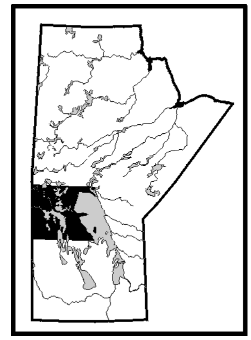
GS-17 PHANEROZOIC SOLID-SULPHIDE OCCURRENCE CONTAINING DEVONIAN DOLOMITE BRECCIA CLASTS, PEMMICAN ISLAND, LAKE WINNIPEGOSIS (NTS 63B12NW), MANITOBA

by J.D. Bamburak, I.T. Hosain and K. Klyne[1]



Bamburak, J.D., Hosain, I.T. and Klyne, K. 2002: Phanerozoic solid-sulphide occurrence containing Devonian dolomite breccia clasts, Pemmican Island, Lake Winnipegosis (NTS 63B12NW), Manitoba; *in* Report of Activities 2002, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 131-143.

SUMMARY

J.B. Tyrrell noted iron-sulphide concretions in 1889 on the shoreline of Pemmican Island at the north end of Lake Winnipegosis. This summer, large solid-sulphide slabs, containing breccia clasts of sucrosic Devonian dolomite, were found just below the waterline. These slabs contain up to 1.18% Ni and 0.76% Zn. The island is a Protected Area, but the surrounding lake bottom has been staked.

Pemmican Island is situated at the eastern margin of the Precambrian Superior Boundary Zone, which cuts two subdomains of the Berens River Domain within the Archean Superior Province. The island is also at the northern edge of the Camperville gravity low. Basement reactivation during the Phanerozoic is thought have fractured the overlying Paleozoic carbonate rocks and provided avenues for fluid migration from depth.

Kaolin clay of the Cretaceous Swan River Formation has been found along the shoreline. The clay is believed to occupy a preglacial channel within the dolomite bedrock on the island. The interpreted channel, striking 070°, joins the East and South beaches, where the sulphide concretions have been found over localized areas. A fault zone beneath the channel is believed to have provided a path for iron-sulphide–rich fluids to reach and precipitate within the Devonian carbonate bedrock.

Numerous exploration companies have attempted to find buried Precambrian Thompson-type nickel-copper deposits to the north and west of Pemmican Island. Other companies have attempted to find Paleozoic Mississippi Valley–type lead-zinc deposits to the north and southwest of the island. On the basis of these new analytical results, more work is recommended in the vicinity of Pemmican Island to determine the possible presence of one or both of these deposit types.

INTRODUCTION

As early as 1889, iron-sulphide concretions were noted on Pemmican Island, located near the west shore at the north end of Lake Winnipegosis. Recently, concretions were found to contain up to 1.18% Ni and 0.76% Zn. These values are anomalous compared to Ni and Zn values from concretions found in Phanerozoic formations located elsewhere.

In 2000, all mineral rights on Pemmican Island were pending withdrawal from staking by Order of the Minister of Industry, Trade and Mines at the request of the Parks Branch. During the following year, Ken Klyne of Swan River staked 23 Ken claims (MB3069–3072, 3200–3207, 3236–3240 and 3272–3281) surrounding Pemmican Island, mainly in 27-43-18-W1 (NTS 63B12NW). Early in 2002, Pemmican Island Park Reserve was recorded in the Mining Recording Office. All mineral rights on the island were withdrawn.

GEOLOGICAL SETTING

Pemmican Island, shown in Figure GS-17-1, is an outlier of Devonian Winnipegosis Formation dolomite situated within the Silurian outcrop belt (Fig. GS-17-2). According to Norris et al. (1982, p. 31), the argillaceous dolomite on Pemmican Island is the Lower Member of the Winnipegosis Formation. The Winnipegosis Formation and underlying Phanerozoic units dip towards the southwest and are part of the Western Canada Sedimentary Basin.

The Precambrian basement forms the western margin of the Archean craton of the Superior Province and the northeast-trending Superior Boundary Zone (SBZ; Fig. GS-17-1). Two east-trending subdomains of the Berens River Domain also underlie the island, forming a T-shaped intersection with the SBZ (Pilkington and Thomas, 2001). Pemmican Island is also situated at the northern edge of the Camperville gravity low (Bamburak et al., 2000). Basement reactivation along the SBZ has been documented by Bezys (1996), Bezys et al. (1996), Bamburak (1999) and Bamburak et al. (2000).

Cretaceous Swan River Formation (Fig. GS-17-2) is draped on the eroded surface of the Devonian dolomite.

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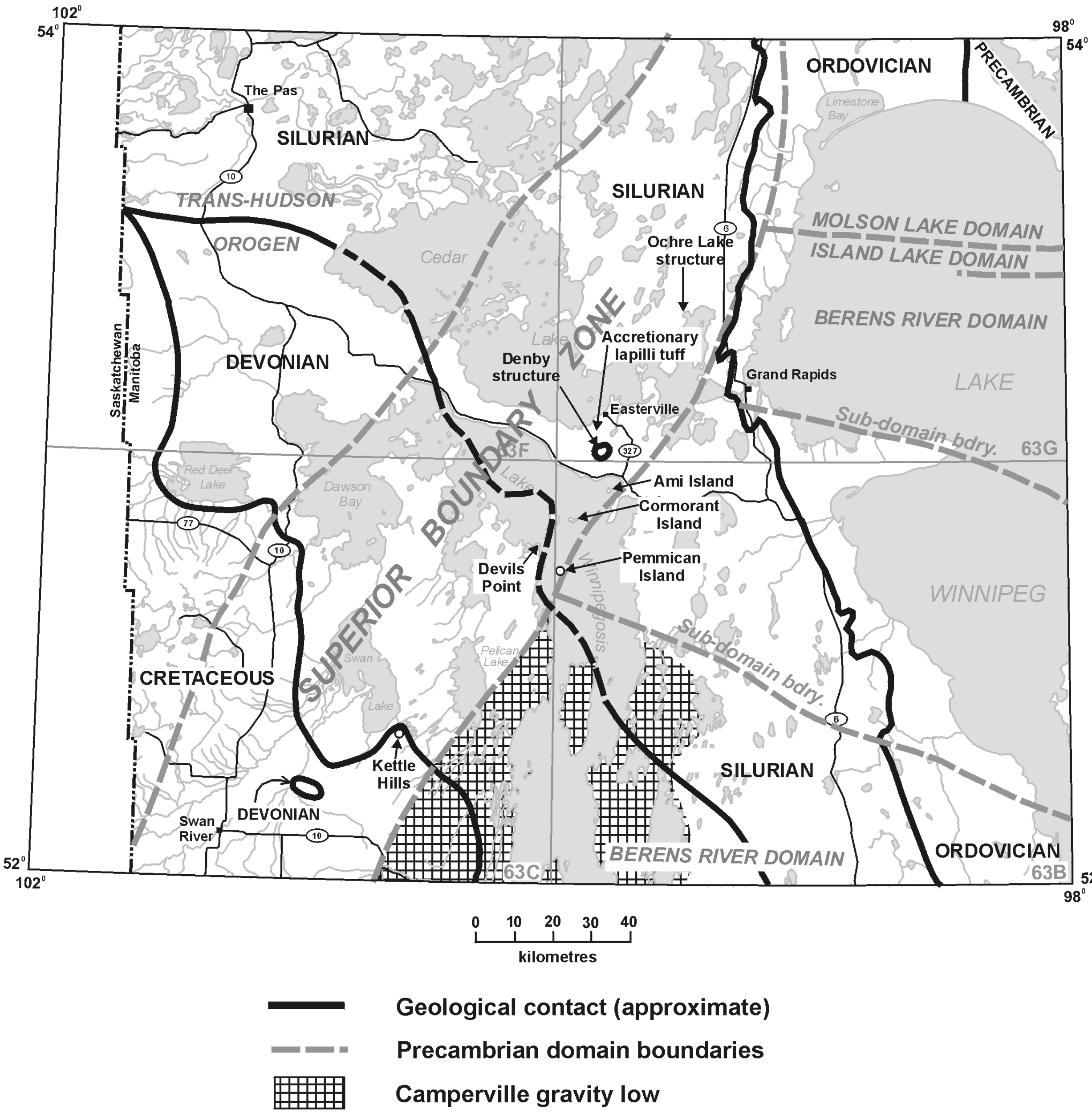


Figure GS-17-1: Geological setting of Pemmican Island, related features and immediate vicinity at the north end of Lake Winnipegosis. Precambrian domain boundaries after Pilkington and Thomas (2001).

Pleistocene glacial till and lacustrine sediments overlie the Swan River beds except along the shoreline, where Recent boulders, cobbles and sand are reworked annually by ice push and subsequent wave action.

PREVIOUS WORK

In the summer of 1889, J.B. Tyrrell visited Pemmican Island. Tyrrell documented the presence of nodules of marcasite and fragments of lignite, associated with white sandstone. He interpreted this to be a Cretaceous "outlier of Dakota sandstone deposited in a hollow of the Devonian rocks" (Tyrrell, 1892, p. 170E).

Later, Tyrrell (1890, p. 228) described the distribution of what he believed to be the 'Dakotah Group' (now known as the Swan River Formation) as follows:

> "The terrane can be seen in several exposures along the foot of the northern portion of the Cretaceous escarpment, and at a small island known as Pemican Island in lake Winnipegosis, forty-four miles east from the foot of the escarpment there are evidences of the presence of this or the overlying group. The exposures seen were altogether

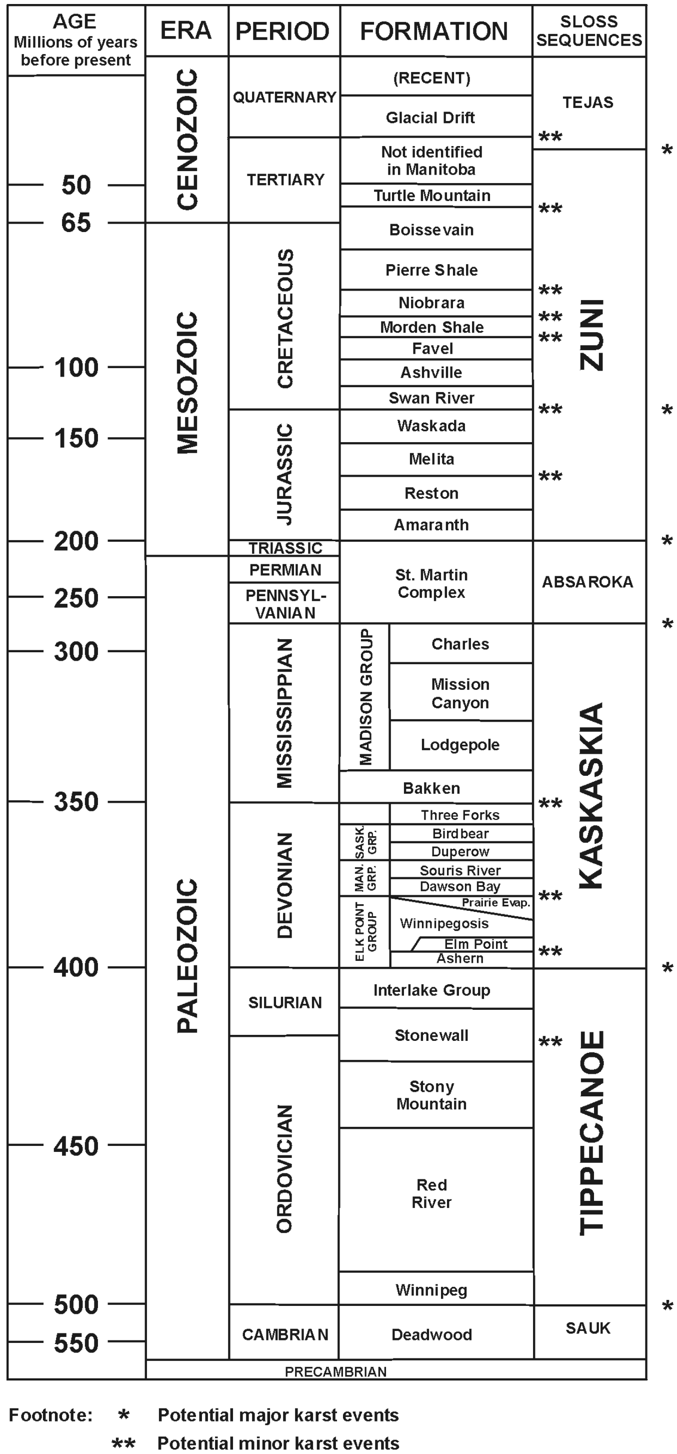


Figure GS-17-2: Generalized stratigraphic section for southern Manitoba, with asterisks showing times of karst events (McRitchie, 1991).

too few and small to allow of any exact determination being made of the total thickness of the group, but on account of the irregularities of the floor on which it was laid down it certainly varies greatly even in short distances. Near the northwest end of Lake Winnipegosis it has probably a maximum thickness of two hundred feet, while on the north side of the Riding Mountain, where it was passed through in the Manitoba Oil Co's well on Vermillion River, it has, so far as can be determined from the few specimens at hand, a thickness of fifty-five feet."

Similar concretions were also described on Ami Island, Devils Point and Cormorant Island, at the north end of

Lake Winnipegosis (Fig. GS-17-1) by Tyrrell (1892, p. 153E, 170E and 171E, respectively). On Ami Island, Tyrrell 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, 0.32 km northwest of the east tip of the island (Norris et al., 1982, p. 31). Norris and Oullet also measured two sections along a cliff face, 0.16 and 0.38 km west of the east tip of the island. The sections extended to heights of 5.0 and 8.5 m above lake level, respectively, and consisted of argillaceous dolomite of the Lower Member of the Devonian Winnipegosis Formation. The dolomite beds exposed in the cliff were estimated to be within 6 m of the base of the formation, and the underlying Devonian Ashern Formation is believed to be present near the edge of the lake (Norris et al., 1982, p. 31, 165). Baillie (1950) could not find any evidence of the Ashern Formation at the base of Pemmican Island.

Numerous exploration companies have attempted to find buried Precambrian Thompson-type nickel-copper deposits to the north and west of Pemmican Island. McRitchie (1995) and Hosain and Bamburak (GS-16, this volume) documented the results of exploration along the southwest extension of the Thompson Nickel Belt, beginning in the 1970s. Other companies have attempted to find Paleozoic Mississippi Valley–type (MVT) lead-zinc deposits to the north and southwest of the island (Bamburak et al., 2000).

In 1970, Cominco Ltd. attempted to locate MVT deposits in the vicinity of Denbeigh Point (Fig. GS-17-1), 12 km northeast of Pemmican Island and 8 km south of Easterville (Assessment File 91785, Manitoba Industry, Trade and Mines, Winnipeg). Cominco was attracted to the area by the reported occurrence of “massive botryoidal marcasite”. The occurrence “was considered as encouragement with regard to Pb-Zn mineralization in the Paleozoic section.” In October of the same year, Cominco reported that “Despite the fact that islands and the shoreline around the Denbeigh Peninsula were intensively searched, no evidence was found of marcasite mineralization, in either float or outcrop.” Due to drilling, however, this work resulted in the discovery of the Denby structure, an anomalous Precambrian basement high close to a Cretaceous “channel or karst deposit” with limestone boulders that contained a large amount of marcasite (McCabe, 1978; Bezys et al., 1996).

Cominco’s investigations, this time for Ni-Cu mineralization, resumed in the late 1990s (Assessment Files 94638 to 94643, Manitoba Industry, Trade and Mines, Winnipeg). Most of the drilling was done to the north, west and southwest of Pemmican Island, and as far south as the Kettle Hills (Fig. GS-17-1). Although not successful in locating an economic deposit, the drilling did result in the discovery of an accretionary lapilli tuff within Cretaceous channel fill in drillhole RP-96-21, south of Easterville (Bezys et al., 1996). The Denby structure, mentioned above, is 5 km southeast of this hole.

Bezys (1996) noted disturbed Silurian bedrock at Ochre Lake (Fig. GS-17-1), on strike with the sulphide occurrences described by Tyrrell (1890, 1892) and the lapilli tuff and Denby structure (described above). Ochre Lake is approximately 70 km northeast of Pemmican Island. Bezys interpreted that the structurally disturbed in situ carbonate beds represented a fault-controlled feature or a diatreme structure.

Mineralized Swan River Formation core, from the Survey’s stratigraphic drillholes and from holes drilled by private companies, has been sampled and analyzed (Fedikow et al., 1998).

CURRENT STUDY

In May 2001, Ken Klyne of Swan River, Manitoba contacted the Manitoba Geological Survey to report the presence of numerous sulphide cobbles on the east beach of Pemmican Island in Lake Winnipegosis. A visit was made to Swan River to view the samples, and a trip was subsequently made to Pemmican Island in 2001. Geological and geophysical investigations were carried out over two days at three sites on the east and south shoreline of Pemmican Island (Fig. GS-17-3). In July 2002, a second opportunity to visit Pemmican Island, as well as Ami Island (at the north end of Lake Winnipegosis, near Denbeigh Point), was provided.

Sulphide beach east

Station no. 99-01-PI-001 (SE-27-43-18-W1; UTM 14U, 433501E, 5842619N, NAD 27)

Iron-sulphide concretions are present along a north-trending shoreline on the east side of Pemmican Island (Fig. GS-17-3). The angular, reddish-brown concretions, ranging in size from pebbles to boulders, lie in an unconsolidated sandy matrix between typical, well-rounded, Precambrian and Paleozoic cobbles and boulders (Fig. GS-17-4, GS-17-5). In September 2001, the iron-sulphide concretions were found within a zone measuring 28 m in length (parallelling the shore) and 2 m in width. A weak EM-16 anomaly corresponded to the mineralized section of the beach.

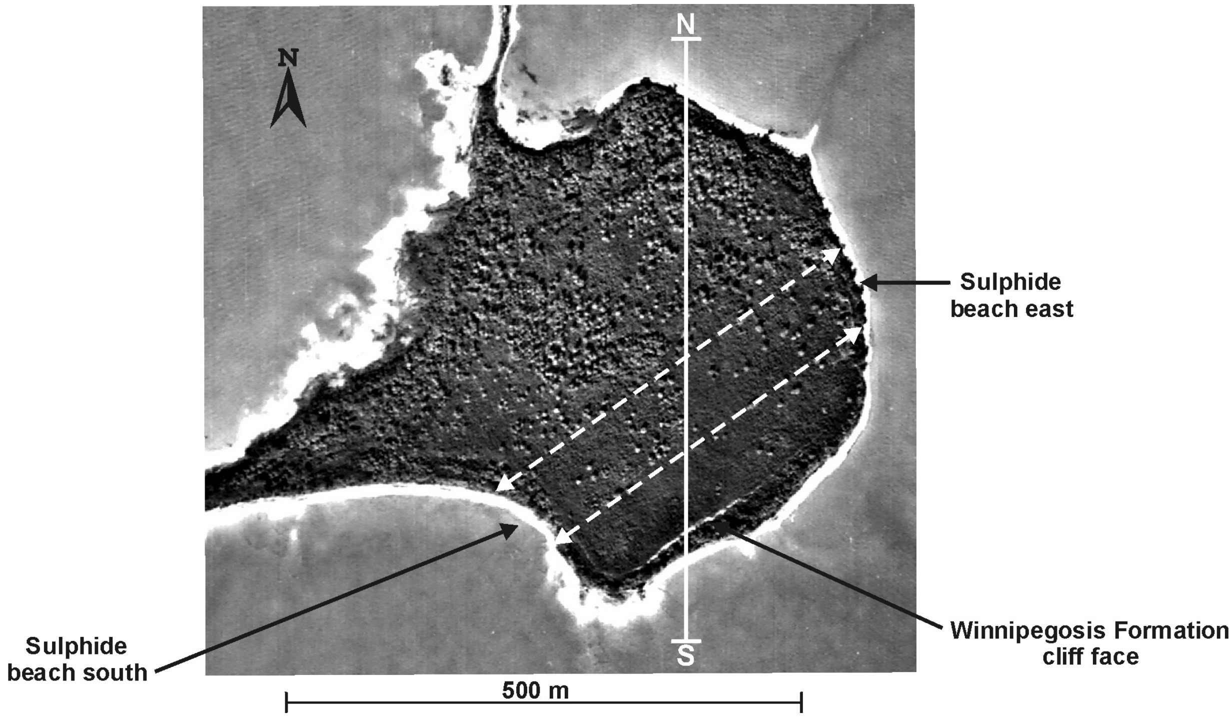


Figure GS-17-3: Pemmican Island, showing sample sites, interpreted northeast-trending karst channel (shown between white dashed lines) and north-south line of section (shown in Fig. GS-17-9).

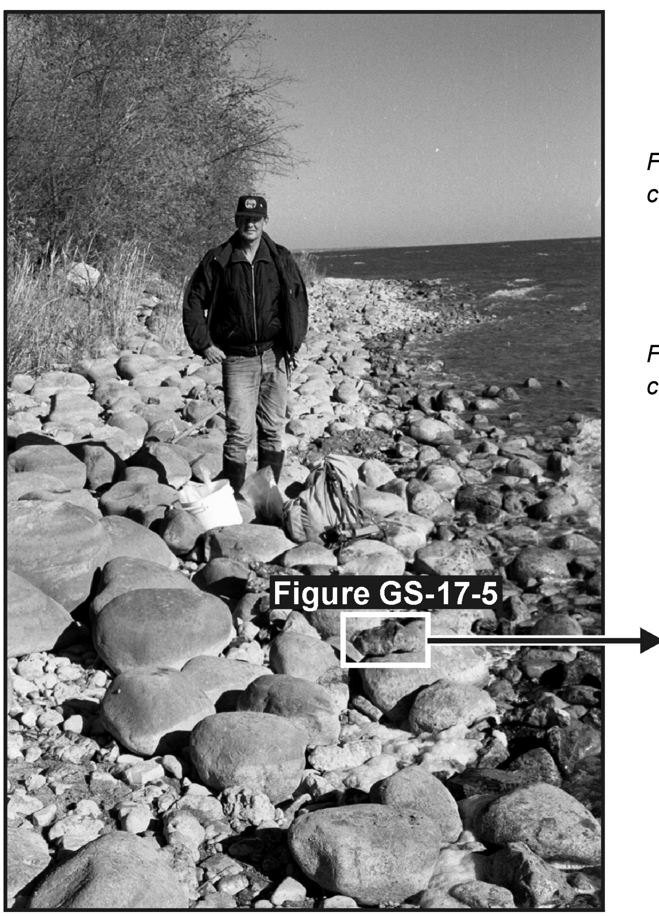
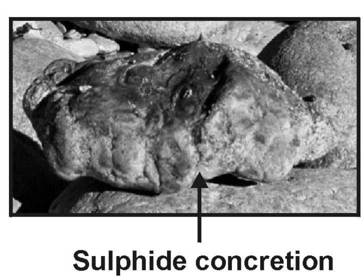


Figure GS-17-4: Ken Klyne and iron-sulphide concretions, Sulphide beach east.

Figure GS-17-5: Close-up of iron-sulphide concretion, Sulphide beach east.



In July 2002, with falling lake levels, the width of the exposed zone increased by another 2 m. Within this newly exposed area, iron-sulphide concretions (many containing irregular clasts of dolomite) formed up to 80% of the surface. Further investigation, 1 m below the current lake level and parallel to the exposed zone, disclosed many large, solid-sulphide slabs (Fig. GS-17-6, GS-17-7). Some of the slabs ranged in size up to 40 cm by 40 cm by 15 cm and weighed 30 to 50 kg. They were located within fine silt, up to 4 m away from the shoreline.

Winnipegosis Formation bedrock is exposed in thin slabs on the beach and may be continuous within the cliff. The formation consists of sucrosic dolomite, which is similar to the clasts within some of the iron-sulphide concretions.

Devonian Winnipegosis Formation dolomite cliff

Station no. 99-01-PI-002 (SE-27-43-18-W1; UTM 14U, 433345E, 5842396N, NAD 27)

Vuggy sucrosic dolomite is present in a 3 m high, east-northeast-trending cliff of Devonian Winnipegosis Formation along the southeast shore of Pemmican Island (Fig. GS-17-3). Karst-like channels, plunging 70°SE, cut diagonally downward on the face of the cliff. The top of the cliff is vegetated and the plant roots utilize the vuggy

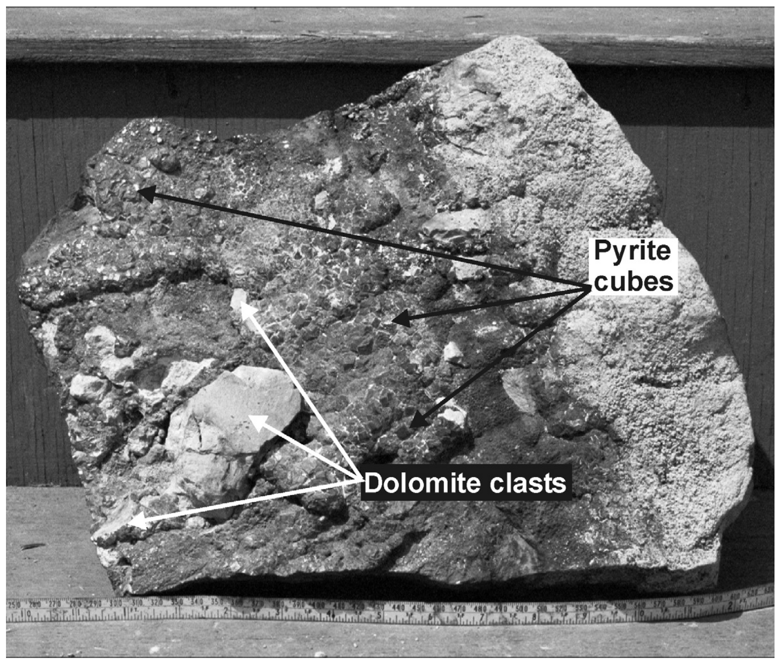


Figure GS-17-6: Solid-sulphide concretion with dolomite clasts and pyrite cubes, Sulphide beach east.

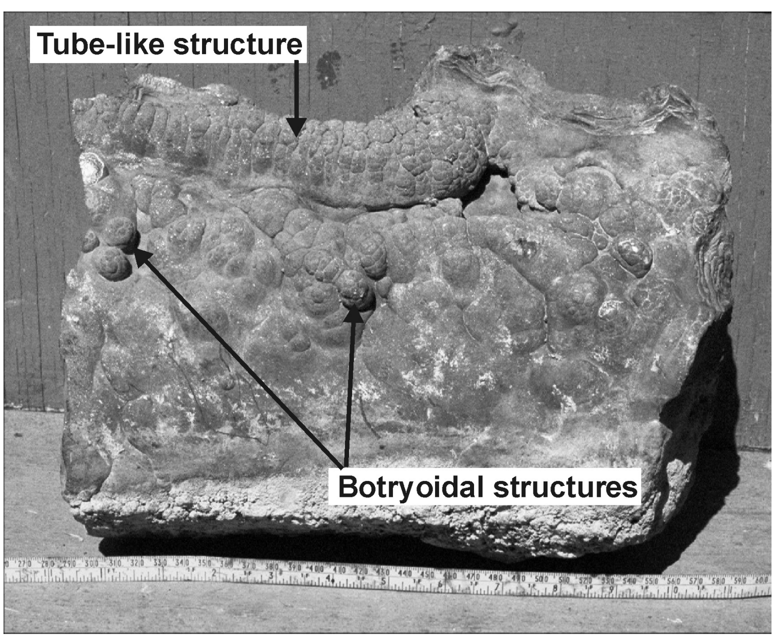


Figure GS-17-7: Solid-sulphide concretion with botryoidal and tube-like structures, Sulphide beach east.

dolomite for water. No fracture pattern is evident and no rusty appearance is present on the cliff face of the dolomite.

Sulphide beach south

Station no. 99-01-PI-002 (SE 27-43-18-W1; UTM 14U, 433307E, 5842446N, NAD 27)

Iron-sulphide pebbles and lignite fragments are interspersed between cobble-sized erratics on an east-trending shoreline on the south side of Pemmican Island (GS-17-3). A strong EM-16 anomaly corresponds to the mineralized section of the beach. Underlying the cobbles, pebbles and sand on the beach is a relatively pure, cream-coloured kaolin clay (Fig. GS-17-8), probably of the Cretaceous Swan River Formation. The clay is topographically lower than the dolomite cliff (described above) and is at about the same elevation as the dolomite bedrock on the East beach.

Chemical analyses

The results of chemical analyses done on Pemmican Island samples, provided by Ken Klyne, are shown in Tables GS-17-1 and GS-17-2. Most samples were collected at Sulphide beach east (Klyne's site 1), and a few at the Sulphide beach south (Klyne's site 2). The analytical work was done at Activation Laboratories Limited (Actlabs) in Ancaster, Ontario and at TSL Laboratories in Saskatoon, Saskatchewan.

A sample from station no. 99-01-PI-001 (described above) was sent to Actlabs by the Manitoba Geological Survey in February 2002, and the analysis is also included in Table GS-17-1.

Analytical results below the level of detection, or those covered by another method, were deleted from Table GS-X-1. The elements Ag, Ba, Br, Ca, Cs, Ir, Mo, Ni, Rb, Sn, Sr, Ta, U, Tb and Yb were removed for INAA, and Be for ICP.

DISCUSSION

- All of the sulphide-concretion occurrences noted by Tyrrell (1890, 1892) at the north end of Lake Winnipegosis, including Pemmican Island, are aligned with the eastern margin of the underlying northeast-trending Superior Boundary Zone. The occurrences are on strike with: the Denby structure, an anomalous Precambrian basement high described by McCabe (1978); the fault-controlled or diatreme Ochre Lake structure of Bezys (1996); and accretionary lapilli within Cretaceous channel fill of Bezys et al. (1996). It should be noted, however, that the sulphide concretions described by Tyrrell in 1889 could not be found in 2002 on the shoreline of Ami Island.
- Pemmican Island lies very close to the T-intersection between two subdomains of the Berens River Domain and the Superior Boundary Zone (Fig. GS-17-1). The northwest trend of the common margin of the subdomains roughly

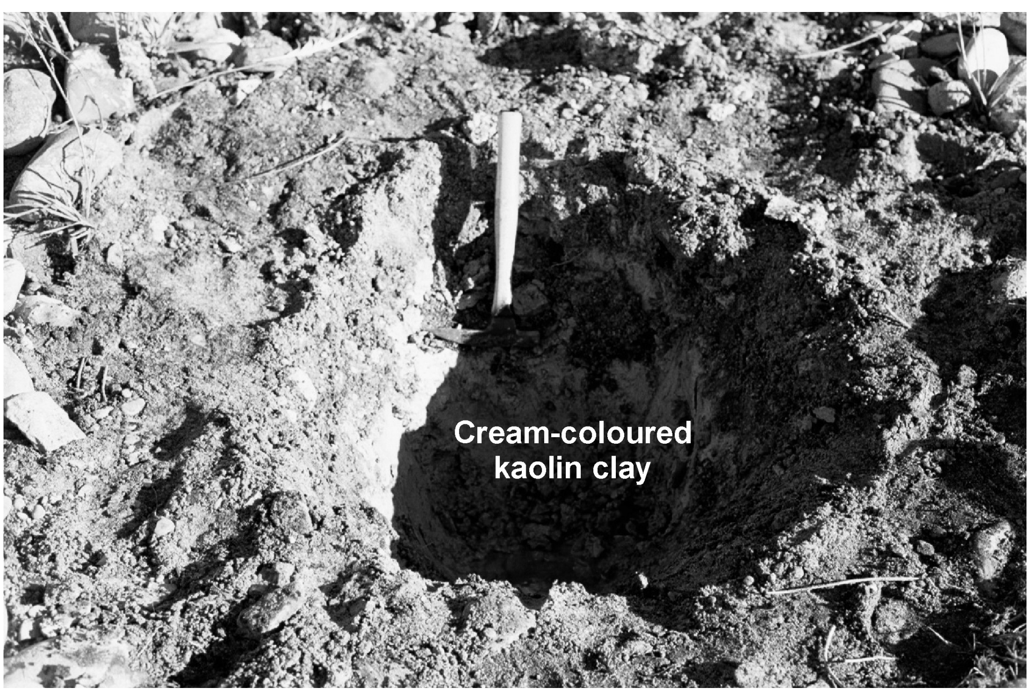


Figure GS-17-8: Cream-coloured kaolin clay beneath cobbles, Sulphide beach south.

Table GS-17-1: Ken Klyne's Pemmican Island sulphide-concretion analyses (by instrumental neutron activation analysis [INAA] and inductively couple plasma–mass spectrometry [ICP-MS]).

Element Units Method	Au PPB INAA	As PPM INAA	Co PPM INAA	Cr PPM INAA	Fe % INAA	Hf PPM INAA	Hg PPM INAA	Na % INAA	Sb PPM INAA	Sc PPM INAA	Se PPM INAA	Th PPM INAA	W PPM INAA	La PPM INAA	Ce PPM INAA	Sm PPM INAA	Eu PPM INAA	Lu PPM INAA
Activation Laboratories Ltd.																		
Detection Limit	**2**	**0.5**	1	5	**0.01**	**1**	**1**	**0.01**	**0.1**	**0.1**	**3**	**0.2**	**1**	**0.5**	**3**	**0.1**	**0.2**	**0.05**
22203-1	-2	1120	50	13	43.4	-1	-1	-0.01	7.4	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22203-2	-2	3670	73	13	45.5	-1	-1	0.01	1.1	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22203-3	-2	857	15	11	45.3	-1	-1	0.01	1	0.2	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22203-4	6	1610	130	7	41.3	-1	-1	0.02	17	0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22203-5	-2	2270	160	14	46.7	-1	-1	0.01	22.3	0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22203-6	-2	1220	49	20	45.6	-1	-1	0.01	6.4	0.1	-3	0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22367-1	-2	1230	3	9	42.3	-1	-1	-0.01	-0.2	-0.1	-3	0.6	-1	-0.5	-3	-0.1	-0.2	-0.05
22367-2	-2	1780	120	17	53.2	-1	-1	0.01	15.3	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22367-3	-2	833	25	13	41.4	-1	-1	-0.01	-0.1	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22367-4	-2	3300	79	11	46.2	-1	-1	-0.01	-0.3	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22429-1	-2	1980	174	14	45.2	-1	-1	-0.01	8.3	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22429-2	-2	1170	350	-5	48.1	-1	-1	-0.01	18.7	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22429-3	-2	1540	813	-5	52.1	-1	-1	-0.01	13	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22512-1	-2	1470	64	-5	61.7	-1	-1	0.02	3.3	0.3	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22512-2	-2	2570	64	25	62.2	-1	-1	0.02	3.5	0.4	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
22598-1	-2	2070	21	15	50.2	-1	3	0.01	-0.1	0.1	-3	-0.2	2	-0.5	-3	-0.1	-0.2	-0.05
22598-2	-2	2240	55	14	43.9	-1	1	-0.01	-0.1	-0.1	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
23025-2	-5	5620	382	-5	52.8	-1	-1	0.02	2.8	1.9	-3	-0.6	-1	1.5	-3	-0.1	-0.2	-0.05
23025-3	-5	154	6	25	23.8	4	-1	0.02	8.1	1.6	-3	1	-1	4	-3	0.7	-0.2	-0.05
23025-4	-5	303	8	30	50.8	-1	-1	0.03	5.1	1.9	17	1.4	-1	8.3	-3	0.6	-0.2	0.16
23025-5	-5	450	8	27	45.8	-1	-1	0.06	4.3	2.5	-3	-0.3	-1	9.1	12	4	0.3	-0.05
99-01-PI-001	8	1740	165	12	46.4	-1	-1	-0.01	19	0.2	-3	-0.2	-1	-0.5	-3	-0.1	-0.2	-0.05
TSL Laboratories																		
Detection Limit		**1**	**1**	**1**	**0.01**			**0.01**	**1**	**1**			1					
S10928-2		1520	38	138	28.8			<0.01	3	<1			<1					
S10928-3		198	4	464	18.5			<0.01	2	<1			<1					
S10928-4		150	2	172	26.8			<0.01	3	<1			<1					
S10928-5		357	2	63	29.2			<0.01	3	<1			<1					

Note: S10928-2 to -5 are sample duplicates of 23025-2 to -5, above. Analysis was by aqua regia digestion with an ICP-MS finish.

Table GS-17-1: Ken Klyne's Pemmican Island sulphide-concretion analyses (by instrumental neutron activation analysis [INAA] and inductively couple plasma–mass spectrometry [ICP-MS]). (continued)

Element	Mass	Ag	Cd	Cu	Mn	Mo	Ni	Pb	Zn	Al	Bi	Ca	K	Mg	P	Sr	Ti	V
Units	g	PPM	PPM	PPM	PPM	PPM	PPM	PPM	PPM	%	PPM	%	%	%	%	PPM	%	PPM
Method	INAA	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP
Activation Laboratories Ltd.																		
Detection Limit		**0.3**	**0.3**	**1**	**1**	**1**	**1**	**3**	**1**	**0.01**	**2**	**0.01**	**0.01**	**0.01**	**0.001**	**1**	**0.01**	**2**
22203-1	48.02	-0.3	2.7	6	337	118	565	19	24	0.11	-2	0.02	-0.01	0.03	0.003	2	-0.01	-2
22203-2	43.99	-0.3	1.5	2	23	68	699	32	83	0.01	-2	0.12	0.02	0.02	0.002	3	-0.01	-2
22203-3	49.16	-0.3	2.1	-1	429	219	191	-3	21	0.29	-2	-0.01	-0.01	0.04	0.004	3	0.02	4
22203-4	49.01	-0.3	1.7	-1	107	82	1518	24	21	0.10	-2	0.02	-0.01	0.04	0.006	3	-0.01	-2
22203-5	40.04	-0.3	2.3	-1	77	85	1737	35	21	0.12	-2	-0.01	-0.01	0.02	0.004	3	-0.01	-2
22203-6	46.21	-0.3	2.1	-1	360	152	515	-3	26	0.04	-2	0.24	-0.01	0.06	0.002	6	-0.01	-2
22367-1	41.53	-0.3	0.7	-1	30	47	45	-3	10	0.12	-2	-0.01	-0.01	-0.01	-0.001	3	-0.01	-2
22367-2	15.62	-0.3	-0.3	-1	172	104	1020	30	27	0.29	-2	0.02	0.03	-0.01	-0.001	5	-0.01	-2
22367-3	49.53	-0.3	0.6	-1	164	157	287	22	20	0.11	-2	-0.01	0.01	0.02	-0.001	2	-0.01	-2
22367-4	22.11	-0.3	1.4	-1	35	84	681	20	48	0.01	-2	-0.01	-0.01	-0.01	0.001	-1	-0.01	-2
22429-1	8.295	-0.3	-0.3	8	159	94	1470	6	26	0.02	-2	-0.01	0.01	-0.01	0.002	-1	-0.01	-2
22429-2	6.658	-0.3	-0.3	4	69	64	2832	59	34	0.02	-2	-0.01	0.01	-0.01	0.002	-1	-0.01	-2
22429-3	5.84	-0.3	0.3	6	132	84	2125	16	40	0.01	-2	-0.01	-0.01	-0.01	0.002	-1	-0.01	-2
22512-1	12.79	-0.3	0.8	9	96	61	435	-3	17	0.10	-2	0.04	0.01	-0.01	-0.001	4	-0.01	-2
22512-2	13.25	-0.3	1	14	92	58	471	-3	15	0.14	-2	0.04	0.01	-0.01	-0.001	5	-0.01	-2
22598-1	5.31	-0.3	-0.3	13	82	90	150	-3	25	0.01	-2	-0.01	0.01	-0.01	-0.001	1	-0.01	-2
22598-2	15.34	-0.3	-0.3	3	62	84	273	-3	28	0.01	-2	-0.01	0.01	-0.01	-0.001	-1	-0.01	-2
23025-2	12.54	0.3	3.2	33	51	76	2710	13	107	0.03	36	0.10	-0.01	-0.01	-0.001	3	-0.01	-2
23025-3	23.85	-0.3	0.5	32	26	19	235	196	5	0.34	18	0.08	0.02	0.02	0.001	7	0.10	5
23025-4	14.17	-0.3	5.7	10	12	111	24	54	1	0.27	32	0.09	-0.01	-0.01	0.001	7	0.04	2
23025-5	15.85	-0.3	2.4	27	21	58	21	43	-1	0.2	32	0.08	-0.01	0.06	0.003	8	0.02	3
99-01-PI-001	49.32	0.4	3.3	16	142	84	1559	16	44	0.21	9	0.10	0.08	-0.01	0.002	3	-0.01	-2
TSL Laboratories																		
Detection Limit		**0.2**	**1**	**1**	**10**	**2**	**1**	**2**	**1**	**0.01**	**1**	**0.01**	**0.01**	**0.01**	**10**	1	**0.01**	**1**
S10928-2		1.2	<1	40	21	44	330	11	163	<0.01	<1	0.06	<0.01	0.02	43	1	<0.01	35
S10928-3		0.7	<1	29	42	24	79	215	5	<0.01	<1	0.21	<0.01	0.02	25	4	<0.01	22
S10928-4		0.8	<1	10	9	101	31	76	9	<0.01	<1	0.04	<0.01	<0.01	40	4	<0.01	33
S10928-5		0.7	<1	8	<10	60	18	74	4	<0.01	<1	0.04	<0.01	0.01	49	3	<0.01	34

Note: S10928-2 to -5 are sample duplicates of 23025-2 to -5, above. Analysis was by aqua regia digestion with an ICP-MS finish.

Table GS-17-1: Ken Klyne's Pemmican Island sulphide-concretion analyses (by instrumental neutron activation analysis [INAA] and inductively couple plasma–mass spectrometry [ICP-MS]). (continued)

Element Units Method	Y PPM ICP	S % ICP	Sample type	Site	Easting	Northing
Activation Laboratories Ltd.						
Detection Limit	**1**					
22203-1	-1	33.555	Single concretion	1	433501	5842619
22203-2	-1	34.538	Single concretion	1	433501	5842619
22203-3	-1	34.123	Single concretion	1	433501	5842619
22203-4	-1	32.807	Single concretion	1	433501	5842619
22203-5	-1	33.262	Single concretion	1	433501	5842619
22203-6	-1	33.348	Single concretion	1	433501	5842619
22367-1	-1	30.732	Single concretion	1	433501	5842619
22367-2	2	30.979	Single concretion	1	433501	5842619
22367-3	-1	31.172	Single concretion	1	433501	5842619
22367-4	-1	30.926	Single concretion	1	433501	5842619
22429-1	-1	26.561	Single concretion	1	433501	5842619
22429-2	-1	28.530	Single concretion	1	433501	5842619
22429-3	-1	26.840	Single concretion	1	433501	5842619
22512-1	-1	31.865	Single concretion	1	433501	5842619
22512-2	1	32.359	Single concretion	1	433501	5842619
22598-1	-1	33.381	Single concretion	1	433501	5842619
22598-2	1	30.645	Single concretion	1	433501	5842619
23025-2	-1	30.121	Composite sample	1	433501	5842619
23025-3	2	19.060	Composite sample	2	433345	5842396
23025-4	2	26.480	Composite sample	1	433501	5842619
23025-5	-1	26.374	Composite sample	2	433345	5842396
99-01-PI-001	-1	36.440	Single concretion	1	433501	5842619
TSL Laboratories						
Detection Limit	**1**					
S10928-2	<1	nil	Composite sample	1	433501	5842619
S10928-3	<1	nil	Composite sample	2	433345	5842396
S10928-4	1	nil	Composite sample	1	433501	5842619
S10928-5	<1	nil	Composite sample	2	433345	5842396

Note: S10928-2 to -5 are sample duplicates of 23025-2 to -5, above. Analysis was by aqua regia digestion with an ICP-MS finish.

corresponds to the northern edge of the Camperville gravity low. The 070° direction of the interpreted karst channel and dolomite cliff on the southeast shore of Pemmican Island may represent differential basement reactivation between the Superior Boundary Zone, the Camperville gravity low and the subdomain boundary.

- A karst channel (Fig. GS-17-3), striking 070°, is interpreted between the iron-sulphide–rich area on Sulphide beach east (Station PI-001) and that on Sulphide beach south (Station PI-003). The channel is north of and parallel to the strike of the Winnipegosis Formation dolomite cliff at Station PI-002. The bottom of the channel is near lake level on Sulphide beach east. The channel seems to plunge towards Sulphide beach south, where it is filled with kaolin clay of probable Cretaceous age. Figure GS-17-9 shows a composite cross-section from south to north across Pemmican Island, approximately halfway between the two beaches. A fault zone is interpreted to underlie the karst channel, which could provide a means for mineralizing fluids from depth to reach the Devonian carbonate rocks.
- Maximum analytical values obtained from single concretions, shown in Tables GS-17-1 and GS-17-2, are: 62.2% Fe, 36.4% S, 1.18% Ni, 0.76% Zn, 3670 ppm As, 1100 ppm Pb and 813 ppm Co. It should be noted that the sample with 1100 ppm Pb also contained 1700 ppm Zn.
- Composite sample 23025-2, consisting of pebbles taken from the East beach by Ken Klyne, contained 52.8% Fe, 30.12% S, 0.45% Ni, 5620 ppm As and 382 ppm Co. Since this sample had values much higher than many of the single concretion samples, it is likely that at least one pebble must have had significantly higher values than the rest.
- Portions of the sulphide samples collected on Pemmican Island are weathered and the resulting iron-oxide–rich cement has incorporated more recent materials (e.g., limestone and granite pebbles, and sand) into a reddish oxide matrix surrounding some of the nodules or concretions. The reddish matrix that colours the beaches may account for the previous interpretation by Baillie (1950) that the Devonian Ashern Formation is present near the base of

Table GS-17-2: Ken Klyne's Pemmican Island sulphide-concretion analyses (by aqua regia digestion and atomic absorption [AA] finish).

Element Units	Ni PPM	Ni %	Zn PPM	Zn %	Cu PPM	Pb PPM
TSL Laboratories						
Detection Limit	**1**	**0.01**	**1**	**0.01**	**1**	**1**
S11617-1	270		8		3	2
S11617-2	89		140		4	25
S11617-3	1320		140		2	60
S11617-4	330		16		1	6
S11617-5	200		11		1	7
S11617-6	770		1000		3	85
S11617-7	140		11		3	1
S11617-8	610		16		1	15
S11617-9	520		1180		3	270
S11617-10	270		14		3	14
S11617-11	280		31		1	22
S11617-12	160		280		11	63
S11617-13	320		22		1	9
S11617-14	290		11		1	10
S11617-15	200		180		2	36
S11617-16	20		18		4	7
S11617-17	360		87		3	23
S11617-18	58		75		3	15
S11617-19	200		9		1	7
S11617-20	270		9		1	6
S11617-21	250		800		13	28
S11617-22	1330		23		4	51
S11617-23	1350		51		10	57
S11617-24	1160		1720		18	1100
S11617-25	330		820		5	36
S11617-26	310		610		8	75
S11617-27	>5000	1.18	>5000	0.54	12	540
S11617-28	330		1260		9	26
S11617-29	2410		5000	0.50	9	190
S11617-30	350		73		5	17
S11617-31	240		18		2	2
S11700-1	430		560		20	44
S11700-2	1940		1630		11	130
S11700-3	440		>5000	0.76	16	300
S11700-4	390		73		2	24
S11700-5	210		270		3	18
S11700-6	51		26		1	<1
S11700-7	55		86		8	6

Extraction for ppm analyses by $HCl-HNO_3$ and for % analyses by $HNO_3-HF-HClO_4-HCl$

Pemmican Island.

- Many of the iron-sulphide concretions are coated with a caliche crust of calcium carbonate, which gives them a beige appearance.

RECOMMENDATIONS

- A shallow drilling program should be carried out beneath the water to a depth of 60 m, adjacent to Sulphide beach east, to determine if mineralization continues to depth.
- A ground electromagnetic survey should be conducted, on the ice adjacent to Pemmican Island, to determine whether any anomalies are present near the triple point at the junction between the two subdomains of the Berens River Domain and the Superior Boundary Zone. Follow-up drilling should be done through the Paleozoic rocks into the underlying Precambrian basement.
- A magnetic survey should also be carried out to determine if there are any Precambrian basement Thompson-type nickel anomalies within the Superior Boundary Zone in the vicinity of Pemmican Island. However, the testing of any resulting anomalies will require much deeper drilling.

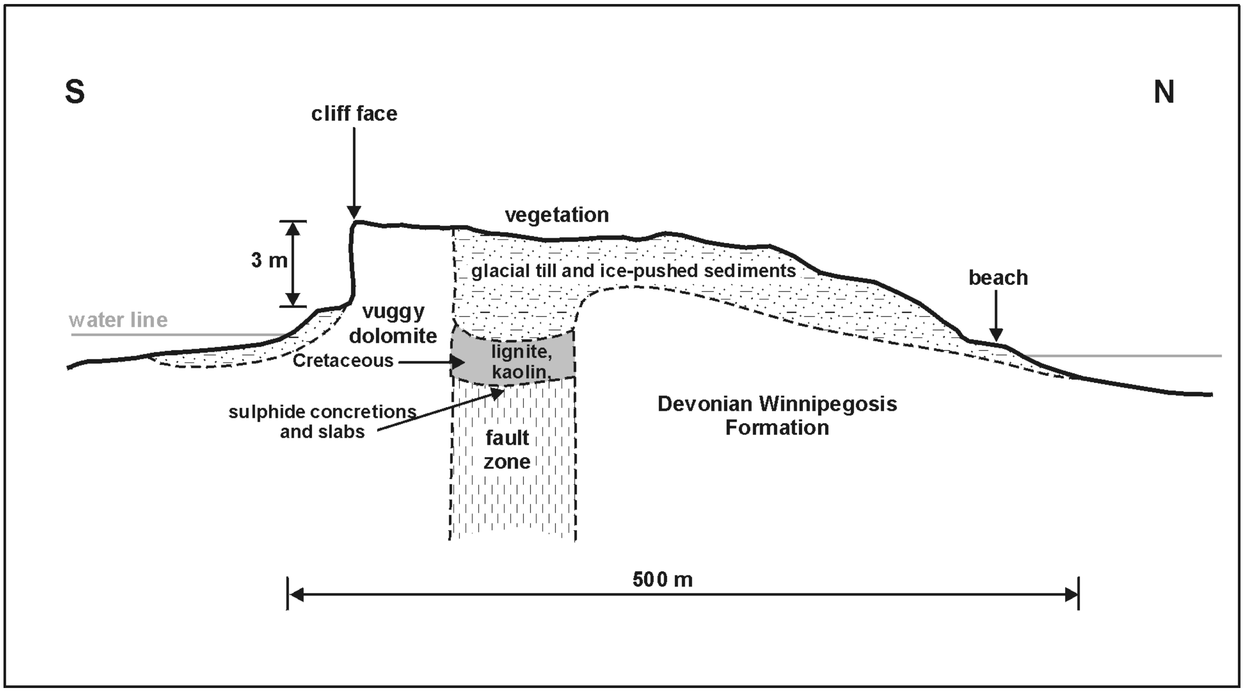


Figure GS-17-9: Composite cross-section from south to north across Pemmican Island, looking west. Line of section is shown on Figure GS-17-3. Vertical scale exaggerated about 20X.

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