum values for the three elements. The bed is present in three of the holes, and the metal content increases toward the north. The highest Cu analysis (182 ppm) came from the

Winnipegosis Formation in hole 1-28-36-26W1. The interval from 341.4 to 353.6 m in hole 15-32-36-26W1, in the Interlake Group, returned average values of 297 ppm Cu and 294 ppm Zn, with maximum values of 721 ppm Cu and 690 ppm Zn occurring from 347.5 to 350.5 m. Nevertheless, Gulf Minerals concluded that, because sampled intervals did not have significant base metal content, further work was not warranted (A.F. 92116).

Canadian Nickel Company Limited (Canico; 1979–1983)

In 1979–1980, a literature search by Canico indicated that the Dawson Bay area (Figure GS-26-1) met its criteria for MVT Pb-Zn deposition, by having the following features:

- presence of Devonian Formation (Table GS-26-1) reefs
- presence of unconformities
- proximity to evaporite deposits
- location of major faults (A.F. 93877)

During 1980, Canico collected and analyzed about 1000 soil, rock and water samples near Dawson Bay. Numerous anomalies, resulting from the analyses, coincided with the western boundary of the SBZ (Figure GS-26-3). The boundary was recognized from magnetic and gravity maps, and was interpreted by Canico as a reactivated fault that localized the development of reefs during the Devonian.

Over the next two years, Canico carried out photogeological interpretation; airborne electromagnetic test flying; seismic testing; magnetometer, resistivity and IP surveys; and basal till and subcrop sampling. This work was followed up in 1981 with 189 km of reconnaissance airborne electromagnetic survey, a marine reflection-seismic survey and a 1600-sample soil sampling program. The airborne electromagnetic survey showed that the overburden and limestone have variably high conductivity. The magnetic survey indicated the presence of weak magnetic highs from the Precambrian basement. The seismic survey equipment was incapable of penetrating the carbonate bedrock to any significant depth; however, several probable, small-scale, fault-like structures were detected in the lake bottom. The soil samples were analyzed for Pb, Zn, Ag and occasionally Hg. More than 80% of the anomalous Pb, Zn and Ag sites were situated near the mouth of the Red Deer River and within four areas near the shore of Salt Point (Figure GS-26-1). Most of the sample sites on the islands in Dawson Bay were anomalous. One goethitic carbonate sample, taken near The Bluff (Figure GS-26-1), returned 0.16% Pb and 0.12% Zn. A carbonate sample from Rowan Island gave a value of 265 ppm Pb (A.F. 93877).

In 1982, a test of resistivity and induced polarization (IP) surveys, a basal till and subcrop sampling program, and a time-domain IP survey were carried out. The IP test, conducted in two areas with anomalously high Pb and Zn geochemical values, indicated that valid results could be obtained despite the high conductivity of the soils and rocks. The 63-sample basal till survey confirmed most of the geochemical anomalies. The time-domain IP survey indicated an anomaly on the north side of Salt Point (A.F. 93878).

In 1983, IP, magnetometer and detailed geochemical surveys were carried out in five areas. Three areas were situated on The Bluff claims and two on the Salt claims. Numerous IP anomalies and well-defined zones high in Pb and Zn were found in all five areas. The anomalous zones were recommended for drilling (A.F. 92829).

Five 80 m holes (63546–63550) were drilled on the Salt and The Bluff claim blocks, based upon

- the presence of well-defined IP anomalies; and
- their coincidence or proximity to Pb and/or Zn geochemical anomalies (A.F. 92830).

According to Canico, Pb-Zn mineralization was not recognized in any of the holes and only sporadic occurrences of pyrite and marcasite (up to 10%) were found in the Lower Dawson Bay Formation (Table GS-26-1) limestone. A 1.86 m interval (in hole 63549) within Winnipegosis inter-reef bituminous dolomite, located over the western boundary of the SBZ, contained up to 3% pyrite as fine specks, but no mineralization was found in the reef facies. Further work on the property was not recommended (A.F. 92830).

Present study

Denbeigh Point corehole M-1-01 analyses

Corehole M-1-01 was drilled vertically on the west shore of Denbeigh Point (Figure GS-26-1) to investigate strata of Silurian age and older. Chemical analyses of the core, usually at 1 m intervals, showed relatively low values of base-metal mineralization throughout the 203 m long core. The highest values for Cu (78 ppm) and Ni (34 ppm)

occurred at a depth of 2.0–2.5 m, within the Cedar Lake Formation of the Interlake Group (Table GS-26-1).

The Winnipeg Formation, at the bottom of the hole, averaged 22 ppm Cu and 20 ppm Ni at a depth of 201.1–201.3 m; this interval contained pyrite and marcasite, and had the highest contents of Zn (20 ppm), Pb (22 ppm), Fe (2.8%) and S (2.5%) in the hole.

Slightly elevated Zn values (16 and 13 ppm) corresponded to bituminous partings within the lower beds of the Stony Mountain Formation (Table GS-26-1). Slightly elevated values for Cu (ranging from 19 to 24 ppm in 13 samples) occurred in the uppermost beds of the Stony Mountain Formation.

Pemmican Island area

Klyne Exploration geophysical surveys

In April 2003, Klyne Exploration employed Discovery Geophysics Inc. to conduct 4 line-km of total field magnetic and 1.7 line-km of transient electromagnetic (TEM) surveys on the ice off of the northeast shore of Pemmican Island. A broad but weak magnetic anomaly and a large, high-amplitude TEM response were indicated from the surveys. These coincided with the inferred northeast-trending zone of sulphide slabs and concretions found on the shore of Pemmican Island and slightly offshore, as described by Bamburak et al. (2002).

Klyne Exploration drillholes

In 2004, Klyne Exploration drilled three holes, all on an angle of 60°, from the ice near the northeast shore of Pemmican Island (Figure GS-26-4). Diamond-drill hole Klyne no. 1 (Table GS-26-2) confirmed the presence of Ashern Formation below waterline near Pemmican Island. Only a few grains of sulphides were found near the base of the hole.

Core from diamond-drill holes Klyne no. 2 and 3 (Table GS-26-2, Figure GS-26-4) is partly mineralized with specks, clots and fracture-filled stringers of sulphides within dolomite. Figure GS-26-5 shows a fracture-filled stringer within dolomite from 17.7–17.8 m in hole no. 3. Five small loose chip samples were selected from the mineralized intervals of this hole and sent to TSL Laboratories Inc. for inductively coupled plasma–mass spectrometer (ICP-MS) analysis. The chip samples, containing both dolomite and sulphide, returned the following values:

- 1) 95% dolomite and 5% sulphide: 6.04% Zn, 8590 ppm Pb

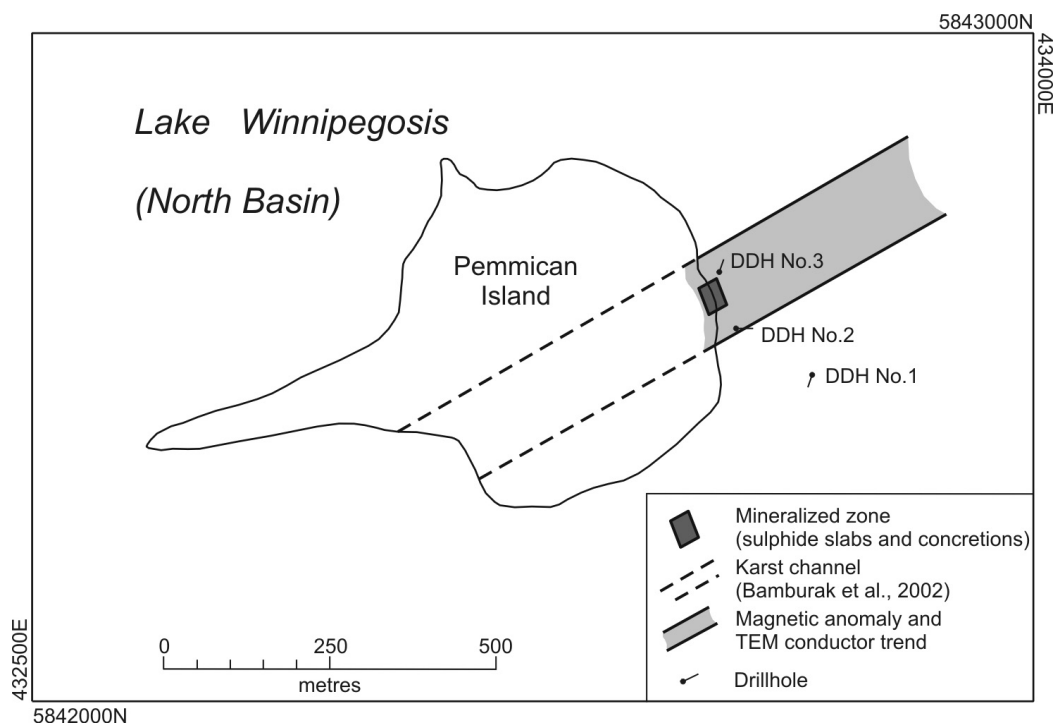


Figure GS-26-4: Pemmican Island in the north basin of Lake Winnipegosis, showing location of solid sulphide slabs and boulders, magnetic and conductivity trend, and drillhole locations.

Table GS-26-2: Summary of Klyne diamond-drill holes, Pemmican Island, north basin of Lake Winnipegosis.

Hole no.	Location and elevation	SYSTEM/Group/Formation	Interval (m)	Lithology summary	
Klyne No. 1, Pemmican Is. East	16-27-43-18W1; UTM 5842526N, 433678E; 289 m	water	0.0–3.0		
			DEVONIAN/Ashern Formation	3.0–5.6	Dolomite, brecciated, reddish orange, argillaceous, with greenish beige clasts
				5.6–6.9	Dolomite, greenish (reduced), argillaceous, with greenish beige clasts
		6.9–11.4		Dolomite, reddish buff, argillaceous, becoming whitish downward with minor crystal-filled vugs	
		SILURIAN/Interlake Group/Cedar Lake Formation		11.4–14.3	Dolomite, rubbly, vuggy and sandy with blue-green cavity infill, missing 2.1 m of core
			14.3–14.6	Dolomite, grey and yellow, slightly mottled, slight pinpoint porosity	
			14.6–14.8	Dolomite, honey-coloured, very porous, crystalline, 7 cm thick interval, then rubbly to 14.8	
Klyne No. 2, Pemmican Is. East	16-27-43-18W1; UTM 5842550N, 433545E; 289 m	water	0.0–12.2		
			SILURIAN/Interlake Group/Cedar Lake Formation	12.2–22.1	Dolomite, beige-buff, porous with subangular to subrounded inclusions (0.5–3.0 cm) and minor sulphides along fracture surfaces
		22.1–32.6		Dolomite, white to very light pink, fine-grained, finely laminated with minor chert, and pyrite and sphalerite along fracture surfaces	
		32.6–54.3		Dolomite, beige-buff, porous with abundant flame structures, and pyrite and sphalerite in fractures and vugs	
		54.3–54.5		Silt, beige-buff with quartz, pyrite and sphalerite grains	
		54.5–60.4	Dolomite, beige-buff, laminated with pyrite and sphalerite along fractures and laminations		
Klyne No. 3, Pemmican Is. East	16-27-43-18W1; UTM 5842645N, 433525E; 289 m	water	0.0–2.7		
			SILURIAN/Interlake Group/Cedar Lake Formation	2.7–17.7	Dolomite, beige-buff, fine grained, slightly mottled with pyrite and sphalerite in vugs and along fracture surfaces
		17.7–17.8		Dolomite, beige-buff, mineralized with up to 20% sulphides as a fracture coating. Minor very fine grained pyrite and sphalerite	
		17.8–26.2		Dolomite, beige-buff, slightly vuggy, sucrosic, altered with sphalerite and pyrite grains	

- 2) 80% dolomite and 20% sulphide: 31.2% Zn, 6880 ppm Pb, 62 ppm Ag
- 3) 75% dolomite and 25% sulphide: 5.66% Zn, 1.04% Pb
- 4) 100% sulphide: 7.48% Zn, 2750 ppm Pb, 23 ppm Ag
- 5) 95% dolomite and 5% sulphide: 0.98% Zn, 1610 ppm Pb

After viewing and logging the core, Inco Limited sent mineralized core intervals from diamond-drill holes Klyne no. 2 and 3 to Chemex for ICP-MS analysis, which showed that

- a 15 cm intersection of solid sulphide in Silurian dolomite hostrock at an approximate depth of 15 m below the ice in diamond-drill hole Klyne no. 3 graded 4.59% Zn, 0.41% Pb, 0.014% Cu, 10.4% Fe and 14.05% S; and
- a 6.5 m intersection from 17.5 m to 23.9 m in the same hole averaged 0.61% Zn (includes the above intersection).



Figure GS-26-5: Fracture-filled sulphide stringer in dolomite, diamond-drill hole Klyne no. 3, Pemmican Island.

Lead isotope analysis

Analysis of Pb isotopes from known MVT and other massive sulphide deposits have proven useful in determining the genesis of these deposits. Figure GS-26-6 is a plot of the $^{206}\text{Pb}/^{204}\text{Pb}$ versus $^{207}\text{Pb}/^{204}\text{Pb}$ values for Upper Mississippi Valley-type (UMV), and Pine Point and Flin Flon deposits from Gale and Conley (2000). The purpose of the plot was to determine the possible origin of the Balmoral glacially transported pebble described by McCabe (1969), which triggered MVT investigations throughout southern Manitoba in the 1970s and 1980s.

In order to determine the possible origin of the Pemmican Island mineralization, George Gale of the Manitoba Geological Survey selected four samples for possible Pb isotope analysis and sent them to Activation Laboratories Ltd. These samples of dolomite and sulphide were analyzed for Pb, as the first step in the process. The results were as follows:

- 1) 50% dolomite and 50% sulphide: 3.146% Pb
- 2) 75% dolomite and 25% sulphide: 0.335% Pb
- 3) 40% dolomite and 60% sulphide: 2.417% Pb
- 4) 70% dolomite and 30% sulphide: 2.927% Pb

Sample 1 was selected for Pb isotope analysis. The results are shown in Table GS-26-3 and Figure GS-26-6, together with those of the Balmoral pebble and the Flin Flon galena sample from Gale and Conley (2000).

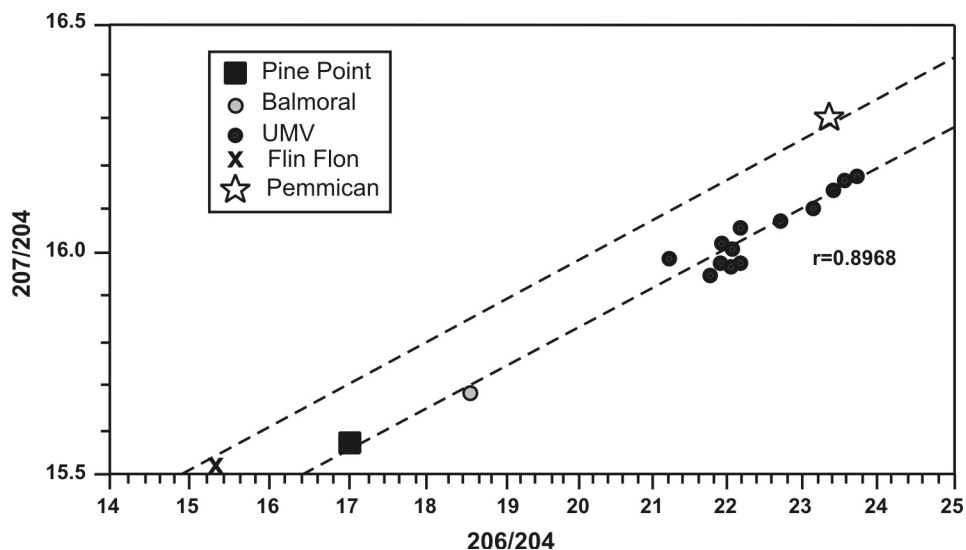


Figure GS-26-6: Lead isotope determinations for a Pemmican Island corehole sample, the Balmoral pebble, Pine Point, Upper Mississippi Valley-type (UMV) and Flin Flon galena samples (modified from Gale and Conley, 2000).

Table GS-26-3: Results of Pb isotope analysis on sulphide samples, Pemmican Island and Flin Flon.

Sample	$^{206}\text{Pb}/^{204}\text{Pb}$	$^{207}\text{Pb}/^{204}\text{Pb}$	$^{208}\text{Pb}/^{204}\text{Pb}$
Pemmican Island	23.3	16.3	46.0
Balmoral pebble	18.48	15.68	39.03
NREP 1 Flin Flon	15.404	15.217	34.983
NREP 2 Flin Flon	15.417	15.210	34.983

Enzyme LeachSM soil sampling

In September 2004, three double Enzyme LeachSM soil samples were collected from three shallow holes on the east shore of Pemmican Island, to test whether a distinct geochemical signature is present within the mineralized zone, compared to samples collected north and south of the zone. If successful, this method could be used to detect Pb-Zn mineralization on the mainland.

Fox Bay and Ami Island investigations

The shoreline of the east half of Fox Bay (Figure GS-26-1), located on the west shore of the north basin of Lake Winnipegosis southwest of Pemmican Island, was checked for sulphide mineralization in September 2004. Although a few small sulphide nodules were found on the shore, there did not seem to be sufficient numbers of them to warrant further work.

The shoreline of Ami Island, lying northwest of Pemmican Island near Denbeigh Point, was also investigated in an attempt to find the sulphides reported by Tyrrell (1892). A small fracture zone containing marcasite-pyrite was located on the west shore, adhering to chert and dolomite of the Silurian Cedar Lake Formation. More work is required to determine the potential of this showing, but it does imply that there is a northeast trend to the sulphide occurrences, parallel to the SBZ, within the north basin of Lake Winnipegosis.

Discussion

The eastern boundary of the buried Superior Boundary Zone (SBZ), in the vicinity of Pemmican Island, is placed along the east side of a northeast-trending zone of low magnetization, where it is adjacent to the relatively high magnetic signatures of the Berens River domain (Figure GS-26-3). Due to its sharply contrasting magnetic signatures, this contact is assumed to be a fault that separates the Archean rocks from the SBZ. This fault would be a southwestward continuation of a fault depicted on an inset map of the Grand Rapids 1:250 000-scale compilation map (Manitoba Industry, Trade and Mines, 2002), which is situated immediately to the north of the study area. Reactivation of the basement fault during the Phanerozoic would have provided avenues for mineralized fluid migration from basement into the overlying sedimentary rock, where the right conditions of pressure and temperature would have resulted in deposition of metallic minerals, such as Cu, Pb and Zn.

According to Porter and Fuller (1959) and Andrichuk (1959), secondary infilling of pore spaces by calcite and clay likely occurred at the pre-Middle Devonian unconformity in Manitoba and Saskatchewan. This infilling should have provided truncation-type stratigraphic traps within porous carbonate rocks and karst features of the upper Interlake Group. Further, the Ashern Formation redbeds probably formed a secondary caprock or seal to prevent upward movement of (hydrocarbon and/or hydrothermal?) fluids along the unconformity. Theiede and Cameron (1978) showed that the highest concentrations of Cu, Pb and Zn within the Elk Point Evaporite sequence occurred in the green shale and red dolomitic shale of the Ashern Formation, below the massive nodular dolomite of the Winnipegosis Formation. They also concluded that large tonnages of Cu, Pb and Zn may be present within the Elk Point Group.

The analytical results for drillcore samples from the holes drilled northeast of Pemmican Island, reported herein, show Pb-Zn values in Paleozoic carbonate rock several orders of magnitude above those previously obtained in provincial government and mineral-exploration company investigations. The setting for the Pb-Zn mineralization, at the edge of the Elk Point sedimentary basin, corresponds well with the setting of known Mississippi Valley-type occurrences in the United States and Canada. For comparison, two other Canadian MVT occurrences, in the same setting, are described:

- The Pine Point mining district is located 800 km north of Edmonton (1300 km northwest of the study area; Figure GS-26-2) on the south side of Great Slave Lake in the Northwest Territories. Within the district, over 87 deposits were defined within a 65 km by 24 km area. From these deposits, at least 36 orebodies were mined by Pine Point

Mines Ltd. (controlled and operated by Cominco Ltd.) from late 1964 until June 1987 (Rhodes et al., 1984).

- Canadian Occidental Petroleum Ltd. and Saskatchewan Mining Development Corporation carried out Project Wapa (Figure GS-26-2), 24 km south of La Ronge and 450 km northwest of the study area, from 1976 to 1981. Geochemical analyses of 1600 core samples from 49 drillholes in Middle Devonian hydrothermal dolomite showed values as high as 2850 ppm Pb, but usually in the range 100–600 ppm. These Pb values were accompanied by up to 355 ppm Zn and 3900 ppm F. Visible galena was noted to occupy a zone (10 km long by 5 km in wide) that coincided with the Precambrian Stanley Fault. The project was abandoned in 1981 after shallow drilling (<100 m) failed to locate ore (Campeau and Kissin, 1988; Kent, 1996).

From the present study, it is concluded that a new MVT mineral occurrence has been found in Manitoba, but extensive investigations will be required to determine the economic potential of this occurrence.

Economic considerations

Although metallic mineralization was noted on the shores of islands in the north basin of Lake Winnipegosis as early as 1889, it is an area of the province that is relatively unexplored for its mineral potential. As a result of the present study, however, Manitoba now has the first evidence of Mississippi Valley-type (MVT) Pb-Zn mineralization in the north basin of Lake Winnipegosis. This discovery may attract major mining companies to renew MVT exploration programs in the province, last carried out over 20 years ago.

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