GOLD DEPOSITS *of* MANITOBA

MANITOBA ENERGY AND MINES

Manitoba

Manitoba
Energy and Mines

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Gold Deposits of Manitoba

By D.J. Richardson and G. Ostry (revised by W. Weber and D. Fogwill)

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Energy and Mines

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FRONTISPIECE: *Site of northwest corner post of San Antonio discovery mineral claim, staked by Alexander Desautels, May 17, 1911*

FRONT COVER: *High grade gold specimen from the San Antonio Mine, Bissett, Manitoba. It measures 24x20x5 cm and contains an estimated* 5.41 *kg gold (photograph courtesy of the National Museum of Natural Sciences, Ottawa).*

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PREFACE

At Manitoba Energy and Mines our goal is to make Manitoba the best place in Canada to invest in exploration and mining. In Manitoba, we have a welcoming business environment and a strong commitment to your investment. Close to a century of mining success has spurred the growth of major mining centres such as Thompson, Flin Flon, Snow Lake and Lynn Lake. In Manitoba, you will find that we offer more than just great resource opportunity. We have targeted those factors that directly affect potential investment and have introduced a number of strategic changes.

Since 1994, Manitoba has progressed from having the highest combined income and mining tax rates to among the lowest in Canada for new mine developments. One window permitting establishes standard ground rules and a clearly drawn path that enable projects to progress efficiently from exploration to new mine status. A mineral exploration assistance program intended to stimulate mineral exploration in the province was introduced in 1995. This program provides $10 million over 3 years to the exploration community in support of grassroots mineral exploration. A $5 million geoscience program is underway in the Superior Province of Manitoba. Land access and tenure issues have been made a priority. Manitoba offers highly competitive operating costs including some of the lowest hydro electrical rates in North America. The taxation, incentive, and geoscience programs are in place to achieve our goal, and to help you invest, explore and discover in Manitoba.

Over the past 10 years, since this report was first published, the geological understanding of the Precambrian greenstone belts in Manitoba, in particular the Flin Flon and Rice Lake greenstone terranes, has advanced considerably and there have been significant gold discoveries; Burnt Timber deposit, Little Stull Lake, Monument Bay, and Rusty Zone. Since the writing of the original document the MacLellan mine at Lynn Lake ceased production and the Tartan Lake mine at Flin Flon, the Puffy Lake mine near Sherridon have opened and closed. The Burnt Timber mine at Lynn Lake and the New Britannia mine (formerly the Nor-Acme) at Snow Lake have gone into production. The Farley Lake mine near Lynn Lake is scheduled for production in 1996 and the Bissett Gold mine (formerly the San Antonio mine) in 1997. In 1995, gold exploration and development brought $51 million of investment to Manitoba, while gold mines generated revenues of $60 million and 300 direct jobs.

It is within this progressive environment that we present this revised edition of Gold Deposits of Manitoba. The revised edition contains an up-to-date account the regional geology of the province, gold mines, deposits and occurrences, the location and geological setting of the mines deposits and occurrences, deposit geology, history of exploration, data on mine development and past production, and information that has not been previously published. For some deposits, the information was supplied by the property owner or operator. The four colour maps present the most recent geological information available for those areas of Manitoba.

The original document, prepared by D.J. Richardson and G. Ostry in 1986, formed the basis for this new edition and much of their work remains intact. The new edition was prepared under contract to Douglas Fogwill and Dr. Werner Weber between May and August 1996. Dr. Weber updated the regional and deposit geology and Mr. Fogwill updated exploration, development and/or production data, although there was shared involvement in many areas of the work.

Sponsorship for this project by Rea Gold Corporation, TVX Gold Inc. and Mid-North Resources Ltd. greatly helped defray the cost of printing.

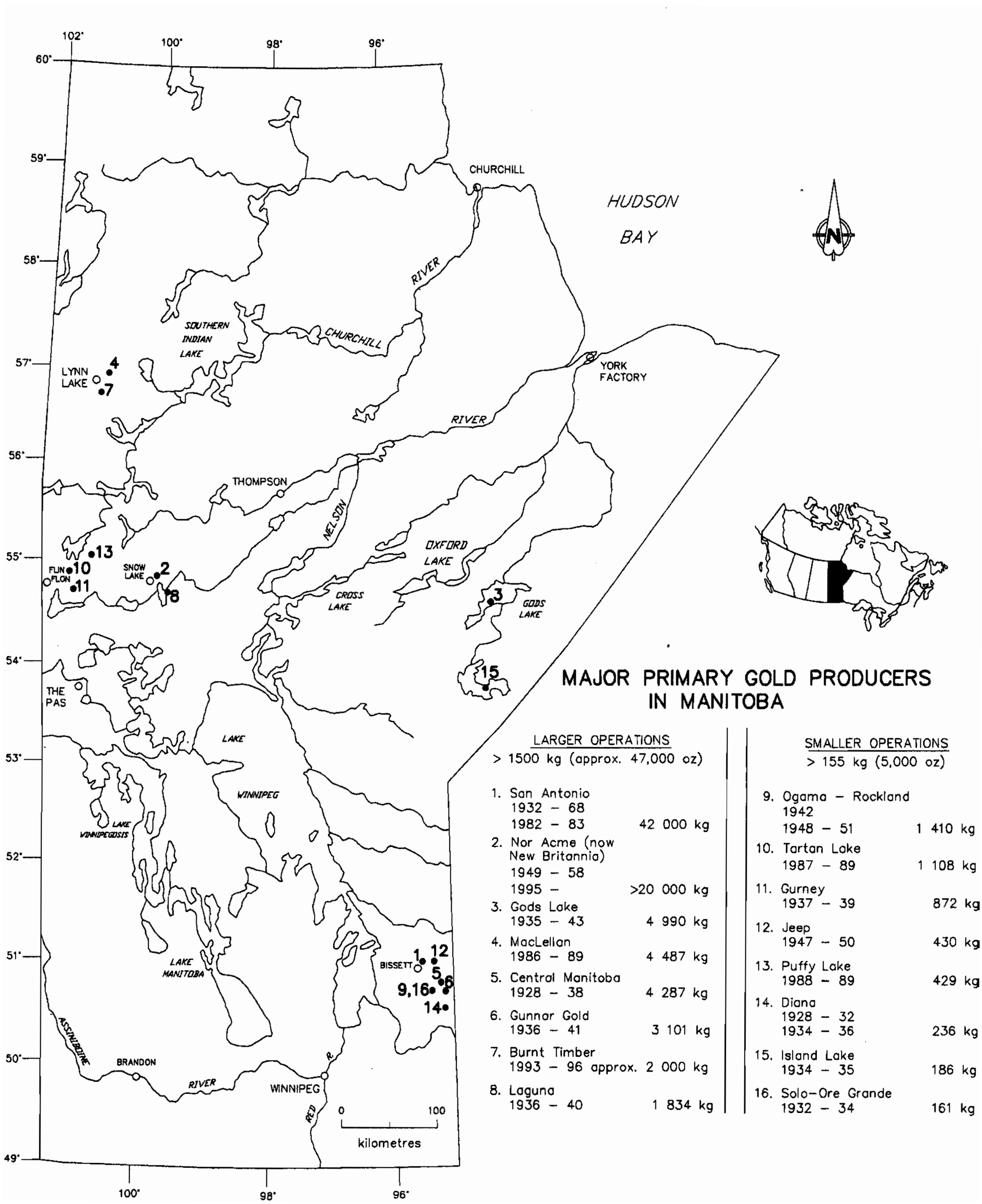

Figure 1: Location Map of major primary gold producers of Manitoba

INTRODUCTION

This report is a compilation of data on the primary gold deposits of Manitoba and was written in response to the resurgence of gold exploration in the province in recent years. It is intended to assist prospectors and mining companies in exploring Manitoba and provide a source of information for use in promoting the province's gold potential. The information was compiled from a variety of sources including: Manitoba Energy and Mines publications and files, Geological Survey of Canada publications, company annual reports, press clippings and personal communication with prospectors and geologists. Throughout this publication areas of primary gold mineralization are referred to as either deposits i.e., former and present producing mines and those gold occurrences with published reserve figures, or simply as occurrences *i.e.,* localities where gold has been reported. The onerous task of describing every gold occurrence in the province is beyond our present mandate; however, we have attempted to describe all gold deposits in some detail and publish the locations of all deposits and occurrences. In providing a description/synthesis of the gold mineralization in any particular area we have, ad hoc, included a description of, or data on. gold occurrences where it was required and reliable information was available.

With the exception of the Cross Lake, Churchill/Superior boundary and Seal River regions, a table that lists major features of mines. deposits and occurrences, described in this report, is presented at the end of each regional description.

TABLE 1 PRODUCTION FROM MANITOBA GOLD MINES *

Mine	Gold Produced kilograms (oz.)	Average Grade gold g/tonne (oz/ton)	Years in Production	Map Ref. in Report
San Antonio	42 000 (1 350 335)	9.2 (0.27)	1932 - 1968 1982 - 1983	Map ER86-1-1 location RL1
Nor – Acme	19 480 (623 330)	3.9 (0.11)	1949 - 1958 1995 -	Map ER86-1-3 location FF1
Gods Lake	4 990.5 (160 451)	10.27 (0.30)	1935 - 1943	Map ER86-1-2 location GL1
MacLellan	4 487 (143 580)	5.50 (0.1 7)	1986 - 1989	Map ER86-1-4 location 1
Central Manitoba	4 287 (137 817)	12.00 (0.35)	1928 - 1938	Map ER86-1-1 location RL2
Gunnar Gold	3 101 (99 713)	11.90 (0.35)	1936 - 1941	Map ER86-1-1 location RL3
Burnt Timber	approx. 2 000 (64 000)	2.80 (0.09)	1993 - 1996	Map ER86-1-4 location 4
Laguna	1 834 (58 962)	16.70 (0.49)	1936 - 1940	Map ER86-1-3 location FF2
Ogama – Rockland	1 410 (45 343)	11.20 (0.33)	1942 1948 - 1951	Map ER86-1-1 location RL4
Tartan Lake	1 108 (34 450)	7.20 (0.23)	1987 - 1989	Map ER86-1-3 location FF8
Gurney	872 (28 045)	9.20 (0.27)	1937 - 1939	Map ER86-1-3 location FF3
Jeep	430 (13 811)	26.1 (0.76)	1947 - 1950	Map ER86-1-1 location RL5
Puffy Lake	429 (13 728)	8.0 (0.25)	1988 - 1989	Map ER86-3 location KS1
Diana (Gem Lake)	236 (7 575)	11.4 (0.33)	1928 - 1932 1934 - 1936	Map ER86-1-1 location RL6
Island Lake	186 (5 987)	20.92 (0.61)	1934 - 1935	Map ER86-1-2 location IL1
Solo – Oro Grande	160.7 (5 166)	11.2 (0.33)	1932 - 1934	Map ER86-1-1 location RL10

* Mines that produced over 155 kg (5000 oz.) gold

MANITOBA GOLD PRODUCTION

Manitoba's total gold production to the end of 1995 was 109 958 kg (6 139 300 oz). Approximately 45% of this production, 85 953 kg (2 763 710 oz), was derived from primary gold deposits, and 55%, 140 995 kg (3 375 589 oz), was produced as a by-product of base metal mining (based on production figures supplied by Statistics Canada). This report will discuss only primary gold deposits.

A total of 27 mines produced gold in Manitoba between 1917 and 1968. The majority of production, however, came from seven mines: San Antonio, Nor-Acme, Central Manitoba, Gods Lake, Gunnar, Laguna and Ogama-Rockland (Fig. 1). Each of these mines produced over 1244 kg (40,000 oz.) gold and in total contributed 95% of the province's gold production (Table 1). The San Antonio Mine at Bissett, in southeast Manitoba, produced 42 000 kg (1,350,335 oz.) gold or 54% of the total gold production (San Antonio Gold Mines Limited, production cards 1932 to 1968; Manitoba Energy and Mines, Mineral Policy, production figures 1982-1983). The Nor-Acme Mine, at Snow Lake, produced 19 547 kg (628,461 oz.) of gold or 24% of the total gold production (Manitoba Mines Branch, Annual Reports 1949-1958). Manitoba's annual gold production peaked in 1950 at 4262 kg (137,020 oz.) and declined rapidly until 1968 when, with the closing of the San Antonio Mine, primary gold production in the province stopped (Fig. 2). In 1986 Manitoba again became a primary gold producer with the opening of SherrGold Inc.'s MacLellan Mine near Lynn Lake. In 1987 two new deposits, Tartan Lake at Flin Flon and Puffy Lake near Sherridon commenced production. All three of these gold mines ceased production in 1989. The MacLellan Mine produced 4487 kg (144 257 oz) of gold between 1986 and 1989, and between 1987 and 1989, the Puffy Lake and Tartan Lake Mines produced 429 kg (13 792 oz) and 1108 kg (35 622 oz) of gold, respectively. Primary gold production in Manitoba ceased until the opening of the BT open pit gold mine, part of the Keystone Gold Project, at Lynn Lake in 1993. In 1995 the old Nor Acme mine at Snow Lake was reopened as the New Britannia Mine, and the former producing San Antonio mine, now called the Bissett Gold Mine, is scheduled for production early in 1997. In 1996 at the Keystone Gold Project, the BT open pit mine was closed, but production began at the Farley Lake open pit mine east of Lynn Lake.

GOLD EXPLORATION AND PRODUCTION IN MANITOBA: 1890-1979

After the gold discoveries in the Black Hills of South Dakota in 1874 and in the Lake of the Woods area of Ontario in 1890, small areas of southeastern Manitoba were prospected. Manitoba's first gold occurrence was discovered there in 1890 when Tom Moore staked the Moore claim 3 km north of Falcon Lake. The significance of the Canadian Precambrian Shield, however, was not fully recognized until after the great gold discovery at Porcupine, Ontario in 1909. Many prospectors and investors then focused their attention on northwestern Ontario and Manitoba in search of the next "Porcupine camp".

In southeast Manitoba the Moore property was developed during the period 1911 to 1915 by Penniac Reef Gold Mines Limited and produced approximately 3.1 kg (100 oz.) gold. This discovery, similar to those in the Lake of the Woods area of Ontario, proved to be of minor importance and prospectors soon moved on to other areas that were reported by officers of the Geological Survey of Canada to be favourable proscting ground.

In the Bissett area, 160 km northeast of Winnipeg, the Gabrielle and San Antonio claims were staked in 1911 over a prospect that later became the San Antonio Mine. These claims initially received little attention in comparison to claims southeast and southwest of Bissett. The Gold Pan, Elora and Onondaga claims produced minor amounts of gold between 1919 and 1924. In 1928 Central Manitoba Mines, Limited became the first major producer of the Bissett area when the Kitchener Mine went into production. It produced a total of 4821 kg (154,988 oz.) gold from 1928 to 1938 (Central Manitoba Mines, Limited, Annual Reports, 1928-1938). At about the same time as the development of the Kitchener Mine, San Antonio Gold Mines Limited was formed to develop the San Antonio claim. The San Antonio Mine was in production from 1932 to 1968 (briefly from 1982 to mid-1983) and produced 42,000 kg (1 350 335 oz.) gold. Other gold producers of the area in decreasing order of importance were: Gunnar, Ogama-Rockland, Jeep, Diana, Poundmaker, Cryderman, Solo-Oro Grande and Grand Central.

The northwestern part of the province, though prospected in the late 1890s, was not systematically searched until after 1907. In 1914 gold was discovered 20 km southeast of Snow Lake on the east shore of Wekusko Lake (Herb Lake). In 1917 a shipment of ore from the Moose Horn claim

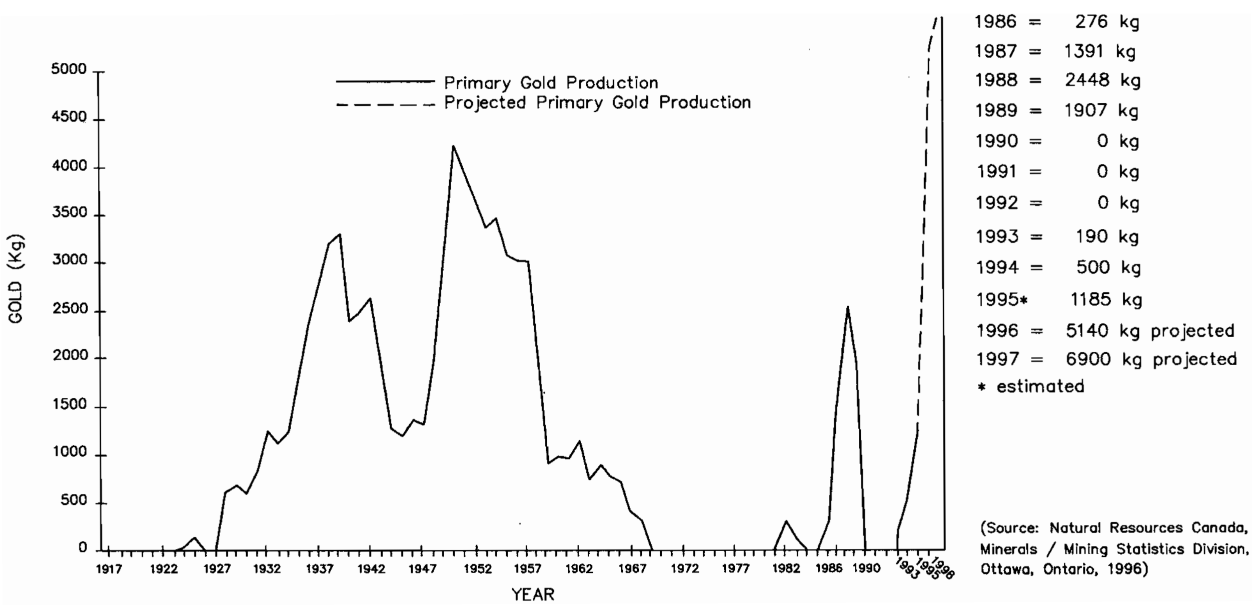

Figure 2: Primary gold production in Manitoba: 1917-1996

produced 3.36 kg (108 oz.) gold (Alcock, 1917). In 1918 the Rex claim (Laguna Mine) went into production. It was in production intermittently until 1939 and produced 1833.9 kg (58,962 oz.) of gold (Manitoba Mines Branch, Annual Reports 1928-1940). In 1925 C. R. Parres staked the Toots and Chums claims in the Snow Lake area over a deposit that later became the Nor-Acme mine. The Nor-Acme mine produced 19 179 kg (616,615 oz.) gold from 1949 to 1958. The Gurney Mine located 44 km east of Flin Flon was staked in 1919 and produced 872 kg (28,045 oz.) gold from 1937 to 1939. Other gold producers in the Flin Flon-Snow Lake area in decreasing order of importance were: Ferro- Rainbow, Bingo, Gold Hill and Century.

The more remote areas of northeastern Manitoba were not explored until the late 1920s. In 1928 several gold occurrences were discovered at Island Lake. Island Lake Gold Mines Limited produced 186 kg (5987 oz.) gold from 1934 to 1935 from an island in the east central part of the lake (Manitoba Energy and Mines, Mines Branch, Corporation Files). Farther to the northeast R.J. Jowsey and A. MacDonald discovered gold in 1932 during a drilling program at Elk Island on Gods Lake. God's Lake Gold Mines Limited produced 4991 kg (160,451 oz.) gold from this deposit between 1935 and 1943 (God's Lake Gold Mines Limited, Annual Reports, 1935-1943).

In the Lynn Lake area there is little record of exploration work prior to 1930. The first gold discovery was made in 1934 by S. Akers and W. Hanson at Cartwright Lake, 23 km southeast of Lynn Lake. Subsequent discoveries were made in the Lasthope lake-McVeigh Lake area. In 1939 drilling by Sherritt Gordon Mines, Limited at Lasthope Lake outlined a deposit of 127 000 tonnes grading 7.9 g/tonne (0.23 oz/ton) gold (Milligan, 1960). There was little gold exploration carried out in the late 1940s and early 1950s mainly due to emphasis on base metal exploration. In 1955 drilling carried out by Agassiz Mines Limited discovered significant gold mineralization 6.5 km northeast of Lynn Lake. The property was explored by several companies between 1956 and 1979. Diamond drilling and underground development outlined a deposit, named the Agassiz deposit, with probable and possible reserves of 1 765 000 tonnes (1 946 000 tons) averaging 8.57 g/tonne (0.25 oz/ton) gold (Royal Agassiz Mines Ltd., Annual Report, 1973).

GOLD EXPLORATION IN MANITOBA: 1980-1986

In the early 1980s gold exploration in the province remained at low levels. The only major project was the re-opening of the San Antonio Mine from January 1982 to May 1983. Expenditures on gold exploration increased 86% to $30.8 million in 1984 with the renewed interest in Manitoba's gold potential and the use of flow-through shares for financing. In 1985 the number of gold exploration projects in the province increased 70% from 61 to 105. As a result of this increased exploration the province had: a new primary gold producer, SherrGold Inc.'s MacLellan Mine (formerly the Agassiz deposit); two deposits, Tartan Lake and Puffy Lake, that commenced production in 1987; and several deposits in advanced stages of exploration (Fig. 3).

From 1980 to 1986 Sherritt Gordon Mines Limited carried out diamond drilling and underground development on the Agassiz property. They estimated the deposit to contain mineable reserves of 1.49 million tonnes grading 7.17 g/tonne (0.21 oz/ton) gold and formed SherrGold Inc. to develop the deposit, which they renamed the MacLellan Mine (SherrGold Inc., Preliminary Prospectus, September 17, 1986). The mine commenced production in mid-1986 and poured its first bar of dore bullion on August 25, 1986. The mine, when in full production, was forecasted to produce 2020 kg (65,000 oz.) of gold annually (News release to the Northern Miner, SherrGold Inc., January 1987).

In 1985 Granges Exploration Ltd. and Aberford Resources Ltd. (Abermin Corporation) discovered the Tartan Lake deposit, 14 km northeast of Flin Flon. They estimated the Main zone to contain reserves of 464 000 tonnes grading 11.97 g/tonne (0.349 oz/ton) gold (Granges Exploration Ltd., Annual Report, 1985). An underground development program, which started in 1986 and is continuing in 1987, consisted of: driving an underground decline, underground drilling and crosscutting to the ore zones. Based on the results of drilling, the joint venture partners proceeded with mill construction. They estimated that the mill may be in production by March 1987 and when in full production could produce 1556 kg (50,000 oz.) of gold annually (Northern Miner, January 12, 26, 1987).

In 1985 Maverick Mountain Resources Limited announced the discovery of the Puffy Lake deposit, 63 km northeast of Flin Flon (Maverick Mountain merged with Pioneer Metals Corporation in October 1986). Based on the results of an underground development program Pioneer Metals Corporation decided to put the deposit, which is estimated to contain 1.2 million tonnes averaging 7.89 g/tonne (0.23 oz/ton) gold, into production (Pioneer Metals Corporation, News release, January 19, 1987). They estimated that production would start in December 1987 and that when in full production the mine could produce 1244 kg (40,000 oz.) of gold annually.

In February 1986 Manitoba Mineral Resources Ltd. and Hudson Bay Exploration and Development Company Limited (HBED) announced the discovery of "widespread gold mineralization" at Farley Lake (Manitoba Mineral Resources, News Release, February 24, 1986). Diamond drilling carried out to test the extent of mineralization outlined several zones. The Wendy and East zones were estimated to contain combined geological reserves of 635 000 tonnes (700,000 tons) averaging 6.86 g/tonne (0.20 oz/ton) gold (Northern Miner, January 19, 1987).

In 1982 HBED estimated total indicated reserves of the Nor-Acme Mine to be 2 510 900 tonnes grading 5.49 g/tonne (0.16 oz/ton) gold (Northern Miner, July 22, 1982).

In 1986 San Antonio Resources, a joint venture between Inco Ltd. and Quest Resources, completed a 6127 m underground drill program at the San Antonio Mine. Resources at the mine are estimated to be 13 064 kg (420,000 oz.) of contained gold (Northern Miner, September 1, 1986, p. 2).

In 1986 Silver Hart Mines Ltd., through subsidiary Snow Lake Mines Ltd., commenced drilling on their Snow Lake property located just north of the Nor-Acme Mine. Hudson Bay Mining and Smelting Co., Limited, who dropped their option on the property in 1986, estimated Number 3 zone drill indicated reserves to total 200 000 tonnes grading 15.09 g/tonne (0.44 oz/ton) gold (George Cross Newsletter Ltd., No. 54, 1986). In March 1987 Snow Lake Mines announced the discovery of a new zone, located 1.2 km north-northwest of the No.3 zone, with drill indicated reserves of 127 000 tonnes averaging 18.10 g/tonne (0.528 oz/ton) gold (Northern Miner, March 9, 1987).

Bighorn Development Corp. estimated drill indicated resources at its Island Lake property to total 316 000 tonnes averaging 15.43 g/tonne (0.45 oz/ton) gold (Northern Miner, November 3, 1986, p. 14). Zenco Resources Inc. estimate their Squall Lake property, located 6 km north-northwest of Snow Lake, to contain 680 000 tonnes grading 3.43 g/tonne (0.1 oz/ton) gold (Northern Miner, January 10, 1985, p. 7).

GOLD EXPLORATION AND PRODUCTION IN MANITOBA 1986-1996

Exploration expenditures in Manitoba for precious metals increased from $16 million in 1985 to a high of $24 million in 1987 dropping to $3.6 million in 1991 and as low as $700,000 in 1993; in 1994 it was about $7 million (Natural Resources Canada, Minerals/Mining Statistics Div., Ottawa, 1996). Overall exploration figures (all minerals) for Manitoba ranged from $36.7 million in 1985 to a high of $50 million in 1987 to a low of $30 million in 1991. Current estimates for 1995 and 1996 are in the $40 million plus range (Manitoba Energy and Mines, 1996).

The historical primary gold production in Manitoba is shown in Figure 2. The value of gold production, in the period 1986-96, from primary gold production ranged from none in 1985 to $42.4 million in 1988, and from none to $20.1 million during the period 1992-1995.

Gold exploration levels were high between 1986 and 1989 because of the gold price and the enormous interest in Canadian Flow Through Share investing by the general public. Many gold projects were quite active in Manitoba and Canada. The Tartan Lake (Flin Flon belt) and Puffy Lake

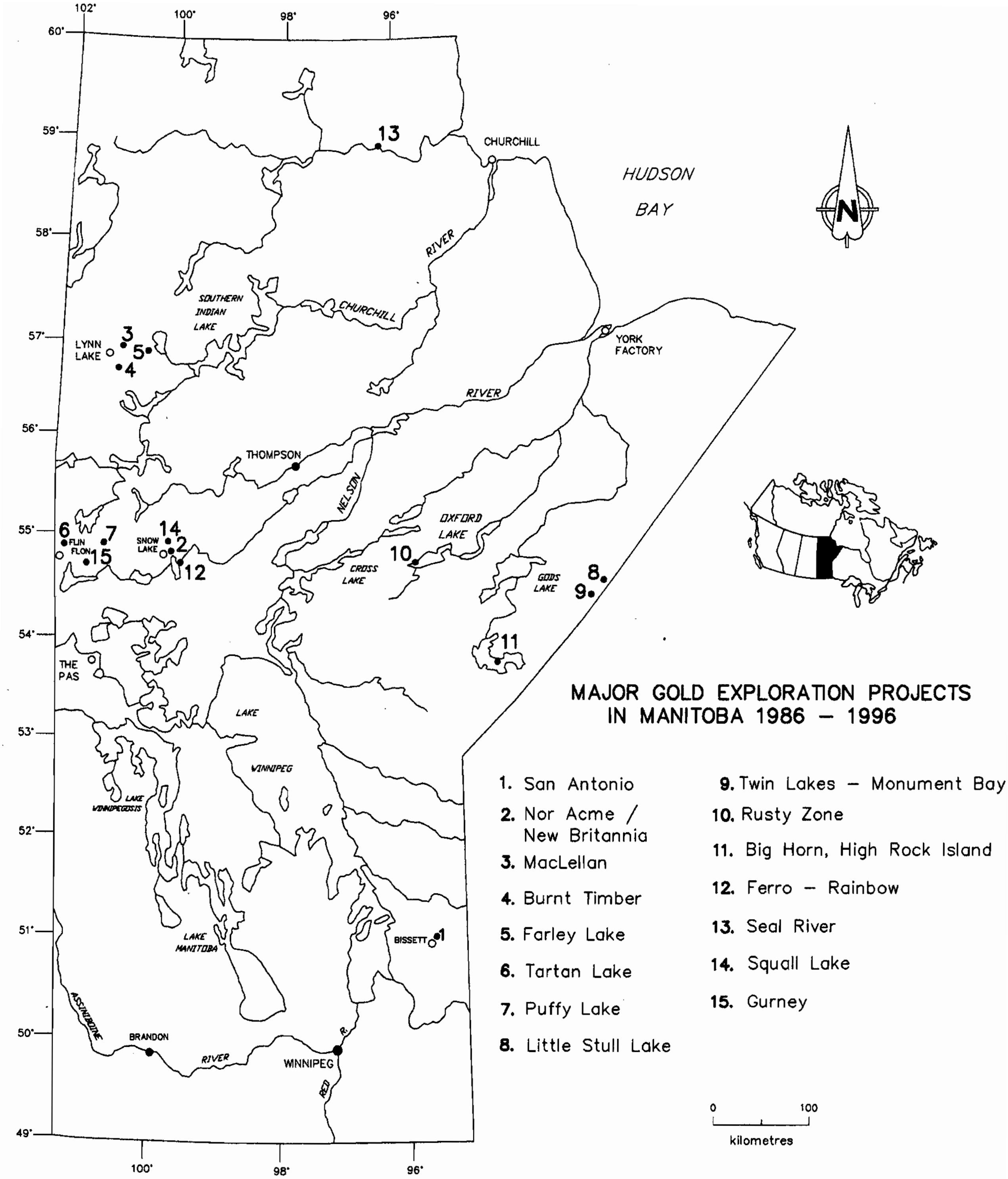

Figure 3: Location map of major gold exploration projects in Manitoba from 1986 to 1996

(Kisseynew belt) Mines opened in 1987 but costs and reserve problems forced their closures in 1989. The MacLellan mine at Lynn Lake opened in late 1986 but high operating costs again caused its shutdown in late 1989. Significant discoveries were made during this period. In the Superior province the Little Stull Lake deposit was discovered by Westmin Resources Ltd. and Tanqueray Resources Ltd. in 1987, and the Monument Bay deposits at Twin Lakes and the Rusty Zone at Oxford Lake were discovered by Noranda and junior partners, in 1989. In the Proterozoic Lynn Lake belt the Burnt Timber deposit was discovered in 1988 by Lynn Gold. Extensive exploration occurred in all the known gold belts; Rice Lake, Oxford-Knee Lake, Flin Flon and Lynn Lake. The modest-sized Sannorm deposit, just east of the Bissett Gold mine was outlined. Bighorn Development did further exploration work on the old Ministik mine at Island Lake. Exploration took place on the old Ferro and Gurney mines in the Flin Flon belt. TVX Gold reactivated the former Nor Acme mine renamed it the New Britannia mine and started production in 1995. The Burnt Timber deposit, south of Lynn Lake, was discovered in 1988, but did not go into production until 1993 when the price of gold recovered.

It is expected that if the price of gold remains steady and national and provincial policies support mining, the current good investment climate for high risk gold exploration and mine development bodes well for the new operations, Burnt Timber and New Britannia and the pending Farley and Bissett Gold mines. Pioneer Metals Corporation recently announced plans to study the feasibility of re-opening the Puffy Lake mine.

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REGIONAL GEOLOGY OF MANITOBA

The Province of Manitoba occupies 650 000 km^2 and is divided into three major geological subdivisions: the Precambrian Shield, the Paleozoic Hudson Bay Basin and the Paleozoic and Mesozoic Williston Basin (Fig. 4). The Precambrian Shield covers approximately 60% of the province's surface area and is the only geological subdivision that hosts gold deposits and producing gold mines. Thus, this report will discuss the geology and gold deposits of the Precambrian Shield in Manitoba.

The Precambrian Shield is divided into the Archean Superior and Proterozoic Churchill Structural Provinces; the Churchill-Superior Boundary Zone contains geological elements of both provinces. The original definition of Structural Provinces (Stockwell, 1964) is based on the age of the dominant structural grain or youngest structural overprint. However, recent advances in determining the precise, absolute age of rock units, using the U-Pb method on zircons, proved to be a deciding factor in advancing the geological understanding of the Canadian Shield. This has led to the practice to group rock units according to their (original) age and the usage of "Structural Provinces" has been largely replaced by "Age Provinces" or other geological entities of a distinct age and/or tectonic setting *(cf.* Hoffman, 1988; 1989). Consequently, the term Superior Province presently implies an Archean Superior craton. The Churchill Province in Manitoba has been divided into the Paleoproterozoic Trans-Hudson Orogen and the Archean Hearne craton (Hoffman, 1988, 1989; Fig.4)

SUPERIOR PROVINCE

The Superior Province comprises *circa.* 2.5 to 3.4 Ga Archean rocks that were deformed and metamorphosed by the Kenoran orogeny between about 2720 and 2660 Ma *(e.g.* Thurston *et al.,* 1991). The Superior Province is divided into subprovinces or domains based mainly on dominant rock lithologies (Fig. 5). The Wabigoon, Uchi, Island Lake and Gods Lake subprovinces are characterized by dominantly metavolcanic and associated metasedimentary and intrusive rocks, The English River Subprovince comprises mainly gneisses derived from sedimentary rocks, and granitoid rocks and migmatites. The Berens River and Molson subprovinces consist mainly of granitoid rocks and migmatites and small enclaves of metavolcanic rocks. The Pikwitonei Domain comprises granulite facies gneisses that represent granitoid rocks and greenstones similar to the Gods Lake Subprovince, but that have been overprinted by granulite facies metamorphism.

The subprovince boundaries are generally along or close to major faults, except the Gods Lake/Pikwitonei boundary that coincides with the orthopyroxene-in isograd.

CHURCHILL PROVINCE

The Churchill Province in Manitoba has been divided into the Reindeer Zone of the Paleoproterozoic Trans-Hudson Orogen and the Archean Hearne craton (Hofman, 1989). The Reindeer Zone of the Churchill Province has been subdivided into the following domains based on dominant lithologies: Flin Flon greenstone belt, Kisseynew gneiss belt, Lynn Lake greenstone belt, Leaf Rapids greenstone belt, Southern Indian gneiss belt and Chipewyan Batholith (Fig. 5). The Wollaston, Seal River and Great Island domains comprise Archean and Proterozoic geological units, as well as a large number of rocks of unknown age between the Reindeer Zone and the Hearne craton, somewhat similar to the Churchill-Superior Boundary Zone. The Nejanilini domain is part of the Archean Hearne craton.

Metavolcanic, granitoid plutonic and metasedimentary rocks form the major components of the Flin Flon, Lynn Lake and Leaf Rapids greenstone belts. The Kisseynew, Southern Indian and Wollaston gneiss belts consist dominantly of gneisses derived largely from sedimentary rocks, migmatites, anatectic granitic bodies and minor amounts of volcanic rocks. The Chipewyan domain of granite, monzonite and granodiorite is part of the over 1000 km long Andean-type Wathaman-Chipewyan batholithic belt. The Nejanilini domain consists of Archean intermediate to mafic gneisses and granulites.

The evolution of the southeastern part of the Churchill Province and the boundary zones with the Archean cratons have had a number of interpretations (Innes, 1960; Wilson and Brisbin, 1961, 1962; Bell, 1971; Gibb and Walcott, 1971; Dewey and Burke, 1973; Gibb, 1983; Baragar and Scoates, 1981; Fountain and Salisbury, 1981; Green *et al.,* 1985).

The most recent interpretation by Lucas *et al.* (1996), Ansdell *et al.* (1995), Zwanzig *et al.* (1996) proposes the following tectonic evolution:

1) rifting and rupturing of Archean cratons during the early Proterozoic (probably *circa.* 2.1 Ga; Heaman and Corkery, 1996).
2) Oceanic and arc volcanism and plutonism in the Lynn Lake, Leaf Rapids and Flin Flon areas(1.92-1.88 Ga) with intraoceanic accretion (1.88-1.87 Ga) and accretion of Lynn Lake belt to Hearne craton.
3) Successor arcs and successor basins in the Lynn Lake-Leaf Rapids domain (1.88-1.85 Ga) and the Flin Flon domains (1.87-1.84 Ga). Successor basins include the Southern Indian domain that formed as a back arc basin during northward subduction of the Lynn Lake-Leaf Rapids domain underneath, and accretion to, the Hearne craton (and producing the Wathaman-Chipewyan batholithic belt during this process). A probably younger successor basin is the (1.85-1.84) Kisseynew domain that formed as a back arc between the accreting Hearn-Wathaman-Southern Indian-Lynn Lake-Leaf Rapids domains and the rising Flin Flon arc. Compression and shortening of arcs and basins.
4) Regional collision and further shortening of arcs and basins (1.84-1.805 Ga) as a result of northwards drifting of the Superior craton relative to the Hearne craton. Major deformation and metamorphism, thrust formation in the Trans-Hudson Orogen, most intensively in the Kisseynew belt, and the Churchill-Superior Boundary Zone.
5) Post collisional thrusting, folding and faulting (1.805-1.69 Ga). Wedging of the Superior craton into the Trans-Hudson collage (White and Lucas, 1994).

CHURCHILL-SUPERIOR BOUNDARY ZONE

The Churchill-Superior Boundary Zone consists of Archean rocks, variably overprinted by the Hudsonian collision and Paleoproterozoic supracrustal rocks. In Manitoba the zone has been divided into three segments: Thompson belt, Split Lake block and Fox River belt. The Thompson belt is underlain predominantly by layered and migmatitic granitoid gneisses. Narrow belts and lenses of metasedimentary, metavolcanic of the Proterozoic Ospwagan Group and ultramafic rocks occur within the migmatites and gneisses. The Split Lake block comprises granitoid gneisses, in part retrogressed from granulite facies, granitic plutons, amphibolite, anorthosite and minor occurrences of Proterozoic supracrustal rocks. The boundaries of the Split Lake block are characterized by distinct and locally up to 5 km wide mylonite belts. The Fox River Belt is composed of a Proterozoic north-facing monoclinal sequence of sedimentary rocks, a large differentiated sill and mafic to ultramafic volcanic rocks, and related sills.

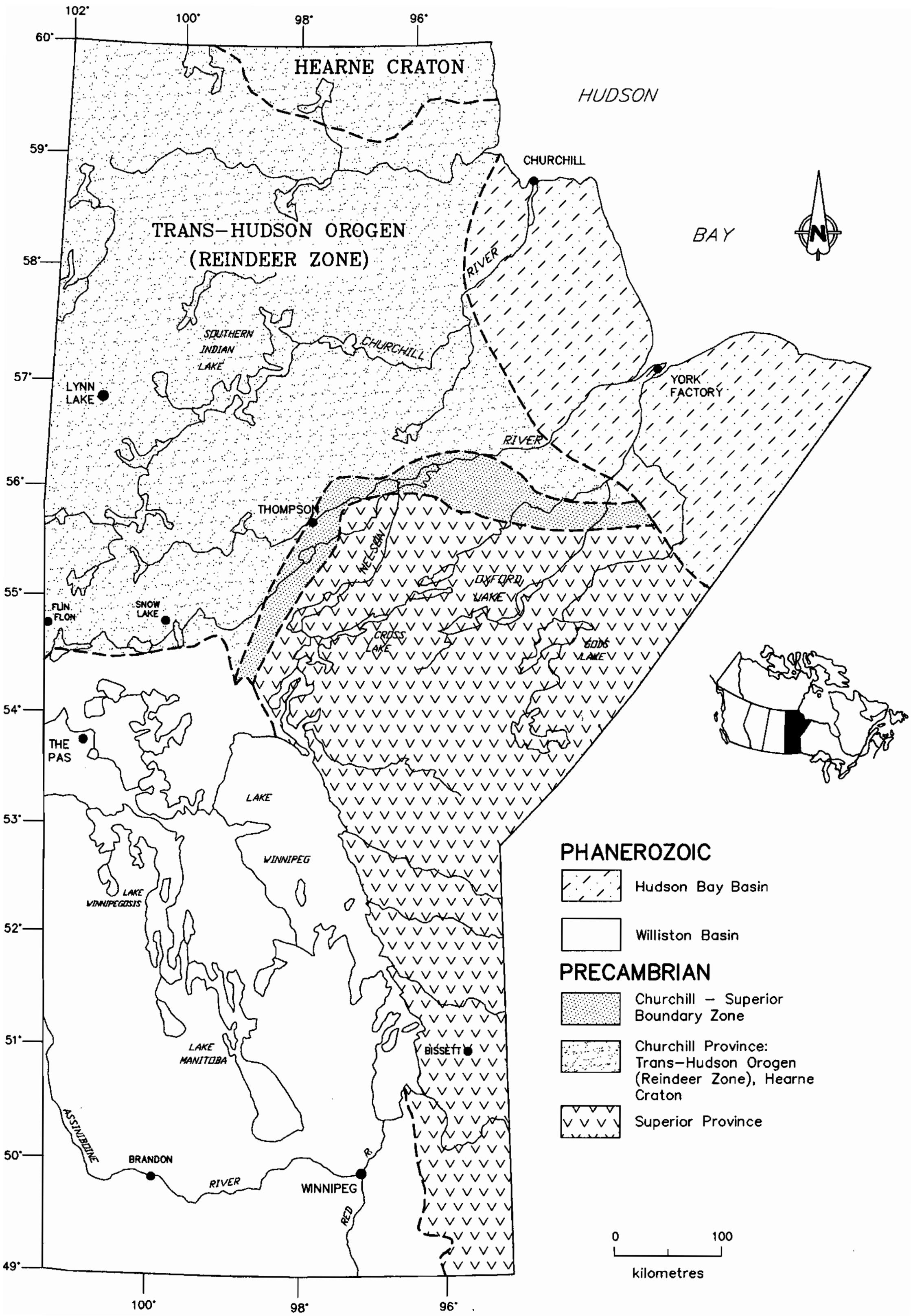


Figure 4: Major geological subdivisions of Manitoba

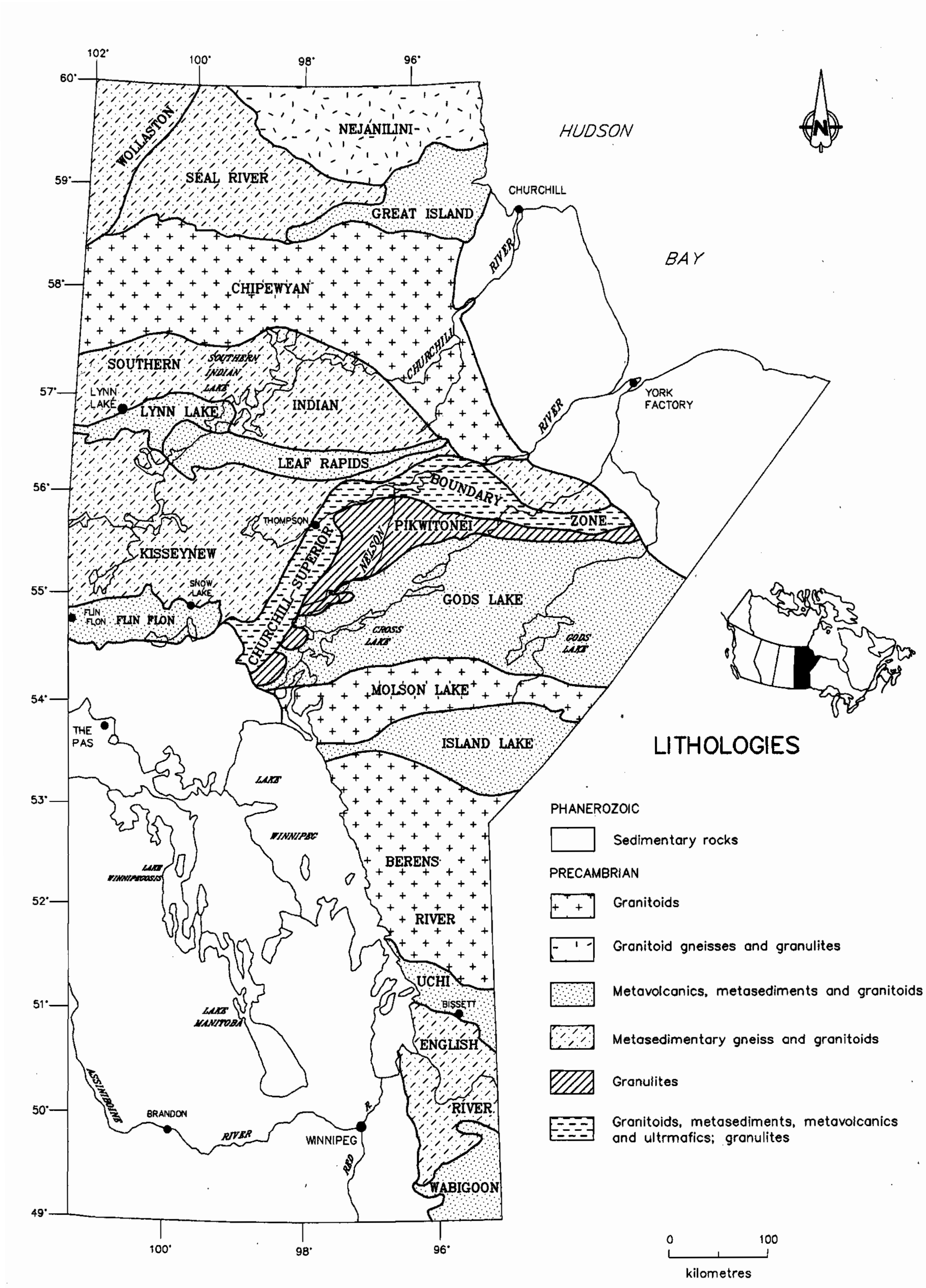


Figure 5: Principal geological domains of Manitoba

WEST HAWK LAKE-FALCON LAKE-SHOAL LAKE AREA

REGIONAL GEOLOGY

Introduction

The West Hawk Lake-Falcon Lake-Shoal Lake area is a granite-greenstone terrane that forms the western extension of the Lake of the Woods greenstone belt that strikes from northwestern Ontario into southeastern Manitoba (Ontario Geological Survey, 1991). The Lake of the Woods greenstone belt is part of the Archean Wabigoon Subprovince in the southeastern part of the Superior Province (Fig. 5). In southeastern Manitoba the Lake of the Woods greenstone belt breaks up into 3 narrow belts (Fig. 6): a northern belt extends from the West Hawk Lake-Falcon Lake area in a southwest direction to the town of East Braintree where it passes beneath an extensive cover of glacial drift; 2) a second belt further south extends southwest from Indian Bay of Shoal Lake, beneath extensive glacial cover; and 3) further south, a third belt extends from Gull Bay at Shoal Lake in southwesterly direction underneath drift cover. Aeromagnetic maps and exploration drillhole data indicate continuation of the northern and southern belt for considerable distances beneath glacial overburden and Paleozoic cover (west of longitude 96°) to the west (Manitoba Energy and Mines, 1987, 1990; McGregor, 1992).

The West Hawk Lake-Falcon Lake-Shoal Lake area is underlain by mafic to felsic metavolcanic rocks, metasedimentary rocks and granitoid intrusions. In the Wabigoon Subprovince of northwestern Ontario a series of older volcanic and sedimentary rocks have been assigned to the Keewatin Series and a sequence of younger sediments to the Timiskaming Series (Thompson, 1937). Recent mapping, geochemistry and geochronology indicate that volcanic sequences of the Keewatin Series are composed of several assemblages or groups, generally separated by discontinuities, faults or thrusts (Blackburn et al., 1991). The rocks along the Manitoba/Ontario border were grouped according to the lithostratigraphic subdivision proposed by Blackburn et al. (1991; Table 2)

Supracrustal Rocks

Rocks of the Lower Keewatin Supergroup (LKS) in northwestern Ontario have been divided into five groups, but only one the Cedar Island Group extends into Manitoba (Fig. 6). The Cedar Island Group comprises dominantly tholeiitic basalts, (aphyric and plagiophyric) and minor komatiitic basalt and felsic volcanic rocks. Although geochemically comparable with modern ocean-floor basalts, the mafic volcanic sequences of the Lower Keewatin Supergroup bear most similarity to low K_2O island arc tholeiites (Blackburn *et al.,* 1991).

The Upper Keewatin Supergroup in northwestern Ontario has been divided into 8 groups, four of which strike into Manitoba (Table 2, Fig. 6). The volcanic sequences of the Upper Keewatin Supergroup are composed of mixed successions of submarine tholeiitic basalts and calc-alkaline intermediate to felsic, subaqueous and subaerial volcanic rocks. Rhyolite has been mapped near Gull Bay in the Andrew Bay Group. Shoshonitic volcanic rocks occur in the Monument Bay Group. Geochemically the volcanic rocks of the Upper Keewatin represent mature arc volcanism.

The Electrum Lake Supergroup comprises two groups in northwestern Ontario, but only one, the Crowduck Bay Group, extends into Manitoba. Fluvial coarse clastic sedimentary rocks of the Crowduck Bay Group unconformably overlie mafic volcanic rocks of the Clearwater Bay Group in the West Hawk Lake and the synvolcanic High Lake stock and its country rocks in Ontario, 5 km east of the Manitoba/Ontario border. In Manitoba the Crowduck Bay Group comprises arkosic rocks at the northeast end of Falcon Lake and sandstones and volcanic conglomerate in the West Hawk Lake area (Lamb, 1975a,b; Janes, 1976). The volcanic conglomerate was previously described as volcanic agglomerate (Springer, 1952; Davies, 1954), but it rests unconformably on mafic volcanic rocks.

TABLE 2: LITHOSTRATIGRAPHY OF THE LAKE OF THE WOODS GREENSTONE BELT IN THE WEST HAWK LAKE-FALCON LAKE-SHOAL LAKE AREA (after Blackburn *et al.,* 1991)

Lithostratigraphic Subdivision	Age	Group	Possible tectonic setting
Posttectonic granitoids	2709-2663 Ma		
Electrum Supergroup	2714-2696 Ma	Crowduck Lake Group A1	alluvial, late tectonic successor basins
		——Unconformity——	
Syntectonic granitoids	2734-2727 Ma		accretion?
Synvolcanic intrusions (mafic to felsic)	2734-2728 Ma		arc plutonism
Upper Keewatin Supergroup	2743-2719 Ma	Clearwater Bay Group B1 Indian Bay Group B2 Andrew Bay Group B3 Monument Bay Group B4	*submarine and subaerial arc volcanism
Lower Keewatin Supergroup	*ca.* 2775-2732 Ma	Cedar Island Group C1	arc/oceanic volcanism

* covered by Quaternary in Manitoba

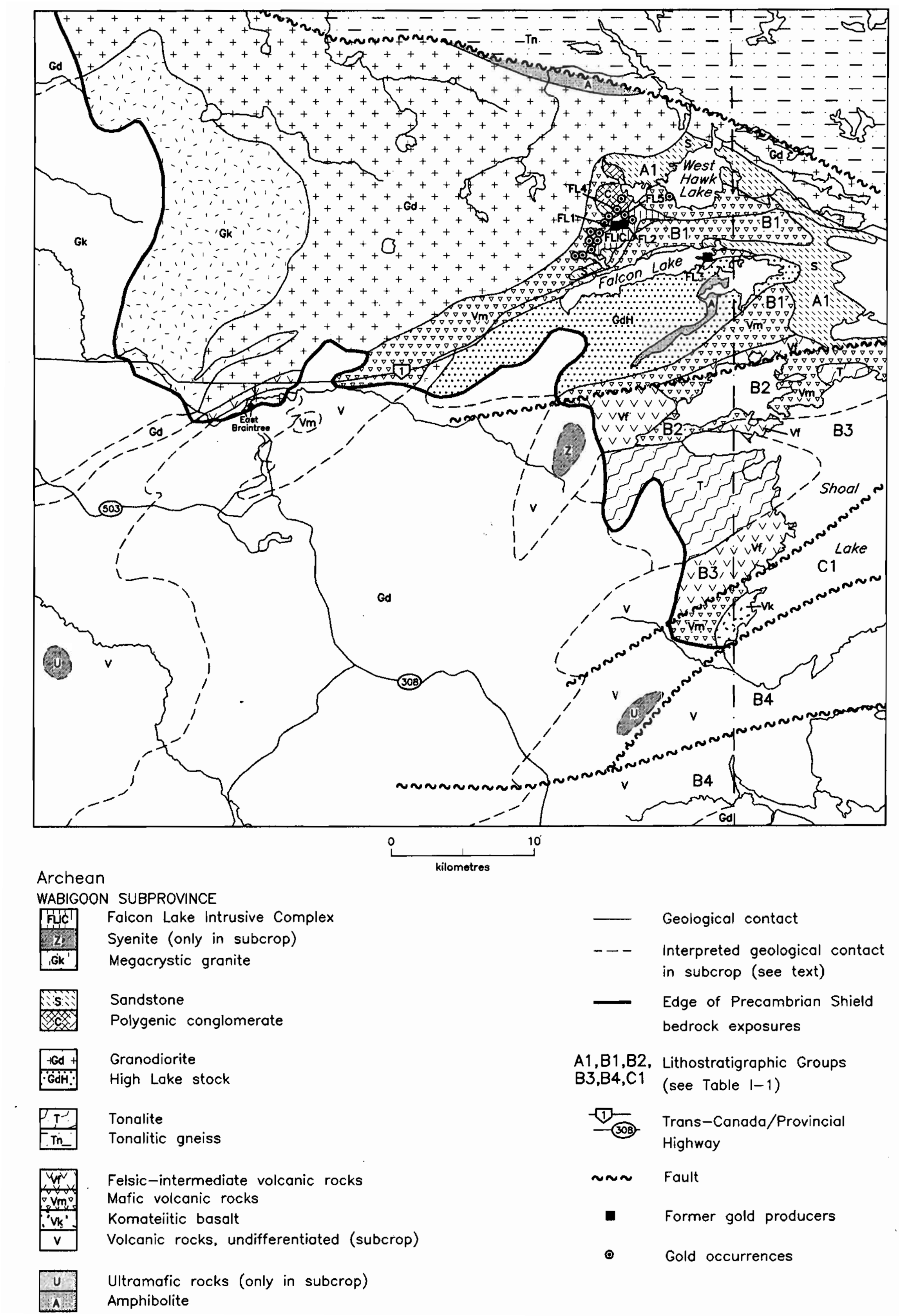


Figure 6: Geology of the West Hawk Lake-Falcon Lake-Shoal Lake area (after Manitoba Energy and Mines, 1987 and Blackburn et al., 1991)

Intrusive Rocks

The Lake of the Woods greenstone belt has been intruded, internally and along its margin by granitoid plutons of granodiorite to granite, and subordinate quartz diorite, composition. The sodium-rich granitoid intrusions have been interpreted as synvolcanic, such as the High Lake stock (Blackburn *et al.,* 1991) which yielded an age of 2727 Ma (Davis and Smith, 1991). None of the intrusions in Manitoba have been dated with the U-Pb method.

Potassic granitoid bodies are generally late- to post- tectonic, yielding ages of 2709 to 2663 Ma (Table 2; Blackburn et al., 1991). Many of these are also composite. The Falcon Lake stock, a lens-shaped potassic granitoid intrusion, was interpreted as a composite or differentiated single intrusion (Brownell, 1941; Davies 1954; Haugh 1962, and Gibbins, 1971). But Mandziuk (1988) and Mandziuk and Brisbin (1989) concluded that the granitoid body was formed by a series of intrusions (based on transgressive magmatic flow layering), and is composed of an older pyroxenite to leucogabbro (oldest) in tabular extensions, younger diorite-granodiorite in outer core, and the youngest, a quartz monzonite in the inner core. He renamed the body the Falcon Lake Intrusive Complex (FLIC). The development of the FLIC through a series of intrusions is shown in Fig.7. Composite granitoid intrusions are common in the Ontario portion of the Lake of the Woods greenstone belt. They are considered late- to post-tectonic. The FLIC has discordantly intruded the folded unconformity between the Crowduck Bay Group sedimentary rocks and the older volcanic rocks of he Clearwater Bay Group (Mandziuk, 1988; Fingler, 1991) and is thus clearly late to posttectonic (cf. Table 2). Two samples of galena from the Sunbeam mine in the FLIC quartz monzonite yielded Pb-Pb model ages of 2685 and 2678±6 Ma (R.I. Thorpe, pers. comm; in Fingler, 1991).

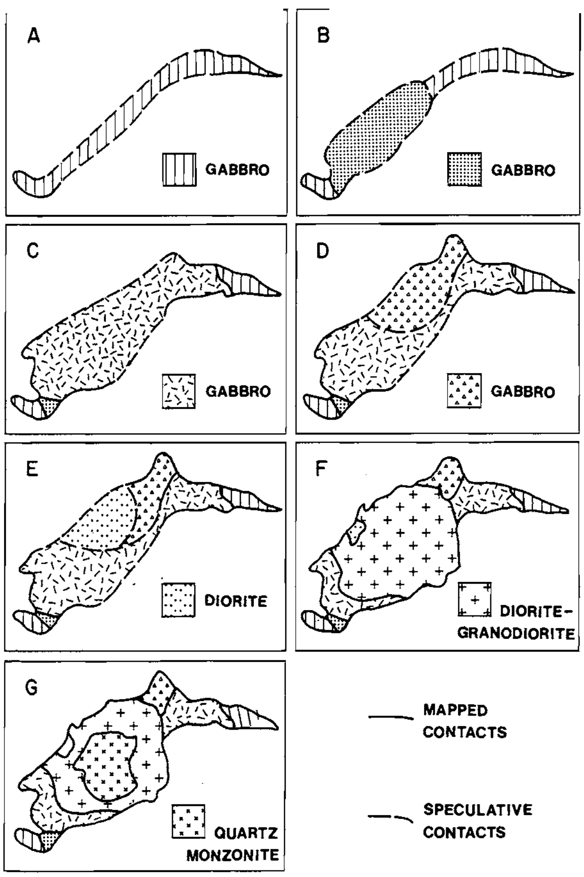


Figure 7: Emplacement history of the Falcon Lake Igneous Complex (from Manziuk et al., 1986)

STRUCTURE

The major deformation in the Lake of the Woods greenstone belt was synchronous with the intrusion of the syntectonic granitoids (Table 2). The northern greenstone belt through Falcon Lake was deformed by a series of arcuate folds with northeast- to east-striking axes, apparently deflected and attenuated by the intrusion of the FLIC (Fingler, 1991). Numerous shear zones occur within the supracrustal rocks. They are generally subparallel to the fold axes or the margin of the FLIC; the four shear zones shown on Figure 6 are part of regional extensive deformation zones in the Lake of the Woods area. Numerous steeply dipping shear zones also occur within the igneous complex at the contact between the inner core and the surrounding dioritic to granodioritic ring.

MINERALIZATION

In the West Hawk Lake-Falcon Lake-Shoal Lake area four small gold deposits (Sunbeam, FL1; Waverley, FL2; Thompson, FL3; Penniac Reef, FL4) and thirteen gold occurrences have been found (Fig. 6, 8). The four deposits produced a total of circa. 58 kg gold between 1915 and 1940.

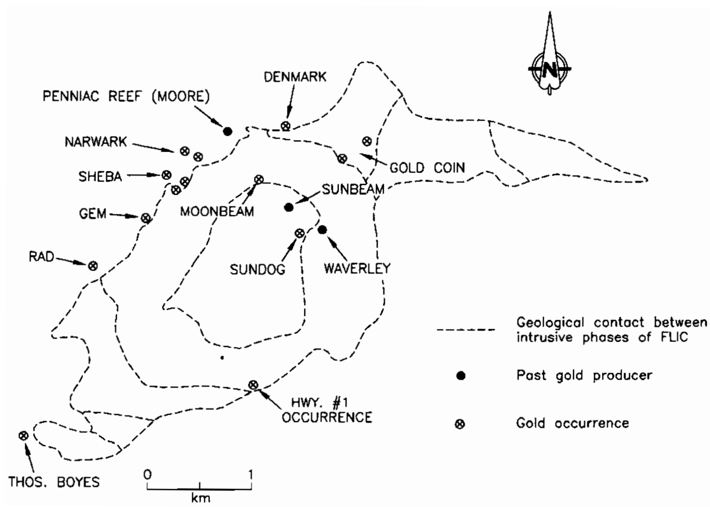


Figure 8: Location of mineral occurrences related to the Falcon Lake Intrusive Complex (after Fingler, 1985)

The Sunbeam, Waverley and Penniac Reef deposits and all of the gold occurrences are spatially associated with the FLIC. The Sunbeam deposit (FL1) and Moonbeam occurrence (FL5) each consist of a gold-bearing breccia pipe that occurs within the FLIC (Fig. 8). The highest gold grades are associated with quartz stringers and gash veinlets that contain disseminated pyrite, irregular patches and grains of sphalerite, chalcopyrite, pyrrhotite and galena. Tetrahedrite, arsenopyrite and gold occur as small isolated grains associated with pyrite. The Waverley and Penniac Reef deposits and the gold occurrences consist of gold and sulphide-bearing quartz veins in shear zones within the FLIC and the adjacent Clearwater Bay Group mafic volcanic rocks. Pyrite, pyrrhotite, arsenopyrite, sphalerite and galena are the most common sulphide minerals. Visible gold occurs locally. Assays of two “gold bars” produced from Penniac Reef indicated the presence of platinum and iridium (French, 1915).

The Thompson deposit is located in a shear zone within sheared and silicified mafic volcanic rocks. Mineralization occurs in quartz stringers within the shear zone and consists of disseminations and stringers of pyrite with lesser amounts of pyrrhotite, chalcopyrite, and visible gold.

The gold occurrences outside the FLIC (Rad, Sheba, Narwak, Moore; Fig. 8) occur in a variety of supracrustal lithologies, but generally in deformation zones. Fingler (1991) postulated that the emplacement of early intrusive phases of the FLIC developed extension fractures in the country rocks, and initiated a convective hydrothermal system that scavenged metals from enclosing country rocks, for deposition. For the deposits inside the FLIC, Fingler (1991) concluded that the consolidation of quartz monzonite initiated an orthomagmatic hydrothermal system and produced breccias at the Sunbeam (and Moonbeam) deposits and that mineralization was derived from the parent quartz monzonite magma.

Ten gold occurrences have been recorded in the High Lake area (Ontario) within 7 km of the Manitoba border (Davies and Smith, 1988). The gold occurrences are located close to the eastern margin of the synvolcanic High Lake stock, and are all located in shear zones associated with felsic dykes intruding mafic flows of the Clearwater Bay Group, a situation similar to the Gunnar deposit east of the (synvolcanic) Ross River pluton in the Rice Lake belt (see below).

PAST PRODUCERS

Sunbeam (FL1) and Waverley (FL2)

Location: 135 km east of Winnipeg, 0.8 km south of Star Lake.

Map Reference: Fig. 6, locations FL1, FL2

Description of Sunbeam Deposit:

The Sunbeam deposit is located in the FLIC (Fig. 8), within a breccia pipe comprising silicified, sericitized, propylitized and slightly carbonatized quartz monzonite. In plan view the deposit is roughly elliptical at surface with an area of about 200 m^2 (Fig. 9). The pipe plunges at 55-65° in the direction 330°.

Halwas (1984) recognized four zones in the area of the breccia pipe (Fig. 9): 1) an outer zone of widely spaced concentric sheet fractures in propylitized quartz monzonite; 2) a zone of more closely spaced concentric fractures with intense sericitic and carbonate alteration; 3) fragments of extensively sericitized and silicified quartz monzonite within a matrix of comminuted quartz monzonite, disseminated sulphides with gold, and gold-bearing quartz veins; and 4) a more extensively mineralized breccia similar to zone three above.

Mineralization consists of pyrite and pyrrhotite with lesser amounts of arsenopyrite, sphalerite, galena, tennantite, chalcopyrite and minor associated free gold.

A flatly dipping fault displaces the lower part of the deposit 20 m to the north. Several other northeast-trending fractures displace the deposit for distances of a few centimetres to several metres.

Halwas (1984) proposed multistage development for the breccia pipes consisting of: 1) upward migration of a high pressure fluid in a conduit within quartz monzonite causing alteration and exerting compressive strain on the wall rocks; 2) an implosion caused by boiling of the fluid when an area of low confining pressure was reached; 3) decompression followed by deposition of quartz in fractures and breccia; 4) migration of hydrothermal fluid followed by a second implosion; and 5) following decompression gold-bearing quartz and sulphides were deposited in the fractures and breccia.

Description of the Waverley Deposit:

The following description is summarized from Fingler (1991). Two groups of occurrences are located on the Waverley claims: 1) the Letain shear zones located within granodiorite of the FLIC; and 2) the Waverley shear zones within quartz monzonite of the FLIC (Fig. 8).

The Letain shear zones are not exposed, but were investigated by drilling and underground development. Wright (1946) identified two main shear zones, whereas Chastko (1986) identified two, the A and B zone each of which consists of a network of subparallel shear zones up to 1.5 m wide. Zone A has an orientation of 77°/30° SE and a strike length of 150 m. Zone B has an orientation of 55°/30° SE and has a strike length of 80 m. The shear zones have been pervasively silicified and carbonatized. The mineralization consists of pyrite, arsenopyrite, with minor amounts of pyrrhotite, sphalerite and galena. Gold distribution is erratic, with or independent of sulphides.

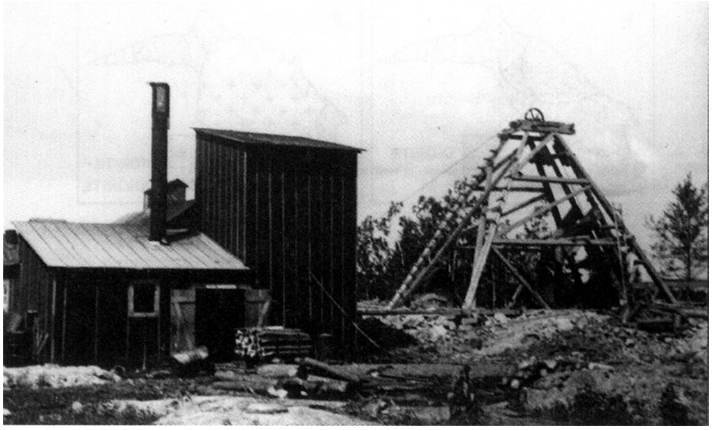
The Waverley shear zones comprise three northeasterly trending and moderately southeasterly dipping parallel shear zones. The zones are exposed for up to 35 m and are 2 to 8 m wide. The shear zones consist of a network of widely spaced, anastomosing fractures across the width of the zone. Locally the quartz monzonite has been brecciated and milled. The milled matrix has been altered to sericite, quartz, minor carbonate and biotite-pyrite clusters. Mineralization is associated with coarse grained quartz, in 1-2 cm wide shears, which occur in the central portions of the shear zones. Biotite-pyrite clusters are common in the veins and fine grained pyrite is disseminated throughout the altered and milled quartz monzonite, and quartz veins

History of Exploration and Development:

The Sunbeam and Waverley deposits were first staked in 1912 and 1913. Exploration of the claims between 1912 and 1928 consisted of sampling and trenching. In 1923 eighteen channel samples were taken from three open cuts on Sunbeam. Each sample was taken over a 0.1 m width, spaced every 1.5 m along the bottom of the cuts. The average assay of these samples was 21.94 g/tonne (0.64 oz/ton) gold. From 1928 to 1934 a minor amount of shaft sinking and diamond drilling was carried out.

In 1936 surface trenching and a 1525 m 28-hole diamond drill program was undertaken on the Sunbeam claim. A total of 69 channel samples taken over an area of 93.5 m^2 averaged 13.03 g/tonne (0.38 oz/ton) gold. Core and sludge samples taken across the mineralized zone in four holes averaged 10.29 g/tonne (0.3 oz/ton) gold over 8.54 m. In 1938 an inclined shaft was sunk to a depth of 134 m with stations cut at 30, 61, 92 and 130 m. Wright (Manitoba Mines Branch, Corporation File, Goldbeam Mines Limited) estimated reserves to total 99 800 tonnes with an average grade of 8.91 g/tonne (0.26 oz/ton) gold. In 1940 a 4257 tonne bulk sample shipped to a mill near Kenora, Ontario produced 24.7 kg (794 oz.) gold. A dispute arose over the amount of gold extracted; no further ore shipments were made.

Goldbeam Mines Limited acquired the property in 1941. A 91-hole 8522 m drill program discovered a series of six lenticular veins, later named the Waverley deposits (Goldbeam Mines Limited, Annual Report, 1945). This increased drill indicated reserves to 500 000 tonnes averaging 10.04 g/tonne (0.29 oz/ton) gold. In 1946 a 3-compartment vertical shaft was completed to a depth of 137 m with levels at 46, 92 and 137 m. Operations were discontinued in late 1946.



Sunbeam Mine, 1938, 0.8 km south of Star Lake, Manitoba

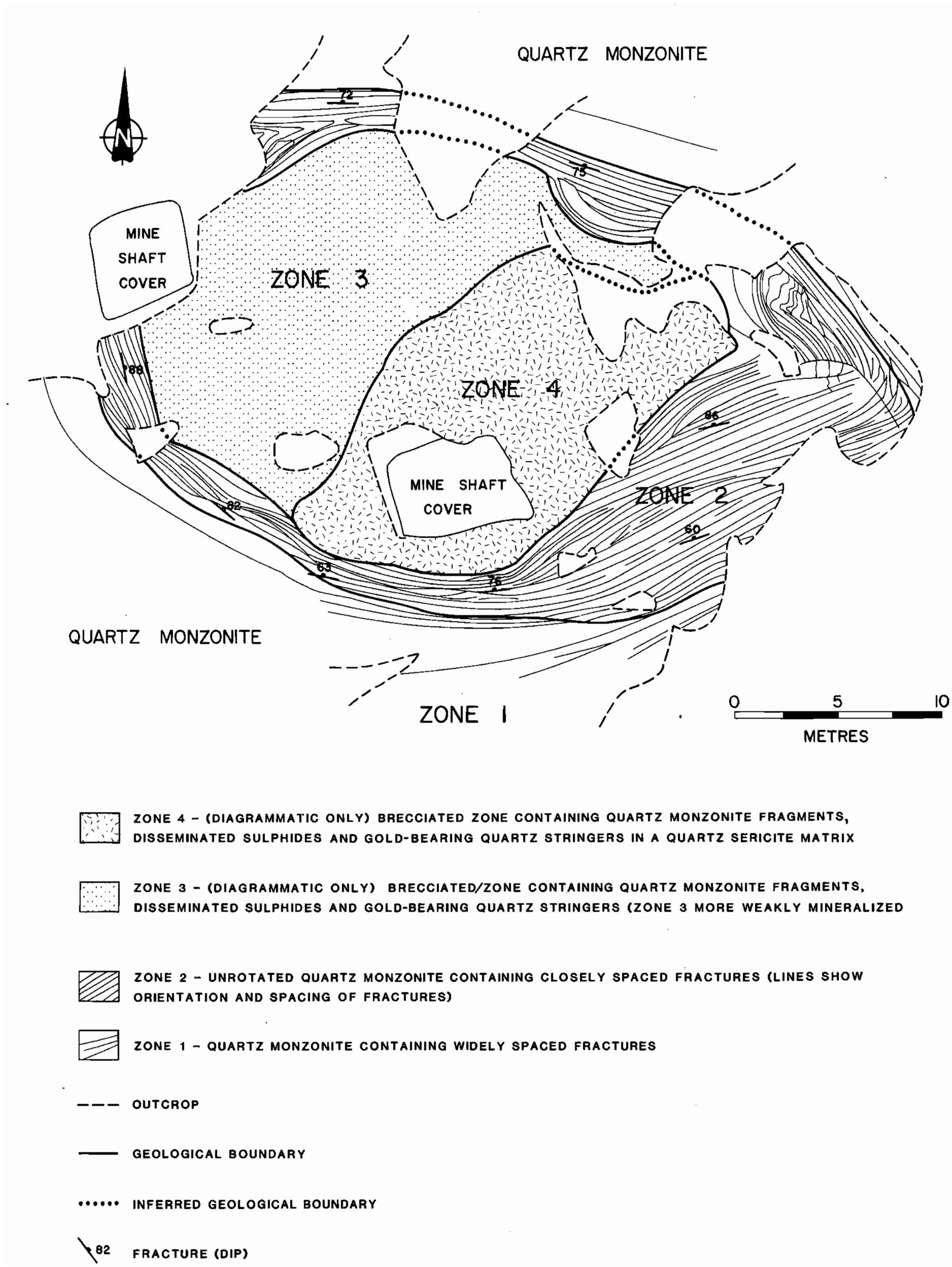


Figure 9: *Geology of the Sunbeam breccia pipe (from Halwas, 1984)*

From 1950 to 1976 a number of prospectors and companies held the property, including: Homestake Explorations Limited, A.D. Skogsberg, Hugh Currie and Star Lake Gold Mines, Limited. Very little exploration work was carried out during this period.

In 1976 Whiteshell Ventures Ltd. acquired the property and carried out a 5-hole 173 m drill program. In 1981 Goldbeam Resources Ltd., Whiteshell Ventures' parent company, commenced an exploration program that included detailed sampling of outcrop, testing of the depth potential of the deposit, dewatering of the shaft and underground drilling. Whiteshell Ventures rehabilitated the old shaft in 1985.

In 1987 Goldbeam Resources Ltd. announced that if it could prove up between 320 000 and 450 000 tonnes of approximately 12 g/tonne (0.35 oz/ton) gold they would bring the property into production at 270 tonnes per day, starting with an open pit and with a tank leaching mill. Metallurgical tests on ore samples indicated a 90-94% recovery rate. With 120 000 tonnes grading 7.8 g (0.23 oz/ton) per tonne of proven reserves in the "Sunbeam Pipe" the company would spend $2 million in 1987 and 1988 to increase the reserves. About 15 000 metres of drilling had already been done on the property which "indicated 360 000 tonnes grading 14 g/tonne (0.41 oz/ton) gold. With the Sunbeam pipe open at depth and the three additional pipes on the property, prospects were good for added reserves. The Sunbeam pipe, inclined 55° at surface and steepening at depth to 65°, was previously explored by an inclined development shaft for 134 metres. Four levels were driven off this shaft. Mineralization has been shown to be consistent from surface to 134 metre depth. There is also a 3 compartment production shaft to 152 metres that would be used after the open pit was exhausted. The property is close to the Trans Canada Highway and power lines, but because it is situated in the Whiteshell Provincial Park, government regulation required the mill to be located outside the park. In order to finance the program Goldbeam applied for a listing in the Toronto Stock Exchange (Northern Miner October 5, 1987 and Canadian Mines Handbook 1988-89, p. 191). Little has been done on this property since 1988.

History of Production:

Year	Tonnes milled	Grade g/tonne (oz/ton) gold
1936	4438 tonnes	5.83 (0.17)

Source: Manitoba Mines Branch, Corporation Files (Goldbeam Mines Limited)

Selected Bibliography: Bruce (1919); Davies (1954); DeLury (1927); Fedikow (1981); Fingler (1991); Halwas (1984): Manitoba Mines Branch, Annual Report on Mines and Minerals (1928-1931), Corporation File (Goldbeam Mines Limited), Mineral Inventory File (52E/11 NW Au2, 3), Non-confidential Assessment File (91079); Springer (1952); Stewart (1977).

The Moonbeam occurrence is located 200 m northwest of the Sunbeam breccia pipe. The occurrence is within FLIC granodiorite, close to the contact with the core quartz-monzonite (Fig. 6, 8). Fingler (1991) describes an east northeast-trending, steeply south-dipping shear zone within altered and brecciated granodiorite. Gold mineralization is associated with silicification forming a coarse grained quartz lense in altered and brecciated granodiorite. Outside the mineralized zone, silicification is less intense. The mineralized breccia pipe has a diameter of ca. 15 meters. Drilling to a maximum depth of 200 feet indicated probable reserve of 20 000 tons at 7.5 g/tonne (0.22 oz/ton) gold (Fingler, 1991).

Thompson No.2

Location: 141 km east of Winnipeg, east end of Falcon Lake.

Map Reference: Fig. 6, location FL3.

Description of Deposit:

The deposit consists of a mineralized shear zone that occurs in andesite and basalt flows and tuffs (Davies, 1954) of the Clearwater Bay Group. The shear zone strikes 082°, dips vertically and is up to 3.7 m wide. Mineralization within the shear zone is discontinuous along strike and generally occurs in the central silicified part of the shear over widths of 0.5 to 1.2 m. Mineralization consists of disseminations and stringers of pyrite with lesser pyrrhotite, chalcopyrite and locally visible gold.

History of Exploration and Development:

The property was first staked in 1937 by Vimy Richards and then optioned by Oliver Severin Gold Mines Limited in late 1937. Surface trenching encouraged the company to carry out a 20-hole drill program. In 1939, 39 tonnes of ore hauled to Kenora for milling produced 1.88 kg (60.47 oz.) gold.

From 1941 to 1946 various prospectors and companies held the property, including: Wendigo Gold Mines, R.S. Cohoon, J.E. Thompson, Sylvanite Gold Mines Limited (NPL), J.E. Thompson Jr. and Newcor Mining and Refining Limited. Newcor completed a 2-hole drill program in 1949; a sample from the first hole assayed 42.91 g/tonne (1.25 oz/ton) gold from 13.73 to 14.49 m.

Falnora Gold Mines Ltd. (NPL) acquired the property in 1950. Dawson (1950) concluded that mineralization, where exposed, extends for 162 m - the eastern 76 m averaging 15.09 g/tonne (0.44 oz/ton) gold over 0.64 m, and the western 85 m containing a much lower gold content. Mitchell Mines Ltd. was formed to continue work on the Thompson claims. A total of 15 holes were drilled; significant drill results are summarized as follows:

Drillhole	Depth	Grade g/tonne (oz/ton) gold
K1	9.46-10.37	7.54 (0.22)
K3	12.05-12.35	14.40 (0.42)
	12.35-13.01	360.71 (10.52)
	13.01-14.28	25.72 (0.75)
	14.28-14.59	1.03 (0.03)
	15.05-15.86	3.77 (0.11)
K4	12.66-13.27	126.87 (3.70)
	13.27-14.03	33.60 (0.98)
	14.03-14.49	6.17 (0.18)
K6	12.63-13.52	25.72 (0.75)
K7	10.98-11.54	24.00 (0.70)
B1	28.85-29.16	18.52 (0.54)
B9	33.79-34.01	5.83 (0.17)

Source: Manitoba Mines Branch, Non-confidential assessment file 91070.

The results were considered discouraging and the property was dropped in 1968. The property was held by J. Donner and T. Burke-Gaffney from 1968 to 1971. Ed Roberecki staked the property in 1979 and from September 1980 to June 1984 rehabilitated the open-cut and carried out chip sampling.

History of Production:

Year	Quantity in tonnes (tons)	Grade g/tonne (oz/ton) gold
1939	39.01 (43)	48.21 (1.41)

Source: Manitoba Mines Branch, annual report 1939, p. 82.

Selected Bibliography: Canadian Mines Handbook (1967-1968); Davies (1954); Fedikow (1981); Manitoba Mines Branch, Annual Reports (1938, 1940,1951-52), Mineral Inventory File (52E/11NE Au1), Non-confidential Assessment File (91070); Springer (1952).

Penniac Reef (Moore)

Location: 132 km east of Winnipeg, 0.8 km southwest of Star Lake.

Map Reference: Fig. 6, location FL4.

Description of Deposit:

The deposit is located 200 metres west of the margin of the FLIC (Fig. 8) and consists of quartz stringers within a shear zone in volcanic conglomerate of the Crowduck Bay Group. The shear zone strikes 035-045° and dips steeply to the northwest. Mineralization consists of pyrite, chalcopyrite and arsenopyrite.

History of Exploration and Development:

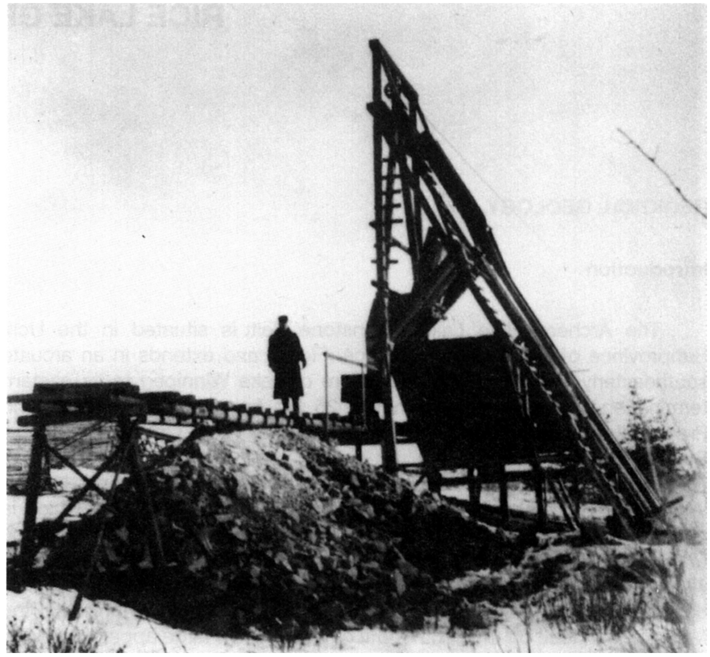
The property was first staked as the Moore claim in 1890. A 3.2 kg sample taken in 1904 or 1905 assayed 181.7 g/tonne (5.30 oz/ton) gold with a trace of silver. A shaft was started and some trenches made.

In 1910 the property was restaked by George Knudson and later assigned to The Penniac Reef Gold Mines, Limited. Thurber (1911) and Jeffrey (1912) sampled the dumps and trenches. Samples of vein and selected dump samples assayed from 5.77 g/tonne (0.17 oz/ton) to 403.96 g/tonne (11.78 oz/ton) gold. The shaft was deepened to 27 m and a 9.1 tonne amalgam mill was installed. It was reported that about 272 tonnes of material was milled to produce two gold bars, with an unknown amount of gold. An assay of the second bar yielded 49.25% gold, 2.25% platinum, 0.25% iridium, 15.5% silver, and 32.75% copper and iron (French, 1915).

Star Lake Gold Mines Limited acquired the property in 1916 and carried out 28 m of drifting on the 25 m level. The only exploration carried out since 1917 was a 488 m drill program that was completed in 1938.

History of Production:

272 tonnes averaging 23.3 g/tonne (0.68 oz/ton) gold
Source: Manitoba Mines Branch, Cooperation File, (Star Lake Gold Mines Limited.)



Penniac Reef Mine, circa 1910, 0.8 km southwest of Star Lake, Manitoba; loading bin at top of shaft (Courtesy of the James Henry Hicks Collection, Manitoba Archives)

Selected Bibliography: Davies (1954); Delury (1927); Jeffrey (1912); Manitoba Mines Branch, Annual Report on Mines and Minerals (1939), Corporation File (Star Lake Gold Mines Limited), Mineral Inventory File (52E/11 NW Au 4); Springer (1952).

TABLE 3: SUMMARY OF MAIN GOLD DEPOSITS IN THE WEST HAWK-FALCON LAKE-SHOAL LAKE AREA.

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
SUNBEAM/WAVERLEY FL1, FL2 Figure 6	Small past producer 1940: 4257 tonnes 24.7 kg (794 oz) gold produced	1987 drill indicated : 360 000 tonnes at 14 g/t (0.41 oz/ton)	quartz veins and stringers in altered, brecciated quartz monzonite (breccia pipe); gangue minerals: pyrite, pyrrhotite; chalcopyrite, arsenopyrite, sphalerite, galena..	Whiteshell Ventures Limited (1996)
THOMPSON NO. 2 FL3 Figure 6	Small past producer 1939: 39.01 tonnes 1.88 kg (60 oz) gold produced	15.09 g/t (0.44 oz/ton) over 0.64 m wide and 76 m long	silicified shear zone in andesite/basalt flows and tuffs; gangue minerals: pyrite, chalcopyrite.	J. Roberecki (1996)
PENNIAC REEF FL4 Figure 6	Small past producer 1913: 63 tonnes 1914: 270 tonnes produced 2 gold bars	unknown	quartz stringers in shear zone in conglomerate; gangue minerals: pyrite, chalcopyrite, arsenopyrite	Star Lake Gold Limited (1996)
MOONBEAM Figure 8	Prospect Drilling to a depth of 60m	18 000 tonnes at 7.5 g/t (0.22 oz/ton)	quartz lenses in brecciated granodiorite (breccia pipe); gangue minerals: pyrite, chalcopyrite, sphalerite, arsenopyrite, biotite	Whiteshell Ventures Limited (1996)

RICE LAKE GREENSTONE BELT

REGIONAL GEOLOGY

Introduction

The Archean Rice Lake greenstone belt is situated in the Uchi Subprovince of the Superior Province (Fig. 5) and extends in an arcuate southeasterly trend from the east shore of Lake Winnipeg to its eastern termination in Ontario approximately 25 km from the Manitoba/Ontario Provincial boundary (Map ER86-1-1; Shklanka, 1967; Ontario Geological Survey, 1991).

The Rice Lake greenstone belt is flanked to the north by the Wanipigow River plutonic complex (Marr, 1971; Weber, 1971a), which is part of the Berens River Subprovince. On the south it is transitional into the Manigotagan gneissic belt (McRitchie and Weber, 1971; Weber, 1971a) which is part of the English River Subprovince. The greenstone belt is bounded by two major faults, the Wanipigow fault on the north and the Manigotagan fault on the south, both of which show large apparent dextral offsets.

The supracrustal rocks of the Rice Lake belt have been divided into the volcanic and derived sedimentary rocks of the Rice Lake Group and the overlying sedimentary rocks of the San Antonio Formation (Stockwell, 1938; 1945a; Davies, 1949; 1950; 1953; 1963; Table 4; Map ER86-1-1).

Mafic dykes and sills, felsic dykes and quartz diorite-granodiorite batholiths intrude the Rice Lake Group.

The Rice Lake Group is unconformably overlain by the sedimentary rocks of the San Antonio Formation.

Rice Lake Group

The volcano-sedimentary rocks of the Rice Lake Group have been subdivided in the eastern half of the belt into the older Bidou Lake Subgroup and the younger Gem Lake Subgroup (Weber, 1971a,b; Table 4). Both subgroups are overlain by sedimentary rocks of the Edmunds Lake Formation. The Wallace Lake subsidiary greenstone belt (Map ER86-1-1), separated from the main greenstone belt by the Wanipigow fault (Wanipigow Lake-Wallace Lake fault, McRitchie, 1969), is made up of volcanic and sedimentary rocks that were assigned to the Wallace Lake Subgroup (McRitchie, 1971a) . A smaller northwesterly trending belt of largely intermediate volcanic rocks in the Little Beaver Lake area (Map ER86-1-1) has been assigned provisionally to the Wallace Lake Subgroup by Poulsen *et al.* (1994, 1996).

Recently volcanic and sedimentary rocks of the Garner Lake area have been identified as the Garner Lake Subgroup (Poulsen *et al.,* 1994; 1996).

Campbell (1971) subdivided the Bidou Lake Subgroup into seven formations. The Bidou Lake Subgroup is characterized by a bimodal volcanic sequence (basalt-dacite-rhyodacite) and derived sedimentary rocks (Weber, 1971b), whereas the Gem Lake Subgroup is characterized by a complete volcanic differentiation cycle (basalt-andesite-dacite-rhyolite) and interlayered sedimentary rocks. The Manigotagan River Formation, recently separated by Seneshen and Owens (1985) and Seneshen (1990) occurs at the stratigraphic top of the Bidou Lake Subgroup, transitional to the Edmunds Lake Formation. The Manigotagan River Formation consists of upper fan (and fluvial?) sediments and shallow-water mafic and subaerially erupted felsic volcanic flows and represents a near-shore environment.

Rocks of the Bidou Lake Subgroup are laterally extensive. In contrast, rocks of the Gem Lake Subgroup are restricted to the Gem Lake area. Volcanic rocks south of Rice Lake, previously included into the Gem Lake subgroup (Weber, 1971a), are now considered as part of the Bidou Lake Subgroup (Poulsen *et al.,* 1996).

Mafic pillowed and massive volcanic flows form the dominant lithology in the Bidou Lake and Gem Lake subgroups. The mafic flows are of tholeiitic (and locally Mg-tholeiitic) affinity (Weber, 1971b, Brommecker, 1991). Recently Brommecker *et al.* (1993) have identified komatiitic basalts and spinifex textured komatiitic flows east of Beresford Lake in a sequence of rocks previously considered to be part of the Bidou Lake Subgroup but now assigned to the Garner Lake Subgroup (Poulsen *et al.,* 1996; Map ER86-1-1).

TABLE 4: LITHOSTRATIGRAPHY OF THE RICE LAKE BELT (after Poulsen *et al.,* 1996)

LITHOSTRATIGRAPHIC SUBDIVISION Group	Formation/subgroup	Age	Lithologies	Tectonic Setting
	San Antonio Formation	<2730 Ma	arenites, conglomerate.	alluvial-fluvial successor arc molasse basin
RICE LAKE GROUP	Edmunds Lake Formation	<2730 Ma >2650 Ma	greywacke/argillite, conglomerate	back arc/fore arc turbidite basin
	Gem Lake Subgroup	>2720 Ma	basalt-andesite dacite-rhyolite	successor arc volcanism; vent facies
	Bidou Lake Subgroup	>2729 Ma	basalt-dacite, sandstone, conglomerate	Successor arc volcanism ——accretion?——
	Garner Lake Subgroup	>2870 Ma	komatiite, basalt, iron-formation, dacite	arc/oceanic volcanism
	Wallace Lake Subgroup	>2920 Ma <3000 Ma	quartz arenite, iron-formation, carbonate, basalt, dacite	platform: shallow submarine to subaerial sedimentation and volcanism; rifting?

Intermediate to felsic volcanic rocks form 30-40% of the Bidou Lake and Gem Lake subgroups. They are calc-alkaline in composition and were interpreted to represent largely subaqueous, in part pyroclastic and in part laharic deposits (Weber, 1971 b). However, in part they are fluvial epiclastic deposits, derived from unconsolidated pyroclastic debris (Tirschmann, 1986). Recent U-Pb zircon geochronology (Turek *et al.,* 1989, Ermanovics and Wanless, 1983; Poulsen *et al.,* 1996) has yielded a 2.73 Ga age for the Bidou Lake rhyodacitic volcanism and a slightly younger age of 2.72 Ga (Poulsen *et al.,* 1994) for felsic volcanism of the Gem Lake Subgroup.

The Wallace Lake Subgroup was described by McRitchie (1971 a) as comprising basal mafic volcanic rocks (Big Island Formation) and felsic-intermediate volcanic-derived sedimentary rocks (Siderock Lake formation) overlain by a distinct sedimentary sequence (Conley Formation) of arkose, quartzite and greywacke interlayered with conglomerate, silicified limestone, and iron formation. More recently Theyer (1983) identified a spinifex textured ultramafic unit within these sediments. McRitchie (1971a) has interpreted the Conley Formation as having been deposited in a (miogeosynclinal) shallow water environment. A quartz-feldspar porphyry dyke intruded into quartz arenites of the Conley Formation yielded an age of 2.92 Ga.(Poulsen *et al.,* 1994). Detrital zircons in the quartz arenite yielded ages of about 3 Ga (Poulsen *et al.,* 1994). This implies that the quartz arenites are between 2.92 Ga and 3 Ga old (Poulsen *et al., 1996).*

San Antonio Formation

West, southwest and northwest of Rice Lake the supracrustal rocks of the Rice Lake Group are unconformably overlain by the arkosic sandstones and conglomerates of the San Antonio Formation (Map ER86-1-1). The formation also rests with an erosional contact on the quartz diorite pluton west of Bissett. Deposition of the San Antonio Formation postdates the first major deformational event recognized in the Rice Lake Belt, *i.e.,* large-scale D_1 isoclinal folding (Weber, 1971c).

Intrusions

The Rice Lake Group has been intruded by a variety of gabbroic and diabasic sills and dykes, felsic plugs, granitoid plutons and related felsic and intermediate dykes, and minor ultramafic intrusions.

Gabbros commonly form sill-like intrusions within the basaltic flows and exhibit a close compositional and chemical affinity to the mafic extrusive rocks (Weber, 1971 b), suggesting that they are essentially synvolcanic. Some of the largest mafic sills that occur within the Bidou Lake Subgroup are differentiated and exhibit a melanocratic base and a leucocratic upper part, such as the diabasic sill that hosts the mineralization of the San Antonio deposit (Ames; 1988, Ames *et al.,* 1991). Differentiated gabbro also hosts the Central Manitoba, Oro Grande and Mirage deposits (Weber, 1971 b, Poulsen, 1989; Fig. 10).

Felsic to intermediate plugs and plutons intrude all rocks of the Rice Lake Group. These intrusions are largely quartz dioritic to tonalitic in composition. The two largest quartz diorite plutons intrude the central part of the greenstone belt east and west of Rice Lake. The oval-shaped Ross River pluton outcrops to the east. It yielded a U-Pb zircon age of 2728 Ma (Turek *et al.,* 1989). To the west a more elongate body of similar composition occurs. Widespread intrusion of 2731-2733 Ma felsic and intermediate porphyry dykes is associated with the emplacement of the quartz diorite plutons (Turek *et al.,* 1989; Turek and Weber, 1991). A distinct felsic plug is associated with rhyolites of the Gem Lake Subgroup. This plug has yielded a U-Pb zircon age of 2722 Ma (Poulsen *et al., 1994)*

Scoates (1971) observed three types of ultramafic intrusions in the Rice Lake area: 1) a discontinuous series of serpentinized lenses within the Wanipigow River plutonic complex located along the Wanipigow fault or its offshoots, between Saxton Lake, 10 km northwest of Bissett, and Lake Winnipeg; 2) a straight-walled cortlandtite dyke at Dove Lake; and 3) a differentiated layered ultramafic intrusion at Garner Lake. Isolated occurrences of ultramafic rock outcrop on the north shore of Wallace Lake and east of Siderock Lake (McRitchie, 1971 a) . The cortlandtite dyke has intruded along a fault which displaces D_1 folded rocks of the Rice Lake Group.

Recent geological work undertaken between 1984 and 1989, and between 1989 and 1993 as part of Canada-Manitoba Mineral Development Agreements and U-Pb zircon geochronology studies during the same period have better defined the geological frame work of the Rice Lake belt established in the early seventies. The new data indicate that the Rice Lake Group consists of at least two fundamentally different sequences or assemblages: (1) an older sequence, represented by the Wallace Lake Subgroup and the newly separated Garner Lake Subgroup, and (2) the younger, more voluminous Bidou Lake and Gem Lake subgroups. The Wallace Lake and Garner Lake subgroups typically comprise komatiites, magnesian and tholeiitic basalts and oxide facies iron formations. The Wallace Lake Subgroup in addition contains quartzites and carbonates and the Garner Lake Subgroup felsic pyroclastic rocks (Poulsen *et al.,* 1994; 1996). The Garner Lake Subgroup is >2870 Ma age, whereas the Wallace Lake Subgroups is between 2920 Ma and 3000 Ma (Table 4). These sequences are distinctive, but in sheared (faulted? thrusted?) *i.e.* uncertain contact with the younger, approximately 2730 Ma volcanic and related rocks of the Bidou and Gem lakes subgroups (Poulsen *et al., 1996).*

U-Pb geochronology data further indicate that the Wanipigow plutonic complex is made up of granitoid intrusions ranging in age from 3.0 to 2.73 Ga (Krogh *et al.,* 1974; Turek and Weber, 1991, 1994; Ermanovics and Wanless, 1983; Ermanovics, 1981). The 3 Ga old crustal component in the complex was probably the source for quartz arenites of the Wallace Lake Subgroup (Weber, 1988; Turek and Weber, 1991, 1994).

The present information indicates that the Rice Lake belt evolved in a similar pattern as the Red Lake belt that is located further to the east in the Uchi Subprovince of Ontario (Corfu and Andrews, 1987; Corfu and Davis, 1992; Stott and Corfu, 1991).

The distribution of the assemblages suggests an original age and lithological progression from northeast to southwest (Map ER86-1-1, Table 4): older Mesoarchean quartz arenite-bearing successions (Wallace Lake Subgroup) and komatiite-bearing successions (Garner Lake Subgroup), possibly representing a rifting stage and subsequent arc/oceanic volcanism, give way southward to Neoarchean tholeiitic and calc-alkaline volcanic rocks and subvolcanic intrusions formed mainly between 2730 and 2720 Ma in a submarine to locally subaerial volcanic arc (Bidou Lake, Gem Lake subgroups), possibly in response to an accretion phase. Turbidites (Edmunds Lake Formation) were deposited southward of this arc, possibly in a successor basin back-arc setting, and alluvial-fluvial rocks (San Antonio Formation) were deposited in more restricted successor basins, presumably in response to rapid uplift of the arc volcanics during faulting under transpressional (collision?) regime (Poulson *et al., 1996).*

METAMORPHISM

Although several phases of metamorphic recrystallization have been recognized in this region (McRitchie and Weber, 1971) the majority of rocks in the Rice Lake greenstone belt exhibit mineral assemblages indicative of greenschist facies metamorphism. Thermal contact metamorphism caused an increase to amphibolite facies of supracrustal rocks in contact with granitoid rocks of the Wanipigow plutonic rocks, in the Wallace Lake and the Little Beaver Lake (northwest of Bissett) areas. Contact metamorphic aureoles associated with the greenstone belt-internal granitoid intrusions are preserved locally.

On the southern flank of the belt regional metamorphic grade increases southward as evidenced by a lithologic gradation from low grade Edmunds Lake Formation rocks to upper amphibolite grade gneisses of the Manigotagan gneissic belt (McRitchie and Weber, 1971).

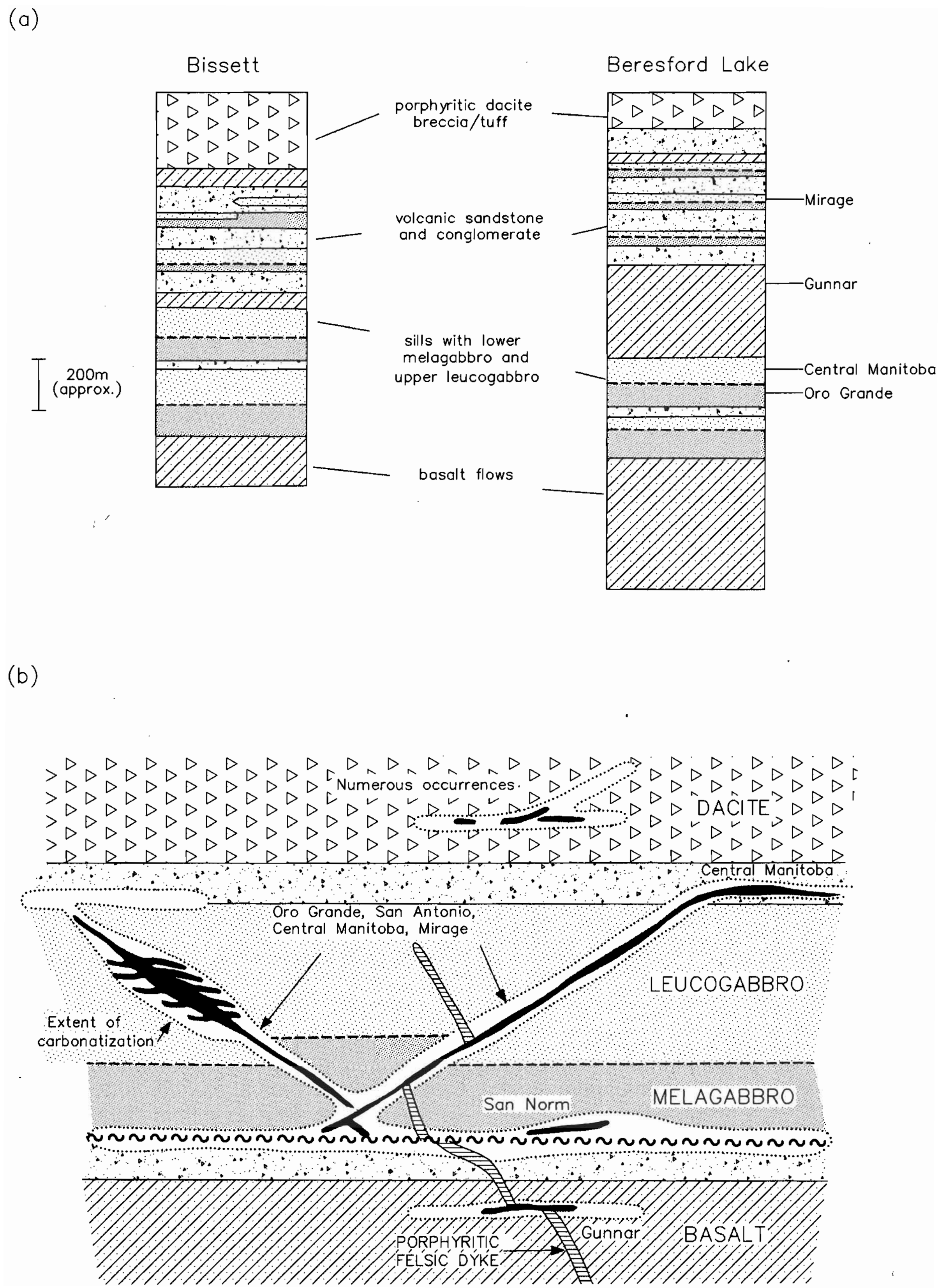


Figure 10: a) Stratigraphic setting of some of the major gold deposits in the Rice Lake belt (after Poulsen, 1989)
b) Schematic diagram of the relationships of stratigraphic position, structure and distribution of alteration for some of the major gold deposits in the Rice Lake greenstone belt (after Poulsen, 1989)

STRUCTURE

McRitchie and Weber (1971) have recognized six periods of deformation in the rocks of the Rice Lake greenstone belt and the adjacent Manigotagan gneiss belt which include three main periods of folding D_1, D_2 and D_3. Interlayering or repetitions of beds evidence D_1 large-scale isoclinal folding with generally shallow axes plunging to the northwest. D_2 deformation is characterized by: 1) small-scale, similar, mainly Z-shaped folds; 2) development of a penetrative foliation (S_2) parallel to the axial planes of the D_2 folds; and 3) flattening of pyroclastic and conglomeratic fragments in the foliation plane with elongation parallel to the fold axes. Foliation and deformation of fragments produced during D_2 deformation exist in most parts of the greenstone belt. Small-scale concentric S-shaped folds developed during D_3 deformation.

Continued movement along S_2 planar fabrics during D_4 deformation may be responsible for the main break between the Manigotagan gneissic and greenstone belts. North-south maximum compressive stress, developed in association with isostatic imbalance and upward movement of the English River (Manigotagan) metasedimentary belt, produced major, steeply dipping conjugate northwest-northeast shear zones within the greenstone belt during D_5 deformation. With decreasing confining pressures rectilinear D_6 microbrecciation fractures and ultramylonitic zones developed that dislocated all earlier structures. The main movement along the Wanipigow Lake fault is attributed to D_6 deformation.

Zwanzig (1971) and Brommecker (1991) established also three main deformation phases in the Long Lake-Beresford Lake area: D_1 isoclinal folding and cleavage development, possibly during thrusting; D_2 tight folding with the development of the main penetrative foliation, possibly developed during out of sequence thrusting; and D_3 open and kink folding, possibly developed during dextral strike slip. Major shear zones at Moore and Beresford lakes and the North Carbonate shear at the Central Manitoba mine developed during D_1 and D_2, whereas the South Carbonate Shear formed during D_2 (Brommecker, 1991).

Rocks in the Bissett area also show evidence of three penetrative deformations. The most prominent evidence of ductile deformation is a penetrative schistosity that strikes west-northwest and dips steeply northward. This foliation (regionally S_2 or S_3) is axial planar to a large reclined syncline in San Antonio Formation and locally overprints an earlier foliation (S_1?) that is sub-concordant with bedding in the Rice Lake Group volcanic and epiclastic rocks. A prominent mineral lineation is coincident with the intersection of the two foliations. This lineation trends northward at the south shore of Rice Lake but, north of Rice Lake, it deviates increasingly to the east, possibly as a result of D_3 deformation along the Wanipigow fault (Poulsen *et al., 1986).*

The most intense effects of deformation in the Rice Lake area are found in ductile shear zones that are common throughout the area. These zones are typically heavily carbonatized and include two types: those, such as the Normandy Creek and footwall (of the San Antonio mafic sill) shears (Fig. 10; Map 86-1-1; Poulsen *et al.,* 1986) that are concordant with lithological layering and those, such as the Rice Lake shear (Fig. 11), that are discordant. The presence of "down-dip" lineation and the fact that the Rice Lake shear places Rice Lake Group volcanic rocks over younger arenites of the San Antonio Formation (Fig. 12), indicate that at least some of these structures are reverse faults.

MINERALIZATION

In the Rice Lake greenstone belt the more than 200 gold occurrences are hosted in vein and stringer quartz that occupies shears, faults and fractures. They occur mainly in the *circa* 2730 Ma mafic volcanic and mafic synvolcanic intrusions. Most of the larger gold deposits are hosted by rocks of a restricted stratigraphic interval dominated by epiclastic volcanic rocks, basalt flows, and layered mafic sills (and locally iron formation) of the Bidou Lake Subgroup (Poulsen, 1989; Poulsen *et al.,* 1996; Fig. 10). The reason for this is not clear. The structural anisotropy created by the

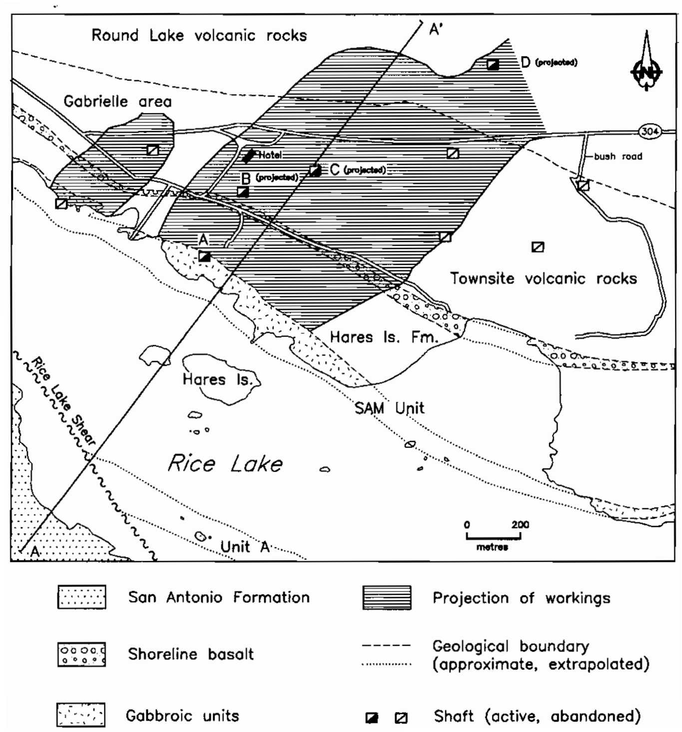


Figure 11: Geology of the San Antonio Mine area *(after Poulsen et al.,* 1996)

intercalation of these rock types of different competency may be one factor.

Vein Formation

Early studies proposed that gold-bearing shear zones in the Rice Lake belt were active during intrusion of felsic to intermediate magma (Stockwell, 1938; Stockwell and Lord 1939; Davies, 1953, 1963) and

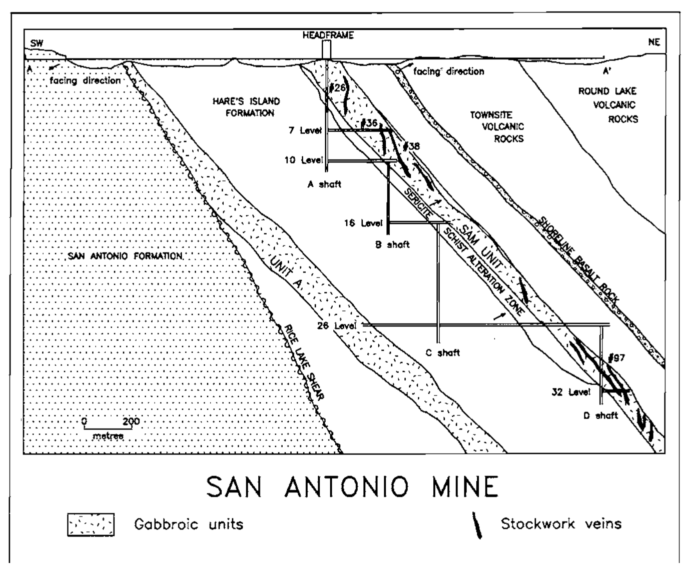


Figure 12: Geological cross section of the San Antonio Mine area (after Poulsen et al., 1996)

propose a long history of shearing lasting from volcanism to after metamorphism.

McRitchie *et al.* (1971) proposed that on a regional scale formation of the quartz veins took place late in the tectonic history of the greenstone belt and postdates the last major period of folding (D_3) and emplacement of the associated intrusions. Development of northwest-striking, steeply dipping conjugate shears and related dilational structures during the D_5 deformation event provided depositional sites for the majority of the gold-quartz veins. D_6 deformation produced localized kinking and granulation of quartz veins and some remobilization of gold.

The more recent interpretation, based on deposit-scale observations *(cf.* Brommecker, 1991) suggests that most gold-bearing quartz veins formed relatively early, during D_1 or D_2 deformation, but later than the felsic to intermediate intrusions, and are only overprinted by D_3 and younger structures (Lau, 1988; Brommecker, 1991).

Stephenson (1971, 1972) came to similar conclusions, but suggested a second period of mineralization during the final increment of strain (D_3).

Vein Distribution

Two dominant types of structures host productive veins: veins that are longitudinal with respect to lithological contacts are a product of layer-parallel shearing, whereas veins that are transverse are likely the result of local layer-parallel elongation and shortening of the stiffest members of the stratigraphic sequence.

Gold-quartz veins are concentrated in the greenstone belt east and west of the oval-shaped Ross River Pluton (Map ERS6-1-1). Structural interference caused by the rigid or deformation-resistant Ross River pluton during north-south compressive stress (D_5?) may have created shears and fractures in the adjacent greenstones.

The Lotus and Vanson deposits (Map ERS6-1-1, location RL7, RL14) and a few small gold occurrences are spatially related to the Wanipigow fault (Weber, 1991) and may be related to mobilization of gold during reactivation of the fault (D_6?).

The San Antonio Formation is devoid of gold-bearing quartz veins.

Vein Form

The majority of gold-quartz veins in the Rice Lake greenstone belt are hosted by shear zones. Shear zones typically do not exceed 3 m in width and approximately 70 m in length (Stockwell, 1935). In general, vein material is irregularly distributed within any particular shear zone as discontinuous lenses, pods, stringers and/or pinch and swell veins. The quartz may be distributed across a portion or the entire width of the structural zone. Vein dimensions and styles are extremely variable due to a great range in physical conditions of the depositional sites. In general, most veins, lenses, series of lenses or stockworks seldom exceed 1 m in width and 100 m in strike length.

The northeast-trending gold bearing quartz veins (16 type veins) of the San Antonio deposit (Fig. 13), the largest deposit in the Rice Lake belt (see below), form discrete elongate bodies and/or a discontinuous series of lenses (Fig. 14) at or near the centre of sinistral reverse ductile shear zones (Lau, 1988) and generally are accompanied by numerous quartz stringers that branch out from the main vein or parallel the shear cleavage.

Less common but important hosts for gold are breccia zones and tensional fractures that form northwest-trending stockwork ore shoots in the San Antonio deposit (Fig. 11, 13). Over the 35 years of mining, thirty steeply dipping stockworks have been identified. These complex, elongate lens-shaped zones of intensely fractured and mineralized host rock, termed “stockworks” occur and are confined to the San Antonio mine gabbroic sill (in en echelon fashion); these breccia zones are up ten metres wide, up to 150 metres long in horizontal direction and 300 metres long down plunge (cf. Fig. 12).

Vein Mineralogy

Accessory ore and gangue minerals normally account for up to 10% of quartz veins. Gold, pyrite, chalcopyrite, pyrrhotite, sphalerite, arsenopyrite and galena are the most prominent accessory minerals. Pyrite is the most common sulphide and occurs as coarse subhedral crystals or as fine granulated streaks and bands. Gold is most intimately associated with pyrite. Ames *et al.* (1991) conclude that gold is both contemporaneous with pyrite as inclusion filling and postdates pyrite precipitation. Blebs of gold occur along internal fractures and on crystal faces of coarse pyrite crystals and interstitial to fine pyrite granules and as blebs in relic crystal fragments within the pyrite streaks and bands. Chalcopyrite is a common accessory and the other sulphides occur locally. Quartz is the second most important carrier of gold and the dominant gangue mineral. Stephenson (1972) noted that the undeformed barren or poorly mineralized veins typically contain white glassy quartz. Cataclastic sugary or cherty varieties of quartz with interstitial gold and sulphides are more common in the ore-bearing deposits. The most common gangue minerals are ankerite, chlorite, sericite and tourmaline. Albite, K-feldspar, calcite, fuchsite and epidote are also present.

Ore and gangue mineral relationships indicate that the majority of gold and pyrite was precipitated with early quartz, albite and tourmaline (Stephenson, 1971). Ankerite deposition occurred during all stages of vein development. Cataclasis during and/or after vein emplacement facilitated the liberation of the early precipitated gold from its pyrite host by mechanical granulation and, in some cases, the introduction of telluride minerals. Wisps, long slivers and thin slices of stress minerals such as chlorite, sericite and fuchsite separate cataclastic quartz layers.

Hydrothermal Alteration

Hydrothermal alteration by CO_2-bearing fluids of similar composition were present during the development of virtually all quartz veins and shear zones (Diamond, 1989; Diamond *et al.,* 1989). The intensity of alteration is controlled to a great degree by the composition of the host rock. In general, mafic host rocks are more susceptible to hydrothermal alteration. Stephenson (1971) subdivided hydrothermal alteration of wall rock adjacent to mineralized quartz veins into an inner and outer visible alteration zone that seldom extends more than 7 m from the vein margin. The invariably sheared inner zone is characterized by intense sericitization, chloritization, pyritization, carbonatization and silicification. Its thickness

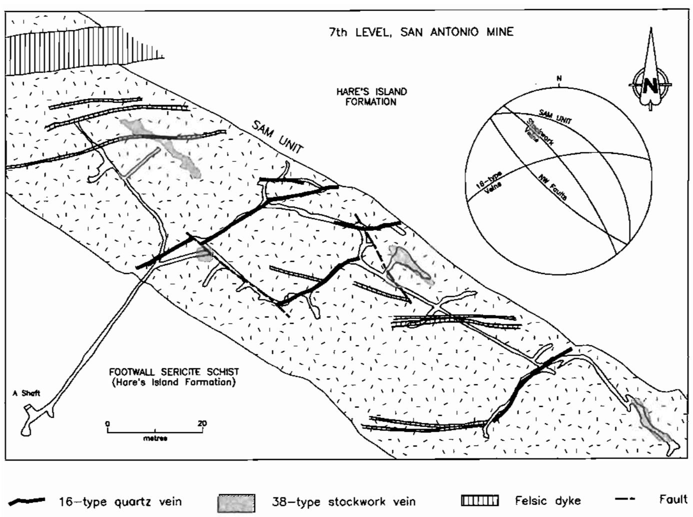


Figure 14: Geological plan of the 7th level, San *Antonio Mine (adapted from Lau, 1988)*

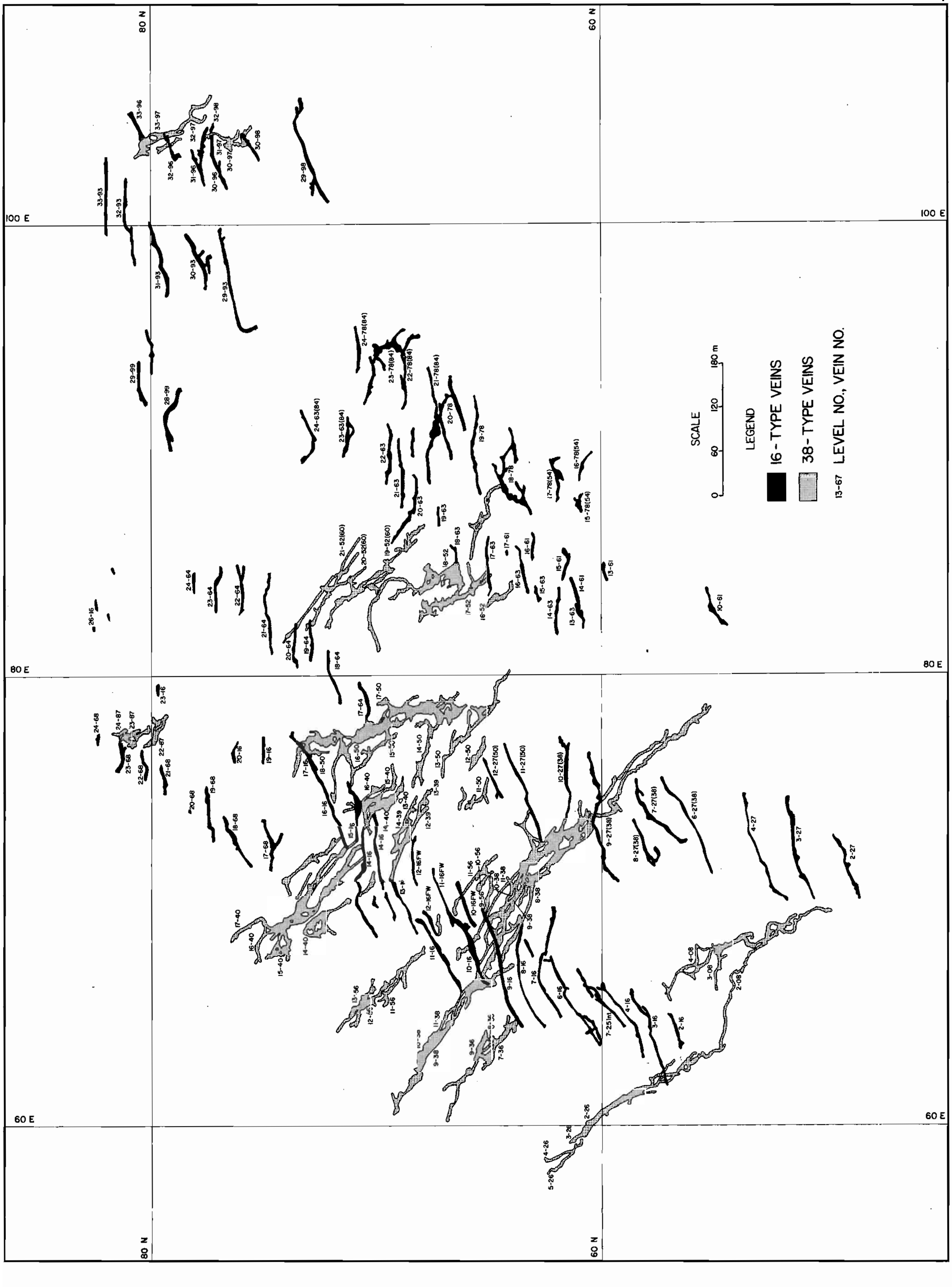


Figure 13: Composite level plan of the San Antonio Mine showing '16 type' shear veins and '38 type' stockwork veins.

ranges from a few centimetres to a metre in width. The wall rock in the outer zones commonly exhibits partial preservation of primary mineralogy. Ames (1988) found that alteration in mafic host rocks is zoned in the San Antonio deposit (see description under the deposit) that is essentially the result of mineralogical changes and reactions due to increased CO_2 flooding. This zonation manifests in the following easily recognizable changes: 1) disappearance of epidote and actinolite (in melagabbro); formation of chlorite (melagabbro) and calcite; 2) disappearance of chlorite (in leucogabbro), reduction of calcite and the formation of ankerite and paragonite; and 3) disappearance of calcite, formation of muscovite and albite (in leucogabbro) and pyrite

The thickest alteration zone occurs at the footwall of the San Antonio mine sill at approximately the 26th level, where it is about 130 m thick (Fig. 12).

Summary

Gold deposits of the Rice Lake greenstone belt are stratigraphically, lithologically and structurally controlled and predominantly of the epigenetic quartz vein type. At a regional scale, most significant deposits occur in a restricted stratigraphic interval that forms the transition from dominantly mafic to dominantly dacitic volcanic rocks of the Bidou Lake Subgroup. This interval is dominated by epiclastic volcanic rocks, basalts and layered gabbroic sills. Many gold-quartz veins occur at stratigraphic intervals that are composed of lithologic units of differing competency. Iron-rich leucogabbro phases of gabbroic sills provided preferred depositional sites for the development of gold-bearing quartz veins because of their relatively high susceptibility of ferro-magnesium minerals to CO_2 bearing hydrothermal alteration fluids, and because the sulphur reaction with iron in the oxides to precipitate gold is more efficiently in the leucogabbro than melagabbro due to higher modal amounts of ilmenomagnetite in the metamorphic assemblage (Ames *et al.,* 1991)

Veins that are longitudinal with respect to lithological contacts and those that are transverse are the two main types of structures that host productive veins: Longitudinal veins are a product of layer-parallel shear whereas those that are transverse are likely the result of local layer-parallel elongation and shortening of the stiffest members of a stratigraphic sequence, due to brittle failure in response to regional or local stress.

Of the fifteen formerly producing deposits located on Map ER86-1-1, eleven, including the San Antonio deposit (Map ER86-1-1, location RL1), are hosted by massive mafic intrusive and/or extrusive rock units; three, including the Ogama-Rockland Mine (Map ER86-1-1, location RL4), are hosted by quartz diorite, and one, the Elora deposit (Map ER86-1-1, location RL12), is hosted by greywacke.

The San Antonio, Central Manitoba (Map ER86-1-1, location RL 2) and Gunnar (Map ER86-1-1 , location RL3) mines were the most important gold producers in the Rice Lake greenstone belt (see Deposit descriptions RL1, RL2 and RL3). Although mineralization at all three deposits is of the gold-quartz vein type and structurally emplaced along shear and fracture zones the ore deposits occupy essentially stratabound positions within discrete massive lithologic units of the Rice Lake Group. Ore zones at the San Antonio deposit are primarily hosted by a mafic rock unit described as a diabase sill (Stockwell, 1938; Stephenson, 1972). Ames (1988) and Ames *et al.* (1991) concluded that the leucocratic top of the San Antonio mafic sill contains the main gold mineralization, because it initially contained a higher iron oxide content than the lower more melanocratic unit. During hydrothermal alteration the leucocratic portion of the San Antonio Mine sill ended up with a higher pyrite content and, since gold is generally assumed to be transported in sulphur-bearing thio-complexes *(cf.* Roberts, 1987), ended up with higher content of gold bearing pyrite.

The association of gold bearing veins with leucogabbro also occurs at the Central Manitoba, Oro Grande and Mirage deposits, although the most productive veins at the Central Manitoba Mine occur in a chert/tuff unit adjacent to the gabbro (Stockwell and Lord, 1939). The Gunnar deposit is hosted by a relatively massive pillowed mafic flow unit. Most of the Gunnar ore came from quartz veins in a shear where it intersects a quartz-feldspar porphyry dyke (Stockwell and Lord, 1939; Stephenson, 1971).

There are differing interpretations as to the relative age of gold-pyrite mineralization. Lau (1988) and Brommecker (1991) conclude that it formed during or prior to D_2 deformation and was overprinted by at least the D_3 deformation event. In an earlier interpretation (McRitchie *et al.,* 1971) mineralization was initiated during the D_4 deformation period. Continuation of D_5 deformation after vein formation, or renewed movement along veins during the D_6 deformation event, resulted in liberation of gold from primary ore minerals by mechanical granulation; locally this event was synchronous with introduction of telluride minerals (Stephenson, 1972).

Geochemical data from alteration studies led Bailes (1969) and Stephenson (1972) to favour a host rock source for the bulk of the gold-bearing vein material. Stephenson and Ehmann (1971) determined that mafic intrusive rocks in the Rice Lake belt had a relatively high background levels of gold. They concluded that initial high gold contents in these units may be the main reason why the most important gold deposits are hosted by mafic intrusive rocks.

Although the association of gold mineralization with mafic intrusive (and extrusive rocks) is prominent throughout the Rice Lake belt, minor gold mineralization does occur within sedimentary rock units. At Wallace Lake (Map ER86-1-1, location RL21) stratabound disseminated gold mineralization at the Gatlan occurrence is hosted by argillaceous quartz wacke (Gaba, 1984; Gaba and Theyer, 1984; Gaba, 1985; Theyer and Gaba, 1986). Theyer and Gaba (1986) also identified gold-quartz vein mineralization within a feldspathic wacke of the Edmunds Lake Formation at Lily Lake (Map ER86-1-1, location RL2D) and approximately 3 km east-northeast of Lily Lake.

Not all quartz veins in one of the more favorable host rocks, the differentiated gabbro sills, are gold-bearing. The Tut showing, 7 km east-southeast of Long Lake (Map ER86-1-1, location RL 24; Theyer and Gaba, 1986; Theyer and Ferreira, 1990; Brommecker, 1991), is within a layered gabbro that strikes WNW. Of three steeply dipping shear zone sets: (i) WNW, (ii) NW, (iii) NE striking, studied by Brommecker (1991), only the older (i) and (ii) shear zones contain quartz lenses or irregularly oriented stringers forming small stockworks, and carry visible gold and sporadic gold values (to 10 000 ppb Au, Theyer and Ferreira, 1990). The younger (iii) shear zones generally do not have significant vein material, have none of the iron-carbonate alteration typically associated with the (i) and (ii) veins and are barren. Brommecker (1991) interpreted the (iii) shear zones as being part of the D_2 deformation and the (i) and (ii) shear zones as part of the D_1 deformation in the Long Lake-Beresford Lake area.

PAST PRODUCERS

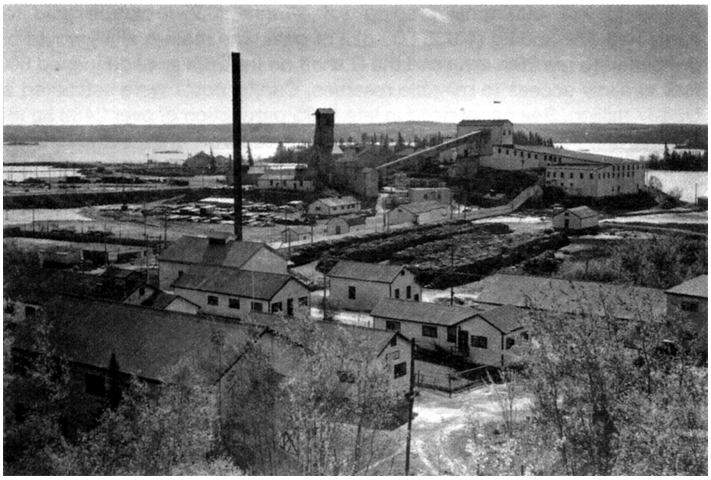
San Antonio Mine

Location: Bissett, on the north shore of Rice Lake.

Map Reference: Map ER86-1-1, location RL1

Description of Deposit:

The property is underlain by volcanic rocks of the Rice Lake Group (Stockwell, 1938; Davies *et al.,* 1962), more specifically by a north-facing panel of intermediate volcaniclastic and volcanic rocks of the Bidou Lake Subgroup (Weber, 1971 a). Gold-bearing quartz veins occur in a diabase sill (Stockwell, 1938; Fig. 10) hosted by epiclastic volcanic rocks (sandstones, conglomerates) of the Hare's Island Formation (Tirschmann, 1986) that is overlain by a mafic flow (Shoreline basalt) and dacitic pyroclastic volcanic rocks (Townsite and Round Lake volcanic rocks (Fig. 11, 12; Poulsen *et al.,* 1986). Theyer (1983, 1984a) interpreted the diabase sill to be a sequence of mafic volcanic flows and volcanogenic sedimentary rocks, and he



San *Antonio Mine, circa 1940, Bissett, Manitoba*

named these rocks the San Antonio Mine unit or SAM unit. Whiting and Sinclair (1986) concurred with Theyer's interpretation. More recent detailed mapping and petrologic studies (Ames, 1988; Ames *et al.,* 1991) supported Stockwell's interpretation, although not everywhere it can be shown that the gabbroic unit is an intrusive body. A chemically identical and thus probably consanguineous mafic flow (Shoreline basalt) occurs above the gabbroic unit (Fig. 11, 12). Thus, not to rule out the possibility that the San Antonio gabbro locally may be transitional into a flow the term SAM unit is being widely used.

The SAM unit has a melanocratic base and leucocratic upper part. The leucocratic upper part hosts most of the ore in the mine (Ames, 1988; Ames *et al.,* 1991). Two types of veins occur within the host rocks: 1) a northeast-striking steeply northwest dipping set called the "16 type" occupy shear zones that crosscut the mafic sill at high angles; and 2) a northwest-striking set called the "38 type" forms stockworks that are subconcordant to discordant to the host sill (Fig. 12, 13).

The "16 type" veins strike 060°-075° and dip 60° NW. The veins pinch and swell along strike and down dip, ranging in length from a few metres to 200 m and in width from a few centimetres to 2 m. The veins are commonly zoned, composed of a core of banded quartz and a quartz-albite-ankerite fringe. Numerous parallel quartz stringers occur in the host rocks on either side of the veins. Pyrite with lesser amounts of chalcopyrite, sphalerite, galena, tellurides and iron oxides form up to 10% of the total vein material. Gold is of widespread, but sparse distribution, and is associated with fine granular pyrite.

The "38 type" or stockwork veins strike from 300° to 330° and dip vertically or steeply NE. Poulsen *et al.* (1986) recognized three types of extension veins in the stockworks: 1) stacked or ladder arrangements of sub-parallel horizontal fractures; 2) a set of sub-vertical fractures of variable strike that link and are coeval with the horizontal ones; and 3) a later set of vertical fractures that are normal to the strike of the stockwork as a whole. The core of the stockworks usually consists of angular wall rock fragments enclosed in vein material. The stockwork veins are similar in composition to the "16 type" veins.

Lau (1988) concluded that the stockworks typically comprise three structural elements: 1) an inner central quartz vein; 2) a central breccia zone composed of angular, altered wall rock fragments cemented by vein quartz; and 3) a peripheral zone containing arrays of extensional, sigmoidally shaped "ladder veins" that are oriented at a mean angle of 45° to the stockwork zones. The stockworks, a major source of ore in the mine, are interpreted to be brittle shear zones that have formed in two stages, an initial sinistral reverse movement to account for the orientation and sigmoidal shape of the ladder veins, followed by a dextral reverse movement to account for the observed dextral displacement of dykes cut by the central quartz veins.

Gibson and Stockwell (1948) believe that the two vein sets occur in complementary shears resulting from a north-south compressive stress. Poulsen *et al.* (1986) suggest the 38-type stockwork veins formed in zones of extension between *en echelon* shears that host the 16-type veins.

Wall rocks adjacent to the "16 and 38 type" veins are fine grained, schistose and have been intensely carbonatized, sericitized, albitized and sulphidized. Ames (1988) and Ames *et al.* (1991) identified a zonation of hydrothermal alteration with respect to ore-bearing veins in the San Antonio mine: Carbonatization produced alteration mineral assemblages that pseudomorphically replaced metamorphic minerals. These alteration mineral assemblages define alteration isograds.

In the upper leucocratic part of the San Antonio mine mafic sill, these isograds correspond to the following changes (Ames *et al.,* 1991):

i) actinolite + epidote + CO_2 = chlorite + calcite + quartz
ii) titanite + CO_2 = rutile + calcite + quartz
iii) chlorite + calcite + albite + CO_2 = paragonite + quartz + ankerite + H_2O
iv) quartz + paragonite + K^+ = albite + muscovite + H^+

These isograds are distributed in zones about the gold-bearing structures such that isograd (iv) is innermost and isograd (i) is outermost. The alteration assemblages and their zonation are similar in the vicinity of stockworks, shear veins and veins in southeast-dipping fractures, indicating that the composition of the hydrothermal fluids remained relatively constant over the time span during which these different vein generations were formed. The alteration zonation about veins hosted by the basal melagabbro is only recorded by isograds (i) and (ii) and, with increasing alteration, ankerite was formed from tremolite and calcite, a reflection of the more mafic bulk composition of this host rock.

Mass balance calculations (Ames, 1988) show that CO_2, S and K were added to the gabbroic rocks from the hydrothermal fluid with a change in the oxidation state of iron towards reducing conditions. Boron and sodium were also added at the contacts of veins in the form of metasomatic tourmaline and albite. Pyrite is most directly related to the occurrence of gold and formed after muscovite and ankerite. Quartz-calcite-chlorite veins crosscut and replace earlier formed alteration minerals.

History of Exploration and Development:

The San Antonio claim was staked in 1911 by Alex Desautels, who immediately assigned the claim to E.A. Pelletier. Very little development work was done on the claim until 1926 when The Wanipigow Syndicate was formed to explore the property. The syndicate changed its name in 1927 to San Antonio Mines Limited. A second name change occurred in 1931 when the property was refinanced and incorporated as San Antonio Gold Mines Limited. The first gold was produced in 1932 and the mine remained in continuous production from 1932 to 1968. The deposit was developed by a series of three shafts and five winzes to a total vertical depth of 1546 m (Fig. 12). The mine ceased production in 1968 due to a fire in the main hoist and the inability to be profitable because the fixed price of gold. The company was placed into receivership and its assets purchased by three of the former directors. Ore reserves were estimated at 186 490 tonnes grading over 8.23 g/tonne (0.24 oz/ton) gold. In 1972 Chemalloy Minerals Limited took out a 60-day option and carried out diamond drilling, limited underground work and ore reserves evaluation. The option was not exercised.

In 1980 Brinco Mining Limited and New Forty-Four Mines Limited entered into a joint venture agreement. Under the terms of the agreement Brinco could earn a 50% interest in the property by conducting a reserves and feasibility study (Northern Miner, August 28,1980). The 7-month study confirmed mineable reserves of 725 680 tonnes that averaged 6.51 g/tonne (0.19 oz/ton) gold; the mine was re-opened in January 1982. Grades of ore from the upper levels were lower than expected and mining was suspended in May 1983. Exploration, however, was continued in an effort to find the downdip extension of the 97 stockwork vein. It was intersected by nine holes and had an average width of 3.45 m and a grade of 9.26 g/tonne (0.27 oz/ton) gold.

In 1983 Lathwell Resources Ltd. negotiated an option agreement and completed exploration that was designed to test the potential and cost of preparing the 33 and 34 levels for underground drifting and crosscutting. Lathwell estimated ore reserves between the 26 and 36 levels to be 1 203 161 tonnes averaging 7.89 g/tonne (0.23 oz/ton) gold (Northern Miner, September 20, 1984). The option was dropped in late 1984.

In November 1985 the property was optioned by San Antonio Resources, a company jointly owned by Inco Ltd., Quest Resources and private investors. An underground drilling program of 22 holes (6 737 m) was carried out from November 1985 to March 1986. San Antonio Resources calculated a "defined mineral resource" below the 26th level indicating 1 773 374 tonnes (1 955 208 tons) grading 7.4 g/tonne (0.215 oz gold/ton) gold containing 13 163 kg (421 231 oz) of gold. The cut-off grade was 1.7 g/tonne (0.05 oz/ton) gold. All assays above 31 g (1 oz) were cut to 31 g (1 oz). From the 26th to the 37th levels, 130 gold intersections, plus all previous drill, drift and stope data were used in these calculations. Their breakdown was:

Category	Grade g/tonne gold	oz/ton gold	tonnes	kg gold	oz gold
Proven	8.7	0.254	503 685	3980	127 360
Probable	7.0	0.204	1 038 505	6612	211 584
Possible	6.6	0.193	413 018	2465	78 880
Mineral Resource	7.4	0.215	1 773 374	13058	417 856

About 40% of the total reserve (*i.e.* 727 498 tons grading 7.4g/tonne (0.215 oz/ton) occurs in the "97 Stockwork vein" (Northern Miner, August 25, 1986).

San Antonio Resources dropped their option in 1986 and Brinco was later amalgamated with Cassiar Mining Corporation. Cassiar engaged Kilborn Engineering Ltd. to carry out a feasibility study who concluded with proven and probable reserves at 1.3 million tons grading 7.7g/tonne (0.223 oz/ton) gold. Kilborn recommended deepening the A shaft 275 m to the 26th level and deepening the D shaft to facilitate access to reserves below the 26th level. They said a 455 tonne (500 ton) per day operation would have capital costs of $11.2 million. Production was projected at 1244 kg (40 000 oz) gold per year with costs of $230 US/oz and mill head was predicted at 8.6 g/tonne (0.25 oz/ton) gold. Cassiar's plans to reopen the San Antonio mine was thwarted by the October 1987 stock market crash and the fall in the price of gold.

Early in 1989 Rea Gold Corporation acquired the San Antonio mine from Cassiar for $3.2 million, shares and a loan agreement (Northern Miner February, 1989). Rea engaged new reviews of the old data that showed minable reserves below the 26th level at 1.2 million tons grading 7.5 g/tonne ((0.22 oz/ton) and 301 400 tons above the 26th level grading 6.6 g/tonne (0.192 oz/ton). Capital costs were put at $18.8 million and operating costs at $86/tonne ($78.53/ton) with increases expected due to additional shaft sinking and new hoisting and mining and milling equipment (Northern Miner, June 5, 1989).

In 1994 Rea announced it would embark on a $3 million exploration-development program at the mine with the help of an incentive grant of $743 000 from the Manitoba Government and a designation of "new mine status" which relieves the operation of mining taxes until capital costs are paid off from new mine revenues. The program would consist of 5 100 m of drilling, de-watering and underground re-activation with the objective of adding 900 000 t inventory to the existing 1.4 million tonnes reserves. Studies by Rea indicated that 2.3 million tonnes at 8.6 g/tonne (0.25 oz/ton) gold were needed to justify a new A shaft and to establish an operation at 900 tonnes per day to yield 2177-2488 kg (70-80 000 oz) annually (Rea Gold Release, July 20, 1994).

A feasibility report by H.A. Simons Ltd. and reserve estimates by Dolmage Campell Ltd. in 1995 concluded after the 1994 underground exploration program the geological reserves now totalled at 3 389 459 tonnes (3 737 000 tons) grading 9.5 g/tonne (0.277 oz/ton) gold for contained 322 350 kg (1 036 500 oz.) of gold. The main A shaft would be deepened to the 26th level and the D shaft on the 26th level deepened 600 feet to allow access to minable reserves. Capital costs were estimated at US$37 million. Rea announced in late 1995 production of over 2488 kg (80 000 oz) of gold per year, at a cash cost of US$238/oz, is expected to begin in the first quarter of 1997. The mine will employ about 240 people and have a 10-12 year live span. The mill will be expanded to 900 tIday with a new leach circuit to permit dore gold bar production on site. The ore horizon remains open along strike in the deeper portions of the mine (Northern Miner, Feb. 12, 1996, and Rea Gold Corporation Release, early 1996).

History of Production:

Year	Gold produced kg (oz.)
1932-1968	41 519 (1 334 892)
1982 (estimate with 90% recovery)	344 (11 050)
1983 (estimate with 90% recovery)	137 (4 393)
Total	42 000 (1 350 335)

Source: 1932-1968 San Antonio Gold Mines, production cards; 1982-1983 Manitoba Energy and Mines, Mineral Policy.

Selected Bibliography: Ames (1988); Davies (1950); Davies *et al. (1962);* Financial Post Survey of Mines (1969, p. 195); Lau (1988); Manitoba Mines Branch, Annual Report on Mines and Minerals (1929-53); Manitoba Energy and Mines, Annual Reports (1982-83), Corporation File (Gabrielle Gold Mines Limited, San Antonio Gold Mines Limited, Scarab Mines Limited), Mineral Inventory File (52M/4SE Au3); Poulsen (1989); Poulsen *et al. (1996)* Robinson (1935); Staff of San Antonio Mine, The San Antonio Mine and Mill; Stephenson (1971); Stockwell (1938, 1945a); Stewart (1980); Theyer (1983, 1984a, 1994a); Tirschmann (1986); Wright (1932).

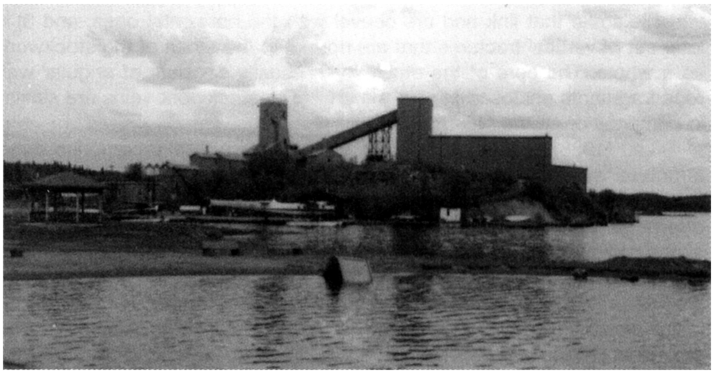
Central Manitoba

Location: 27 km southeast of Bissett.

Map Reference: Map ER86-1-1, location RL2.

Description of Deposit:

The Central Manitoba deposit is located within or along the margin of a differentiated diorite/gabbro sill and sediments of the Dove Lake Formation within the lower portion of the Bidou Lake Subgroup, which is dominated by mafic flows and associated gabbroic intrusions. Ten gold-bearing veins occur within *en echelon* shear zones within or along the margin of the mafic sill that strikes east-southeast and dips south (Stockwell and Lord, 1939; Fig. 15). Five of these veins produced most of



Bissett Gold Mine, 1996, Bissett, Manitoba

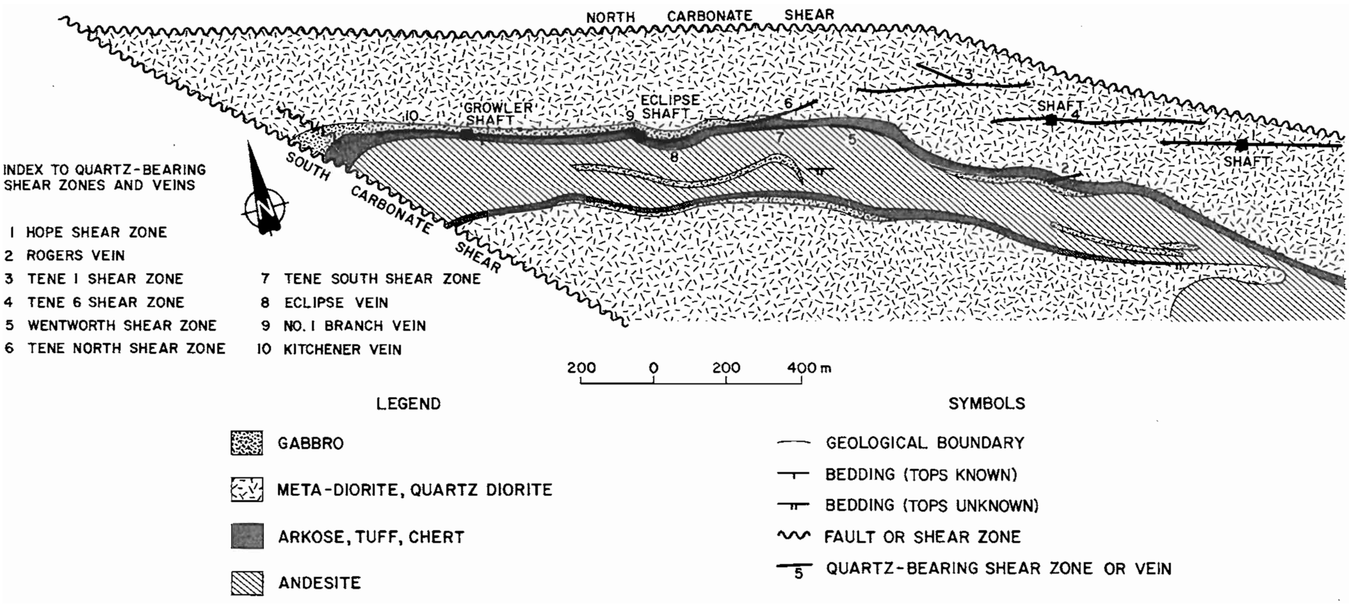


Figure 15: Geology of the Central Manitoba Mine area (after Stockwell and Lord, 1939)

the gold: Kitchener, Eclipse, No. 1 Branch, Tene 6 and Hope. The northward dipping South Carbonate Shear and the southward-dipping North Carbonate Shear bound a wedge-shaped domain which contains the mineralization.

In the western part of the property the Kitchener, Eclipse and No. 1 Branch veins occur in a shear zone along the contact between gabbro and cherty sediments of the Dove Lake Formation (Fig. 15; Stephenson, 1972). The southern, uppermost third of the gabbro sill at this locality is more leucocratic than the lower portion and locally is quartz bearing.

The largest tonnages and best grades of ore were located in “bay-like projections of the sediments into the gabbro” (Wright, 1932). The quartz veins are smoky grey and range from coarse to fine grained. The quartz carries disseminated grains and veinlets of pyrite, chalcopyrite and pyrrhotite. Gold occurs as very fine grained particles.

The Tene 6 vein occurs in the central part of the property within the gabbroic portion of the sill (Fig. 15). The deposit is lenticular, up to 7.6 m wide, 61 m long, and consists of dark quartz and considerable pyrite, pyrrhotite and chalcopyrite.

The Hope vein consists of narrow parallel veins and stringers of quartz within sheared diorite. Chalcopyrite, pyrite and free gold are present in the quartz.

History of Exploration and Development:

In 1915 a number of claims were staked over several quartz veins in the area. Diamond drilling and development work outlined two orebodies, the Kitchener vein and the Tene No. 6 vein. Later discoveries were made on the Eclipse, Branch No. 1 and Hope veins. In 1926 Central Manitoba Mines, Limited acquired all property in the area, except the western portion of the Tene No. 6 vein, which was controlled by Manitowan Exploration Company Limited. A 136 tonne cyanidation mill was built and the Central Manitoba Mine went into production in October 1927. The Kitchener, Eclipse and No.1 Branch veins were developed by 3 shafts to a maximum depth of 266 m. Production from these veins continued until July 1937. A review of the development work from surface to the deepest levels indicated a progressive decrease in the gold content.

The Tene 6 vein was in production from 1932 to 1934. According to Stockwell and Lord (1939) the shaft was sunk to a depth of 107 m with levels at 18, 43, and 76 m.

The Hope vein was developed by a 3-compartment 127 m deep vertical shaft. The property was inactive from 1935 to 1945. In 1946 the Kitchener, Growler and 48 other leased claims were assigned to New Manitoba Gold Mines Limited who carried out a 12-hole drill program.

From 1947 to 1977 the properties were held by various individuals and companies, but was not explored in any detail.

In 1977 J. Calverley staked the property and carried out trenching and sampling. Ownership was transferred to F. Calverley in 1979 and the claims converted to a production lease.

The ground around the lease is held by Barrick Resources Corporation under option from Mid-North Resources Limited. In the winter and spring of 1981 a geophysical survey was carried out and followed up by a summer-fall program of geological mapping and geochemistry. In 1982 a study was carried out to establish the feasibility of hauling and custom milling surface material from the Kitchener to the San Antonio Mine. In total 437 tonnes of material was hauled and custom milled. Data on gold recoveries are not available. Later in 1984 Angela Development Limited and Arbor Resources Inc. entered into an option agreement with Barrick Resources. During the period August to October 1984, a 10 hole drilling program was carried out.

In 1987 Mid-North Resources Ltd. who had gained control of a number of properties in the Rice Lake belt, signed a 5 year $5 million exploration agreement with Somicom management Inc. over the Central and Cryderman properties (Northern Miner, July 20, 1987). Airborne and ground geophysical surveys and diamond drilling were carried out in 1987 and 1988.

History of Production:

Year	Ore milled (Tonnes)	Grade g/tonne (oz/ton) gold	Gold produced kg (oz.)
1928	12 857	15.43 (0.45)	128 (4119)
1929	47 767	17.45 (0.51)	793 (25 482)
1931	41 492	15.97 (0.47)	630 (20 271)
1932	41 789	16.39 (0.48)	652 (20 951)
1933	44 863	14.64 (0.43)	625 (20 099)
1934	43 170	9.35 (0.27)	378 (12 146)
1935	38 830	10.07 (0.29)	363 (11 659)
1936	36 212	12.25 (0.36)	392 (12 596)
1937	27 773	11.05 (0.32)	301 (9670)
1938	13 048 tailings	1.54 (0.045)	16 (529)
mill clean up			9 (295)
Total	347 801		4287 (137 817)

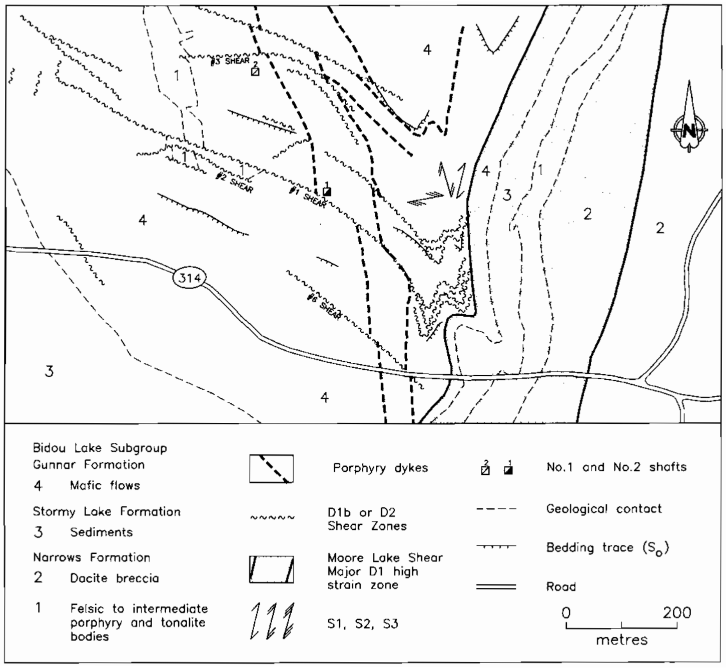
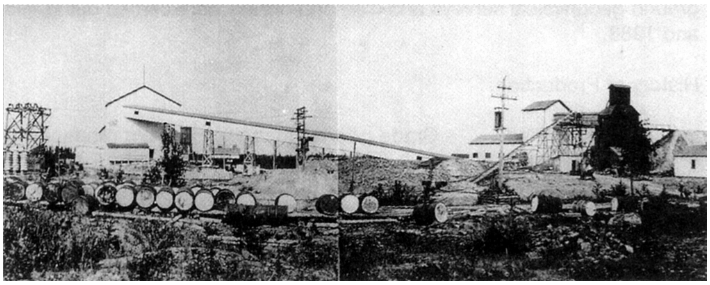


Figure 16: Geology of the Gunnar Mine area (after Stockwell and Lord, 1939; Brommecker, 1991)

Source: Central Manitoba Mines Limited, annual reports, 1928-1938 (Gold produced from muck hauled to Bissett in 1982 is included in the San Antonio Mine production statistics).

Selected Bibliography: Brommecker (1991); Canadian Mines Handbook (1962, p.152); Manitoba Mines Branch, Annual Reports on Mines and Minerals (1929-1937), Corporation File (Central Manitoba Mines Limited, New Manitoba Gold Mines Limited), Mineral Inventory File (52L/14 Au10-14); Mines Branch, Ottawa (1929), Investigations in Ore Dressing and Metallurgy (Report 720, p. 127-139, No. 339); Robinson (1935); Poulsen *et al.* (1996); Russell (1952); Stephenson (1971), Stockwell and Lord (1939); Theyer and Ferreira (1990); Wright (1932).



Central Manitoba Mine, circa 1930, 27 km southeast of Bissett, Manitoba

Gunnar

Location: 35 km southeast of Bissett.

Map Reference: Map ER86-1-1, location RL3.

Description of Deposits:

The following description of the geological setting of the Gunnar deposit is summarized from Brommecker (1991). The Gunnar mine is located near the axis of a major southeast-trending large anticline, the Beresford anticline. The deposit is within pillowed and massive mafic flows of the Gunnar Formation of the Bidou Lake Subgroup. The Gunnar Formation in the deposit area is intruded by felsic to intermediate porphyry dykes that are sub- parallel and strike NNW and dip ENE (Fig. 16). The mafic flows in the mine area generally strike SE and dip steeply to the SW. Thin beds of interflow sediments or pillow breccia mark the boundaries of flows and define the bedding S_0 (Fig. 16). The six shear zones (#1-#6; Fig 16) hosting gold-bearing veins generally strike parallel to flow contacts. Most of the ore came from two main ore shoots within the #1 Shear and separated by a gently dipping fault (Fig. 17). The upper ore shoot coincides with the intersection of the shear with a quartz -feldspar porphyry dyke. The lower ore shoot coincides with the intersection of the shear and a biotite lamprophyre (probably equivalent to hornblende-biotite dykes mapped by Brommecker (1991), and shown as mafic dyke in Figure 17).

The #1 Shear broadens and merges with the Moore Lake Shear (Fig. 16). Near its eastern end the #1 Shear is folded by F_2 and overprinted by S_2, indicating that the Gunnar #1 Shear is relatively old, *i.e.* a D_{1b} (or D_2) shear zone (with the Moore Lake Shear being a D_1 structure). (Younger D_3 kink folds with S_3 cleavages (Fig. 16) overprint the #1 Shear at its western and eastern end). Structural analyses further indicates that movement direction on the #1 Shear is perpendicular to the plunge of the ore shoots in it and that the ore shoots are located on a compressional fault bend (Sibson, 1989).

Three varieties of quartz occur in gold-bearing narrow quartz veins

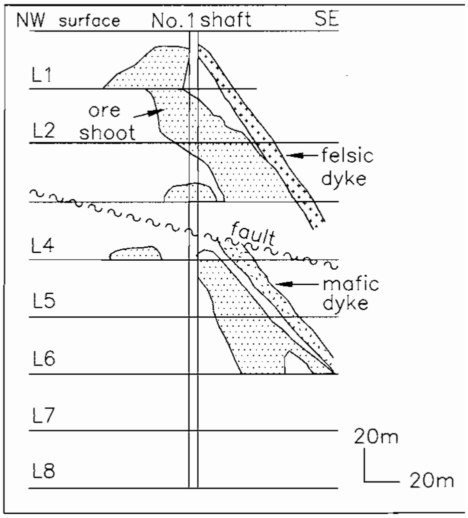


Figure 17: Longitudinal section of the Gunnar Mine (after Brommecker, 1991)

and lenses within the #1 Shear: 1) mottled or streaked grey sugary quartz; 2) transverse veinlets of glassy and cherty quartz; and 3) milky white quartz.

Mineralization consists predominantly of pyrite and chalcopyrite with minor sphalerite, galena and marcasite. The gold occurs as irregular grains and stringers associated with concentrations of finely granulated sulphides in grey cherty quartz (Stephenson, 1972). Dark brown to black varieties of sphalerite are apparently associated with high gold values.

History of Exploration and Development:

In 1921 a gold occurrence was discovered near the south end of Beresford Lake. Gunnar Gold Mines Limited was formed to explore the area and after considerable diamond drilling two shafts were sunk. In 1936 a 136 tonne/day cyanidation mill was built and production began. During the life of the mine drifting and over 22 000 m of diamond drilling was carried out to find new reserves. In 1942, however, reserves were depleted and mining operations stopped. The Gunnar Fraction and Laird claims remained inactive until 1956 when the leases lapsed.

F. Calverley staked the deposit several times from 1957 to 1984. The area was covered by a production lease from 1976 to 1983. Cen Can Ore Recovery Limited gained control of the lease in 1979 with the objective of processing Gunnar mine tailings. The only production figures recorded were for mid-1979 when 363 tonnes were processed to recover 62.2 g (2.0 oz.) of gold. Esso Resources Canada Limited carried out geological mapping, channel sampling and geophysical surveys in the area in 1980 and 1981. In 1984 Highmark Resources Limited and Homestead Resources Ltd. acquired control of the property and undertook a program of tailings sampling, geophysics, soil sampling and prospecting. The joint venture continued into the late 1980's.

History of Production:

Year	Tonnes Milled	Gold production kg	(oz.)
1936	46 024	513.1	(16 496)
1937	47 162	592.5	(19 049)
1938	44 480	588.3	(18 915)
1939	46 698	549.9	(17 681)
1940	45 211	521.1	(16 753)
1941	30 107	336.5	(10 819)
1979	363	0.1	(2)
Total	260 045	3101.5	(99 715)

Selected Bibliography: Broomecker, 1991); Campbell (1971); Canadian Mines Handbook (1936-1943); Davies *et al.* (1962); Manitoba Mines Branch, Annual Reports on Mines and Minerals (1935-41), Corporation Files (Esso Resources Canada Limited, Gunnar Gold Mines Limited, Highmark Resources Limited), Mineral Inventory File (52L/14 Au2); Poulsen *et al. (1996);* Russell (1952a); Shepherd (1939); Stephenson (1972); Stockwell and Lord (1939); Theyer and Ferreira (1990); Wright (1932).

Ogama-Rockland

Location: 26.6 km southeast of Bissett, 1.6 km north of the east end of Long Lake.

Map Reference: Map ER86-1-1, location RL4.

Description of Deposit:

The Ogama-Rockland mine is located within tonalitic rocks of the Ross River pluton. The shear zones hosting gold-bearing quartz veins strike NW (Fig. 18) and dip steeply to the NE. They comprise quartz diorite that is altered to quartz-sericite schist and contains lenticular gold-bearing quartz veins and veinlets of brown and pink ankerite.

The largest ore shoot was in the Ogama Shear. It plunged steeply to the NE, was up to 100 m long in horizontal direction and up to 200 m long down plunge (Fig. 18; Brommecker, 1991). According to Troop (1949) the " major ore shoots seem to be associated with warpings in the shear plane". Troop (1949) and Brommecker (1991) concur that the ore is in a dilational zone of a fault jog produced by dextral strike slip, Supporting data are (Fig. 18): 1) shallow NE plunging mineral lineations; 2) foliations in the shear zone oblique to the shear zone boundaries, indicating dextral movement; 3) dextral offset of a porphyry dyke by the Ogama shear (Fig. 18); and 4) the fact that the main oreshoot is coincident with a bend (of the shear zone) to the south.

The Ogama shear is at least 245 m long and 0.6 to 1.5 m wide. It contains lenses of blue and white quartz with pyrite, chalcopyrite, arsenopyrite, pyrrhotite and sphalerite. The best gold grades were found where both pyrite and arsenopyrite occur; visible gold is present locally.

The Rockland shear, branching off the Ogama shear (Fig. 18), is at least 120 m long and 1.8 to 6.0 m wide. It contains a quartz vein, 0.3 to 0.9 m wide, with pyrite, chalcopyrite, arsenopyrite, minor molybdenite and traces of visible gold.

History of Exploration and Development:

In 1915 W.A. Quesnel and W. Walton staked the Ogama and the Rockland claims. Only limited exploration work was done until Gunnar Gold Mines Limited optioned the property in 1941. Surface work outlined a gold deposit 25 m long on the Ogama vein. A 790 m drill program was carried out and in late 1941 a 2-compartment shaft was sunk. In 1942 Ogama-Rockland Gold Mines Limited was formed to bring the property into production. The mine operated from 1948 to 1951 and was developed by two shafts that reached vertical depths of 314 m and 83 m. The original Ogama and Rockland claims were cancelled in 1966.

In 1966 John Calverley restaked the property and assigned the claims to H.T. Leslie. One hole was drilled before the claims lapsed in 1969. In 1978 the ground was staked by W.B. Dunlop; linecutting and geophysics were carried out in 1979 and 1980. The claims were assigned to Mid-North Resources Limited in January 1981 and subsequently optioned by Camflo Mines Limited who carried out geophysical, mapping and geochemical surveys. In 1 982 68 tonnes of material was hauled to the San Antonio Mine to test the feasibility of custom milling; the grades proved too low to be economic.

In 1984 Angela Development Ltd. and Arbor Resources Inc. optioned the property and carried out a 3-hole drill program. The option was dropped in 1985. In 1988 Exador Resources Ltd. optioned the property

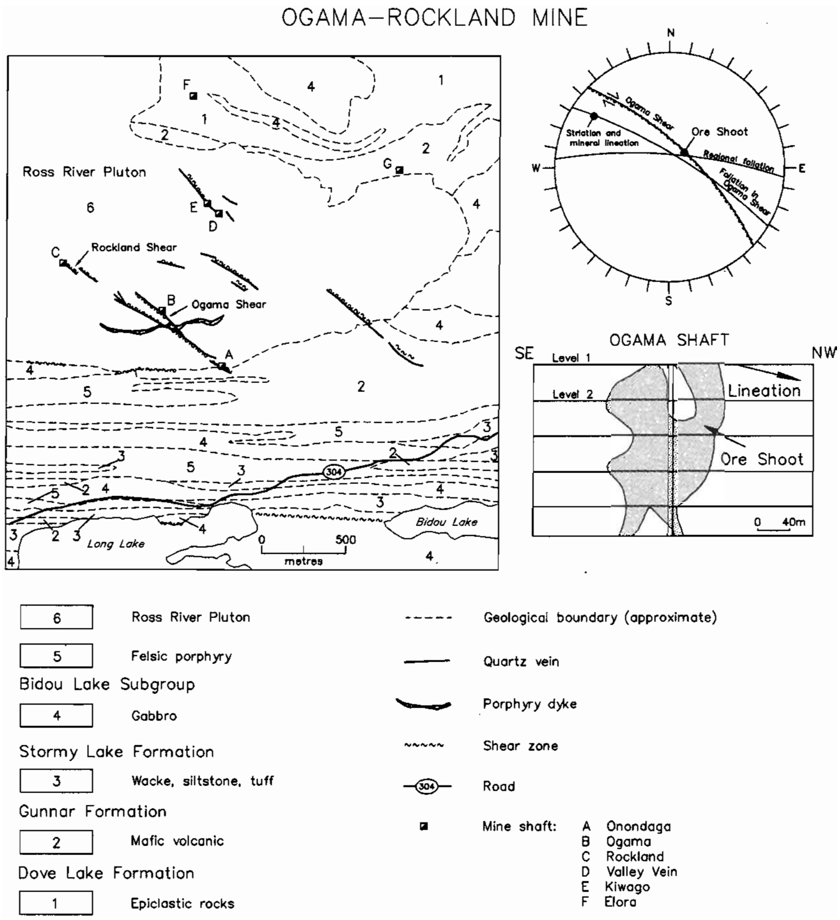


Figure 18: Geology in the vicinity of the Rockland, Ogama and Onondaga veins, Long Lake area (after Brommecker, 1991)

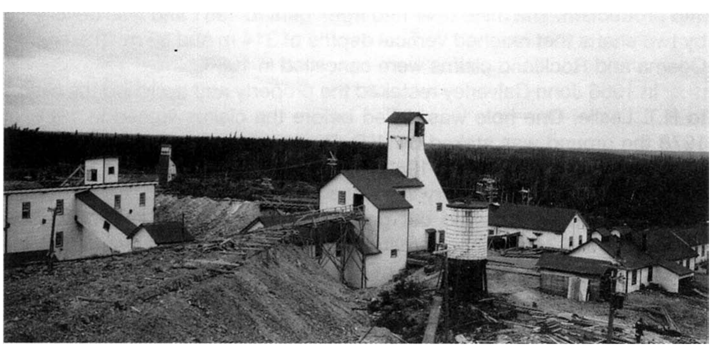
with the intention to undertake underground exploration (Canadian Mines Handbook 1988-89, p. 311). In 1992 Cameco Ltd. of Saskatoon carried out prospecting, mapping and geochemical surveys on the property but later dropped the option.

History of Production:

Tonnes milled	Grade g/tonne (oz/ton) gold
126 192	11.2 (0.33)

(Any gold produced from the surface material hauled to Bissett in 1982 is included in the San Antonio Mine production statistics)

Selected Bibliography: Brommecker (1991); Campbell (1971); Manitoba Mines Branch, Annual Report on Mines and Minerals (1941-53); Corporation File (Gunnar Gold Mines Limited, Ogama-Rockland Gold Mines Limited), Mineral Inventory File (52L/14 Au1), Mining Engineering Files (Ogama Rockland Gold Mines Limited); Russell (1952a); Stephenson (1972); Stockwell (1945a); Stockwell and Lord (1939); Theyer and Ferreira (1990); Troop (1949); Wright (1932)



Gunnar Gold Mines Ltd., 1936, 35 km southeast of Bissett, Manitoba

Jeep

Location: 13.5 km northeast of Bissett, 6.4 km west of Wallace Lake.

Map Reference: Map ER86-1-1, location RL5.

Description of Deposit:

The deposit is located within several shear zones that strike northwest, through an “L” shaped gabbro to leucogabbro intrusion within the Wanipigow plutonic complex.

The deposit is characterized by high grade gold-bearing quartz veins and stringers that occur in sheared hornblende diorite. The veins are less than 0.9 m in width, discontinuous and are composed of grey to bluish quartz with disseminations of pyrite, arsenopyrite and gold. The No.1 vein is exposed for 61 m on surface but pinches out at depth. There is no apparent association between the amount of sulphides in the quartz and the gold content.

History of Exploration and Development:

The property was first staked in 1934. In 1946 San Antonio Gold

Mines Limited formed Jeep Gold Mines Limited to develop the property. Diamond drilling and trenching discovered a high grade, low tonnage deposit. A 3-compartment shaft was sunk and the first gold was produced in 1947. During the life of the mine considerable exploration was carried out to increase ore reserves; however, no new reserves were discovered and the deposit was mined out in 1950.

In 1969 Transtide Industries Limited acquired the property. They carried out a geophysical survey and a 4-hole 546 m drill program in 1973. The holes were collared east of the mine shaft and intersected quartz stringers with disseminated sulphides; assay results are not known (Manitoba Energy and Mines, Mines Branch, Non-confidential assessment file 91561).

Augusta Gold Mines Limited acquired the property in 1981. From July 1981 to August 1982 prospecting and geophysical surveys were carried out.

History of Production:

Year	Tonnes milled	Grade g/tonne (oz/ton) gold	Gold produced kg (oz.)
1947	389	19.54 (0.57)	5.7 (182)
1948	7 425	32.57 (0.95)	236.6 (7 607)
1949	5 707	23.32 (0.68)	131.1 (4 216)
1950	2 798	20.06 (0.60)	56.2 (1 805)
Total	16 319		429.7 (13 811)

Source: The Jeep Gold Mine Limited, Annual Reports 1947-1950.

Selected Bibliography: Amukun (1969); Davies *et al.* (1962); Eakins (1949); Marr (1970); Manitoba Mines Branch, Mineral Inventory File (52M/3 Au1); McRitchie and Weber (1971); Russell (1948); Stephenson (1972); Theyer (1983, 1991 a).

Diana (Gem Lake)

Location: 51 km southeast of Bissett, 300 m northwest of the west end of Kickley Lake.

Map Reference: Map ER86-1-1, location RL6.

Description of Deposit:

The property is underlain by pillowed mafic flows and gabbro of the Gem Lake Subgroup. A series of shear zones within these rocks contain four gold-bearing vein systems. The shears are up to 1.5 m wide, strike 295° and dip 70-75°NE. The veins are composed of stockworks of calcite stringers, and quartz stringers and veins. Gold occurs predominantly in fractures in quartz and in chlorite streaks within the quartz. Minor amounts of pyrite, chalcopyrite, pyrrhotite and galena are also present in the veins.

The most productive vein system, the No. 2, was mined on the 38 m level and produced 8702 tonnes of high grade ore. A total of 4500 tonnes of lower grade ore was mined from the 76, 114 and 190 m levels.

History of Exploration and Development:

The area was first staked in 1926. In 1932 Gem Lake Mines Limited built a 45 tonne mill and sank a 3-compartment shaft to a depth of 229 m. Mining began in 1928 and continued until 1932 when Gem Lake Mines was liquidated. During this period 16.95 kg (545 oz.) of gold was produced. In 1933 Diana Gold Mines Limited was formed and acquired the property. From 1934 to 1936, 24 799 tonnes of ore were mined to produce 199.79 kg (6423.64 oz.) gold. In 1936 Diana Gold Mines Limited was liquidated and the property taken over by Consolidated Diana Gold Mines Limited. This company produced 15.83 kg (509 oz.) of gold over a one year period. A 4-hole drill program carried out to test the No. 2 vein at a depth of 305 m failed to add to the mine's ore reserves and mining was discontinued (Manitoba Mines Branch, Corporation File, Consolidated Diana Gold Mines Limited). The original claim group was cancelled in 1959.

Anderson Lake Mines Ltd. acquired the property in 1967 and planned to rework the old mill tailings; however, the project was never carried out.

In 1972 Rock Ore Exploration and Development entered into an agreement with Gigantes Exploration Company and Selco Mining Corporation. The joint venture drilled 3 holes in 1974 and carried out a geophysical survey in 1977. Canhorn Mining Corp. acquired the property in 1986 and in early 1987 optioned it to Mutual Resources, an affiliate of Teck Corp. Mutual could earn 50% of Canhorn's interest by spending $1 million over 3 years. Mutual also explored the surrounding areas such as Lily Lake where new gold showings had been recently found. Later in 1987, Ausgold Recovery Systems Ltd. undertook a limited Vat leach reclamation of gold from the old Diana mine tailings, whose reserves in 1976 were claimed to be 27 000 to 45 000 tonnes grading 4.25 g/tonne (0.12 oz/ton) gold.

History of Production:

Year	Gold produced kg (oz.)	Silver produced kg (oz.)
1928-1932	16.95 (545.)	1.24 (40)
1934-1936	199.79 (6423.64)	11.66 (375)
1937-1938	15.83 (509.)	(?)
1940-1941	3.02 (97.)	0.31 (10)
Total	235.59 (7574.64)	13.21 (425)

Selected Bibliography: Brownell (1931); Manitoba Mines Branch, Annual Reports on Mines and Minerals (1929-39), Mineral Inventory File (52L/11 Au1), Mining Engineering Files (Gem Lake Mines Limited, Consolidated Diana Gold Mines Limited); Russell (1952b), Theyer (1994b); Weber (1971 b); Wright (1932).

Lotus

Location: 33 km northwest of Bissett, 3 km north of the Wanipigow River.

Map Reference: Map ER86-1-1, location RL7.

Description of Deposit:

The property is underlain by 3 Ga tonalite of the English Lake magmatic complex (Weber, 1991; Turek and Weber, 1994), which forms part of the Wanipigow plutonic complex. A northeasterly trending shear zone in the gneisses contains a narrow gold-bearing quartz vein that apparently occurs on the nose of an eastward-plunging syncline (Russell, 1949). The shear zone appears to be an offshoot of the Wanipigow fault (Weber, 1991). Free gold is visible in many parts of the quartz vein. Pyrite, chalcopyrite and tetradymite are also present.

History of Exploration and Development:

The Ling (33051) and Lotus (33052) claims were staked in 1924 and were optioned in 1926 by individuals representing Bradley Mining Interests. In 1930 a 249 kg ore sample sent to the Ore Dressing and Metallurgical Division laboratories in Ottawa yielded 22.49 g/tonne (0.81 oz/ton) gold (Parsons, 1931a).

In 1935 Manitou Mines Limited carried out surface exploration work and "outlined ore grade material" over a length of 60 m (Manitoba Mines Branch, Corporation File, Extracts from Prospectus of Manitou Mines, Limited).

Limited exploration programs were undertaken on the property from 1939 to 1976 by F. Baker, O.J. Quesnel, and Strategic Minerals Prospecting Syndicate.

Esso Resources Canada Limited acquired the property in 1978. They carried out mapping and diamond drilling that outlined a deposit with reserves of 18 140 tonnes grading 10.29 g/tonne (0.30 oz/ton) gold (New Forty-Four Mines Limited, Annual Report, 1981). The deposit was brought into production in May 1982, primarily as a supplementary source of mill feed for the San Antonio Mine. Mining was discontinued in August 1982.

The claims were transferred to W.N. Baker in 1984.

History of Production:

Year	Tonnes milled	Grade g/tonne (oz/ton) gold
1982	8287	4.56 (0.13)

Source: Manitoba Energy and Mines, Mineral Policy, Annual survey of mining operations.

Selected Bibliography: DeLury (1927); Ermanovics (1970); Manitoba Mines Branch, Corporation File (Brinco Mining Limited, Esso Resources Canada Limited, Manitoba Mines Limited, New Forty-Four Mines Limited), Mineral Inventory File (62P/1 Au3), Mining Engineering File (Bradley Mining Interests), Non-confidential Assessment File (File No. 91222, 91224); Theyer and Yamada (1989); Weber (1971a; 1991); Russell (1949).

Poundmaker (Selkirk, Luleo)

Location: 8.5 km northwest of Bissett.

Map Reference: Map ER86-1-1, location RL8.

Description of Deposit:

The area is underlain by quartz diorite and fine grained mafic dykes of the Wanipigow plutonic complex (Weber, 1971a) . Several shear zones, many of which occur in the mafic dykes, contain veins up to 6.1 m wide that consist of white quartz banded with chlorite and granulated pyrite. Traces of visible gold occur associated with pyrite or in fractures in the quartz. Minor fuchsite and coarse ankerite are of widespread occurrence in the veins. The wall rocks consist of carbonatized and pyritized chlorite schist and locally display well developed slickensides that plunge 025° to the northwest (Stephenson, 1972).

History of Exploration and Development:

The Poundmaker was first staked in 1915 and was optioned by The Bellevue Mining Company Limited in 1917. A stamp mill was erected and a 2-compartment shaft sunk to a depth of 26 m.

From 1921 to 1924 Selkirk Gold Mining Company Incorporated rehabilitated and extended underground workings, and produced 12.4 kg (400 oz.) of gold. Davies (1949) reported gold values of up to 17.11 g/tonne (0.50 oz/ton) on ore milled prior to 1925. Ore from the 99 m and 160 m levels averaged 3.43 g/tonne (0.10 oz/ton), and 14.49 g/tonne (0.42 oz/ton) gold, respectively.

In 1927 Selkirk (Canadian) Mines, Limited acquired the assets of Selkirk Gold Mining Company Incorporated. The mine was dewatered in 1928 and an 8-hole underground drill program was carried out. The company also carried out surface drilling in the Beaver Lake area and reportedly intersected sections of copper and zinc that assayed from $5.95 to $60.96 per tonne (Manitoba Mines Branch, Corporation File, Selkirk Canadian Mines, Limited).

In 1947 Jacobus Mining Corporation Limited carried out a drill program to test a shear zone below the 160 m level. Drill results are summarized as follows:

Hole No.	Width (metres)	Assay g/tonne (oz/ton) gold
1	2.03	5.49 (0.16)
	0.20	21.94 (0.64)
	0.82	4.11 (0.12)
	0.27	18.52 (0.54)
2	0.61	5.98 (0.18)
	0.61	4.11 (0.12)
(narrow stringers)		13.03 (0.38)

The claims were cancelled on December 12, 1942. The deposit was staked by a number of prospectors and companies from 1942 to 1977; however, only surface trenching and sampling were carried out.

John Calverley staked the property in 1977. In 1980, 15.8 tonnes of muck from a surface stockpile was shipped to Hudson Bay Mining and Smelting Ltd. (HBM&S) in Flin Flon. It yielded 0.9 kg (29.07 oz.) of gold. A further 2093 tonnes averaging 3.22 g/tonne (0.09 oz/ton) was milled in Bissett when Brinco re-opened the San Antonio Mine in 1982.

History of Production:

Year	Gold produced kg	(oz.)
1923	5.7	(183.8)
1924	6.7	(216.0)
1980	0.9	(29.0)
1982	3.8	(122.4)
1983	2.9	(93.9)
Total	20.1	(645.1)

Selected Bibliography: Amukun (1969); Cole (1927); Davies (1949, 1953, 1963); Davies *et al*. (1962); DeLury (1920, 1927); Ermanovics (1970); Manitoba Mines Branch, Mineral Inventory File (52M/4 Au4); Marr (1970); McRitchie and Weber (1971); Robinson (1935); Stephenson (1972); Theyer (1994a); Wright (1923, 1940)

Cryderman (Little Pal)

Location: 21.2 km southeast of Bissett, 0.4 km east of Shesheep Lake.

Map Reference: Map, ER86-1-1, location RL9.

Description of Deposit:

The property is underlain by Gunnar Formation (Bidou Lake Subgroup) feldspar-phyric, massive and pillowed mafic volcanic rocks, rhyolite, chert, that are intruded by gabbro and feldspar porphyry dykes. These rocks are transected by a bifurcating shear zone (up to 9 m wide and up to 400 m long exposed) that is oriented 305°/58-78° and is approximately axial planar to a regional anticline (Theyer and Ferreira, 1990). The shear zone contains quartz±carbonate veining and white to grey discordant quartz lenses. Quartz lenses are generally 1-2 m thick, and generally not more than 5 m long. Mineralization consists of disseminated pyrite, pyrrhotite and trace chalcopyrite. Wright (1932) reported “coarse particles of free gold” along cracks in some of the wider quartz lenses. Stephenson (1971) noted traces of visible gold and Au-tellurides.

History of Exploration and Development:

In 1925 J.R. Cryderman staked the property. In 1926-27 The Mining Corporation of Canada, Limited sank a 79 m shaft and carried out diamond drilling to the west of the shaft.

In 1928 Cryderman Mines, Limited was organized to continue development of the property. Two parallel shear zones were exposed by trenching and stripping. In March 1932 the shaft was dewatered to the first level and a 36-tonne mill and steam hoist erected. Total gold production in 1932 was approximately 11.6 kg (373 oz.) (Manitoba Mines Branch, Corporation File, Cryderman Mines, Limited).

In 1936 Cryderman Gold Mines Limited carried out drilling to test a structure along the Main vein.

In 1958 surface sampling on the "Main vein" indicated a deposit with a length of 80 m grading 19.2 g/tonne (0.56 oz/ton) gold over an average width of 1.0 m. The only other surface sampling carried out was on the Discovery vein; a branch of the Main vein. Assays returned 17.9 g/tonne (0.52 oz/ton) gold over a width of 0.64 m and length of 67 m.

From 1963 to 1981 various companies staked the property; however, limited exploration work was done until Noranda Exploration Company Limited carried out geophysical surveys in 1982. Ownership of the property was then transferred to Mid-North Resources Limited and subsequently to Donald William, John Specht and Evan A. Koblanski. In 1983 Augusta Resources optioned the property and contracted J.W. Campbell to undertake a reconnaissance prospecting program on the claim. In May 1985 the property was transferred back to Mid-North Resources. In 1987 Somicom Management Inc. signed a 5 year, $5 million exploration agreement with Mid-North Resources Ltd. for the Cryderman and Central Manitoba properties that included airborne and ground geophysical surveys and diamond drilling (Northern Miner, July 20, 1987).

History of Production:

1931 to 1932 - $7711.82 worth of gold, or approximately 11.60 kg (373.09 oz.) gold (Manitoba Mines Branch, Annual Report 1932-33).

Selected Bibliography: Canadian Mines Handbook (1935, p. 72); Manitoba Mines Branch, Annual Report on Mines and Minerals (1932-33), Corporation File (Cryderman Gold Mines Limited, Cryderman Mines Limited), Mineral Inventory File (52L/14 Au4); Stephenson (1972); Theyer and Ferreira (1990).

Solo-Oro Grande

Location: 34 km southeast of Bissett, 6.4 km east of the former town of Wadhope, 0.4 km west of Beresford Lake.

Map Reference: Map ER86-1-1, location RL10.

Solo-Oro Grande Mine, circa 1933, 34 km southeast of Bissett, Manitoba

Description of Deposit:

The Solo-Oro Grande mine produced gold from a vein in a shear zone near the leucocratic top of a NNW-striking, E-dipping gabbro sill that intruded mafic volcanic rocks of the Gunnar Formation (Bidou Lake Subgroup)(Stockwell and Lord, 1939). The Oro Grande shear zone strikes north and dips moderately to the east. Gold was mined from a ore shoot that plunged at *circa* 30° to the south. The shoot was up to 80 m long in horizontal direction and 120 m down plunge (Brommecker, 1991). Portions 40 metres and deeper of the Oro Grande ore shoot were explored from the Solo shaft 100 m east of the Oro Grande shear zone (Stockwell and Lord, 1939). Brommecker (1991) concluded from structural analysis, that the ore shoot is at a high angle to the interpreted slip direction along the shear and occupies the dilational zone of a sub-horizontal fault bend, as do many deposits in the Beresford Lake-Long Lake area.

Gold-bearing quartz lenses and stringers are distributed across a part or the full width of the shear, for a strike length of 76 m. The lenses are up to 0.6 m wide, 7 m in length and contain grey quartz, minor carbonate, scattered flakes of chlorite, and disseminated pyrite, chalcopyrite, sphalerite, pyrrhotite and locally visible gold. The grey quartz is cut at right angles by short gash veinlets of milky white quartz carrying patches of fine grained chlorite, flakes of biotite, and a few blebs of pyrite. The wall rocks are carbonatized chlorite schist and contain disseminated pyrite.

History of Exploration and Development:

The property was first staked in 1919. From 1923 to 1937 several companies worked in the area: Anglo-Canadian Explorers, Limited; Solo Mining Company, Limited; Oro-Grande Mines Limited; The Oro Grande Development Company Limited; and Beresford Lake Mines Limited.

The property was developed by two shafts: 1) the No.1 shaft, 161 m deep with levels at 38, 76, 114, and 153 m; and 2) the No. 2 shaft, 78 m deep with levels at 38 and 69 m.

Two ore zones were mined from the 69 m level of the No.1 shaft. The first averaged 23.97 g/tonne (0. 70 oz/ton) gold over a width of 1.30 m and a strike length of 49.41 m. The second zone averaged 17.49 g/tonne (0.51 oz/ton) gold over a width of 1.1 m and a strike length of 34 m.

In June 1984 Highmark Resources Ltd. and Homestead Resources Inc. agreed to a 50-50 joint venture to explore four contiguous claims covering the Solo-Oro Grande Mine and Gunnar Mine. They carried out sampling of tailings sites, geophysical surveys and soil sampling. In 1985 reserves between the 150 m level and surface were estimated at 29 000 tonnes averaging 10.29 g/tonne(0.03 oz/ton) gold (Tuba and Ostry, 1994).

History of Production:

	Gold produced	
Year	kg	(oz.)
1932	1.5	(49)
1933	1.7	(54)
1938	62.4	(2006)
1939	74.5	(2395)
1940	19.3	(619)
Total	159.4	(5123)

Source: Manitoba Mines Branch, Annual Reports (1932-33, 1938-40).

Selected Bibliography: Brommecker (1991); DeLury (1927); Financial Post Survey of Mines (1928-29); Manitoba Mines Branch, Annual Report on Mines and Minerals (1929, 1932-33, 1938-40), Corporation File (Beresford Lake Mines Limited, Oro-Grande Mines Limited, The Oro Grande Development Company Limited), Mining Engineering File (Beresford Lake Mines Limited, Oro Grande Development Company Limited), Mineral Inventory Files (52L/14 Au7); Russell (1952a); Stephenson (1972); Stockwell and Lord (1939); Wright (1938)

Gold Pan and Gold Seal

Location: 7.5 km southeast of Bissett, 1.8 km south of Gold Lake.

Map Reference: Map ER86-1-1, location RL11.

Description of Deposit:

The area is underlain by Bidou Lake Subgroup porphyritic dacite breccia that is intruded by northeast-striking diabase dykes and crosscut by northwest-striking shear zones. The deposit has a "pipe-like" shape and occurs where a shear zone intersects the southeast contact of a diabase dyke (Stephenson, 1972). It contains numerous lenticular quartz veins with pyrite, chalcopyrite, sphalerite, galena and free gold.

History of Exploration and Development:

The Gold Pan and Gold Seal claims were staked over the deposit in 1914 by Angus McDonald and John Wood, respectively. Shafts were sunk on the claims and a mill built. In 1917 the claims were assigned to Gold Pan Mines, Limited who produced 6.6 kg (214 oz.) of gold from 1919 to 1921.

The Lake Superior Metals Company Limited reopened the mine from 1923 to 1924 and produced a total of 840 g (27 oz.) of gold.

The claims were assigned to Pan Preference Mines, Limited in 1945 and the next year an option was given to Gold Pan Mines (1945) Limited who carried out underground sampling, mapping and drilling (36 holes, 3058 m). The property was assigned to S.J. Drache in 1947. The Gold Seal and Gold Pan claims were cancelled in 1962 and 1971, respectively.

The property was restaked on several occasions from 1962 to 1968; however, there is no record of exploration work being carried out. In 1977 J.A. Syme restaked the property and negotiated a joint venture with Corporate Oil and Gas Ltd., Seaforth Mines Ltd., Onaping Mines Ltd. and Musto Explorations Ltd. A 3-hole drilling program was undertaken in August 1980. In 1982 ownership of the claim was transferred to Augusta Gold Mines Limited.

History of Production:

Year	Gold produced kg (oz.)
1919	3.51 (113)
1921	3.14 (101)
1923	0.72 (23)
1924	0.12(4)
Total	7.49 (241)

Source: Manitoba Mines Branch, Annual Report (1928)

Selected Bibliography: Cooke (1921); Davies (1953, 1963); Davies (1963); DeLury (1921, 1927); Dresser (1917); Manitoba Mines Branch, Annual Report on Mines and Minerals (1928), Corporation File (Gold Pan Mines Limited, Pan Preference Mines Limited, Gold Pan Mines 1945 Limited), Mineral Inventory File (52U13 Au4); Theyer (1994a).

Elora (Mill Vein)

Location: 26 km southeast of Bissett, 2.4 km southeast of the south end of Halfway Lake.

Map Reference: Map ER86-1-1, location RL12

Description of Deposit:

Gold-bearing quartz lenses occur within a narrow northeast-striking shear zone that crosscuts greywacke of the Dove Lake Formation (Bidou Lake Subgroup) (Fig. 18) and a felsic porphyry dyke. The quartz lenses are up to 0.31 m wide and contain "pockets" of arsenopyrite, free gold, and minor chalcopyrite and pyrite (Wright, 1938).

History of Exploration and Development:

The property was first staked in 1915. The Kingfisher Mining and Development Company, Limited installed a 2-stamp amalgamation mill on the property and during 1922 produced 3.1 kg (100 oz.) gold.

Kingfisher Gold Mines Limited acquired the property in 1928 and carried out a diamond drill program. Very limited exploration was carried out after this and the claims lapsed in 1973.

The ground was not open for staking from 1973 to 1978. In 1978 W.B. Dunlop staked the property. The claim was transferred to Camflo Mines Ltd. in 1981 and they carried out geophysical and geochemical surveys and mapping. In 1984 the property was acquired by Angela Development Ltd. and Arbor Resources Inc. From August to October 1984 a 10-hole drill program was carried out. Ownership was transferred to Mid-North Resources Limited in November 1985.

History of Production:

Year	Tonnes mined	Tonnes milled	Gold produced kg (oz.)
1922	181	113	3.1 (100)

Source: Manitoba Mines Branch, Annual Report (1928).

Selected Bibliography: Campbell (1971); Manitoba Mines Branch, Annual Report on Mines and Minerals (1928), Corporation File (Kingfisher Gold Mines Limited), Mineral Inventory File (52L/14 Au6); Russell (1952a); Stephenson (1972); Stockwell (1945); Stockwell and Lord (1939); Theyer and Ferreira (1990); Wright (1932).

Onondaga

Location: 26.5 km southeast Bissett, 1.2 km north of the east end of Long Lake.

Map Reference: Map ER86-1-1, location RL13.

Description of Deposit:

Gold-bearing quartz lenses occur in the southeast extension of the Ogama shear, 460 m southeast of the Ogama-Rockland Mine (Fig. 18). The shear is 1.8 m wide, strikes 305°, dips 80° NE and crosscuts pillowed basalt of the Gunnar Formation (Bidou Lake Subgroup) and felsic porphyry dykes. The lenses of quartz average less than 0.15 m wide and are sparsely mineralized with pyrite, chalcopyrite and locally free gold. Ankerite and calcite occur as rims around the quartz lenses and as stringers that cut the quartz. The chlorite schist wall rock contains disseminated pyrite.

History of Exploration and Development:

The property was first staked in 1915. In 1924 a shaft was sunk to a depth of 31 m; samples taken from the east and west ribs of the shaft yielded from 1.03 g/tonne (0.03 oz/ton) to 89.14 g/tonne (2.60 oz/ton) gold over widths of up to 1.52 m.

In 1933 the property was assigned to Onondaga Gold Mining Company, Limited who formed Wilson Gold Mines Limited to develop the property. From October 1933 to May 1934, 726 tonnes of ore were milled.

In 1949 Ogama-Rockland Gold Mines Limited acquired the property. The shaft was dewatered, the east and west ribs of the shaft were channel sampled at 3.1 m vertical intervals and drift backs were sampled every 0.9 m. Results of this sampling and a 5-hole drill program carried out in 1950 did not encourage the company to carry out further exploration and the claims were allowed to lapse in 1966.

The property was staked by a number of prospectors and companies from 1969 to 1976; however, limited exploration work was carried out.

The ground was staked in November 1978 by W. B. Dunlop. Linecutting and geophysical surveys were undertaken in 1979 and 1980. In 1981 the claims were optioned by Camflo Mines Limited who carried out mapping, and geophysical and geochemical surveys. In 1984 Arbor Resources Inc. and Angela Development Limited optioned the property and carried out a drill program.

History of Production:

Year	Tonnes milled	Gold produced
1933-34	726	?

Source: Manitoba Mines Branch, Annual Report (1933-34)

Selected Bibliography: Campbell (1971); Manitoba Mines Branch, Mineral Inventory File (52L/14 Au15); Russell (1952a); Stephenson (1972); Stockwell (1945a); Theyer and Ferreira (1990).

Grand Central (Lakeshore)

Location: 20.5 km northwest of Bissett, on the north shore of Wanipigow Lake.

Map Reference: Map ER86-1-1, location RL14.

Description of Deposit:

Gold-bearing quartz veins occur in sheared quartz diorite of the Wanipigow River Plutonic Complex.

History of Exploration and Development:

The Lakeshore M.C. (44784) was staked by E. Bonus in 1928. Some surface work was done before the property was assigned to The Grand Central Gold Mines Limited in 1929.

In 1932 the Walsh brothers optioned the claim and sank a 2-compartment shaft to a depth of 33 m. A 5-head stamp mill operated in 1933 and produced 0.9 kg (30 oz.) of gold.

In 1982 H.R.N.D. Mining and Milling Co. Ltd. staked the property.

History of Production:

		Gold produced	
Year	Tonnes milled	kg	(oz.)
1933	272	0.93	(30)

Source: Manitoba Mines Branch, Sixth Annual Report, 1934.

Selected Bibliography: Davies (1949); DeLury (1920); Manitoba Mines Branch, Corporation File (The Grand Central Mines Limited), Mineral Inventory File (52M/4 Au4); McRitchie and Weber (1971), Parsons (1930); Theyer and Yamada (1989).

DEPOSITS

Packsack

Location: 4 km southwest of Bissett.

Map Reference: Map ER86-1-1, location RL15.

Description of Deposit:

Lenticular *en echelon* quartz stringers and veins up to 15 m wide occur in shear zones within porphyritic dacite of the Bidou Lake Subgroup. Five of the veins are gold-bearing and consist of milky white to black quartz

Packsack Mine, circa 1935, 4 km southwest of Bissett, Manitoba, (from left to right: engine house, shift house, shaft)

with pyrite, minor chalcopyrite, and locally visible gold. The gold is erratically distributed and generally occurs in fractures in quartz or associated with pyrite disseminations.

History of Exploration and Development:

The property was first staked in 1917. In 1928 Montcalm-Tine Mines Ltd. was formed to develop the property. The quartz veins were extensively sampled and assay results indicated several zones grading in excess of 31 g/tonne (0.9 oz/ton) gold over short strike lengths. The property was acquired by Consolidated Goldfields of Manitoba in 1933 and subsequently sold to Packsack Mines Limited in 1935. Packsack Mines drilled the “Big Dome” vein and sank a 2-compartment shaft. They estimated probable ore reserves to total 21 800 tonnes averaging 12.36 g/tonne (0.36 oz/ton) gold (Packsack Mines Limited, Annual Report, 1931).

In 1940 God’s Lake Gold Mines Limited carried out drilling and underground development but failed to prove or extend the ore tonnages estimated by Packsack Mines.

The property was held by numerous individuals and companies from 1940 to 1984, including R.J. Jowsey Mining Company Limited, Open End Mines Limited, F. Rylander and Augusta Gold Mines Ltd. In 1979 reserves were estimated at 272 155 tonnes of 10.3 g/tonne (0.3 oz/ton) gold (Tuba and Ostry, 1994). Reco Gold Mining Co. Ltd. negotiated an operating agreement on the property in 1984, and in the summers of 1984 and 1985 worked a small open-cut and erected a small mill. The property was idle in 1986.

Selected Bibliography: Davies (1953); Manitoba Mines Branch, Annual Report on Mines and Minerals (1935-38, 1941), Corporation File (Montcalm-Tine Mines Limited, Consolidated Goldfields of Manitoba Limited, Packsack Mines Limited), Mineral Inventory File (52L/13 Au3), Unpublished Information File (52L/13NE); McRitchie and Weber (1971); Stephenson (1972); Stockwell (1945a); Theyer (1983, 1984a, 1994a).

Wolf Prospect

Location: 3.3 km south of Bissett, 0.8 km east of Red Rice Lake.

Map Reference: Map ER86-1-1, location RL16.

Description of Deposit:

The property is underlain by porphyritic andesite and dacite breccia, trachyte breccia, rhyolite and a small lens of conglomerate, interpreted to be pat of the Bidou Lake Subgroup. These rocks are intruded by diabase and quartz-feldspar porphyry dykes and crosscut by several steeply dipping northwest- and east-striking shear zones. Gold-bearing quartz veins occur in both sets of shear zones, particularly where they crosscut competent rocks. The veins are lenticular in shape, ranging in width from narrow stringers to 6.1 m, and consist of white to buff quartz with disseminated pyrite and locally visible gold.

History of Exploration and Development:

The property was first staked in 1917. After several interim assignments of ownership Wolverine Gold Mines, Limited obtained the property in 1920. Assays from shallow exploration pits ranged from 11.7 g/tonne (0.34 oz/ton) to 35.3 g/tonne (0.97 oz/ton) gold.

In 1949 Portage Avenue Gold Mines Limited acquired the property and in the following ten years drilled 47 holes; no significant mineralization was intersected. In 1981 Dearin Geological Consulting Ltd. was contracted to carry out mapping, prospecting and drilling. The exploration program indicated five small deposits (New Forty-Four Mines Limited, Annual Report, 1981). Following are the drill indicated reserve estimates:

Vein	Category	Tonnes	Grade g/tonne (oz/ton) gold
Fox	Possible	14 035	6.86 (0.20)
West Fox	Possible	5 990	16.80 (0.49)
Prime	Possible	3 021	25.71 (0.75)

Selected Bibliography: Cooke (1921); Davies (1953); Davies *et al. (1962);* DeLury (1921, 1927); Dresser (1917); Manitoba Mines Branch, Annual Reports on Mines and Minerals (1950-52), Corporation File (Portage Avenue Gold Mines Limited, Wolverine Gold Mines Limited), Mineral Inventory File (52L/13 Au5); Stephenson (1972); Theyer (1984a, 1994a); Wright (1923).

Ranger

Location: 4.5 km southeast of Bissett.

Map Reference: Map ER86-1-1, location RL17.

Description of Deposit:

Gold-bearing quartz veins and lenses occur in steeply dipping northwest-striking shears that crosscut rhyolite, and porphyritic andesite of the Bidou Lake Subgroup. The stringers and veins range in width from 2 cm to 0.46 m, locally forming lenses up to 4.6 m wide. They contain irregular patches of chlorite, carbonate, disseminated pyrite and rare visible gold.

History of Exploration and Development:

The property was first staked in 1912. After a series of interim assignments Manitoba Mining and Exploration Company, Limited acquired the claim in 1916. Shaft sinking and some trenching was done in 1914. In 1934 Ranger Gold Mines Limited carried out drilling that apparently intersected a “spectacular showing of free gold”; however, “it could not be traced” (Manitoba Mines Branch, Corporation Files, Ranger Gold Mines Limited NPL). To the southeast of the shaft Stockwell (1938) reported that mineralization averaged 13.72 g/tonne (0.4 oz/ton) gold over a width of 1.07 m and a strike length of 27.5 m.

Portage Avenue Gold Mines Ltd. acquired the property in 1949. They estimated the possible reserves of the Ranger deposit to total 1787 tonnes averaging 13.7 g/tonne (0.40 oz/ton) gold (New Forty-Four Mines Limited, Annual Report, 1981).

Selected Bibliography: Canadian Mines Handbook (1935-37, 1946); Cooke (1921); Davies *et al.* (1962); DeLury (1921, 1927); Manitoba Mines Branch, Annual Report on Mines and Minerals (1933), Corporation File (Ranger Gold Mines Limited), Mineral Inventory Files (52U13 Au6); Stephenson (1972); Stockwell (1938); Theyer (1983, 1994a), Wright (1923).

Wingold

Location: Bissett.

Map Reference: Map 86-1-1, location RL18.

Description of Deposit:

The property is underlain by dacite to rhyodacite tuffs of the Townsite volcanic rocks (Bidou Lake Subgroup) (Fig. 11) that are crosscut by several northeast- to east-striking shear zones. The shears host eight gold-bearing veins that consist of two phases of quartz: 1) an early high temperature phase containing tourmaline; and 2) a later phase containing carbonate (Stephenson, 1972). Also associated with the quartz are chlorite, pyrite and locally visible gold.

History of Exploration and Development:

The property is located northeast of the San Antonio Mine. The first claims were staked over the property in 1912. Between 1913 and 1915 five shallow shafts were sunk on the property.

Wingold Mines Limited acquired the property in 1931. Exploration outlined a deposit with reserves of 6535 tonnes grading 13.95 g/tonne (0.407 oz/ton) gold, plus 6349 tonnes in a surface dump grading 7.20 g/tonne (0.21 oz/ton) (Shepherd, 1935). In 1936 a 24-hole 2532 m diamond drill program was carried out.

In 1975 Explored Area Leases 32 and 33 were issued to Greenwood Bolin Dixon to cover the Wingold property. New Forty-Four Mines acquired the property in 1981.

Selected Bibliography: Amukun (1969); Davies (1950, 1963); Davies (1963); Davies *et al*. (1962); DeLury (1920, 1927); Ermanovics (1970); Manitoba Mines Branch, Annual Reports on Mines and Minerals (1934-36, 1938-41, 1944), Corporation File (Forty-Four Mines Ltd., Independence Mining and Development, Wingold Mines Limited), Mineral Inventory File (52M/4 Au15); Shepherd (1935); Stephenson (1972); Stockwell (1938); Theyer (1994a); Wright (1923).

Eva

Location: 6.5 km west of Bissett.

Map Reference: Map 86-1-2, location RL19.

Description of Deposit:

The deposit consists of a gold-bearing quartz vein that occurs in a shear zone within a large quartz diorite pluton similar to the synvolcanic Ross River pluton southeast of Bissett. The vein averages 0.9 m wide, has been traced for 244 m on surface and is composed of a greyish-black ribbon-textured quartz with disseminated pyrite, chalcopyrite, sphalerite, magnetite and visible gold. Minor amounts of ankerite, chlorite, sericite and tourmaline are also present.

History of Exploration and Development:

The property was first staked in 1919. The Great West Gold Mining Company, Limited acquired the property in 1921 and sank a shaft to a depth of 18 m.

Various prospectors including Murray, Perry, Harper, Boulette and Henrickson staked the property from 1945 to 1981. Surface exploration continued during this period; however, no further shaft sinking or diamond drilling was reported.

New Forty-Four Mines Limited estimated the Eva deposit to contain mineable reserves of 15 964 tonnes grading 6.17 g/tonne (0.18 oz/ton) gold (New Forty-Four Mines Limited, Annual Report, 1981).

Selected Bibliography: Davies (1949); DeLury (1920); Manitoba Mines Branch, Corporation File (Great West Gold Mining Company, Limited), Mineral Inventory File (52M/4 Au8); Stephenson (1972). Stockwell (1945a); Theyer (1994a).

Sannorm

Location: 4 km east of Bissett

Map Reference: Map E86-1-1, Location 22

Description of Deposit:

Gold-bearing quartz veins occur in the "Normandy Creek shear" (Map ER86-1-1) within a mafic sill that may be the eastern extension of the SAM unit at the San Antonio mine. Drilling in 1944 and 1970's and 1989's outlined narrow low grade mineralized zones along a strike length of over 1220 m. The "A zone" is about 700 m long with an average width of 5 m and a grade of 1.4 g/tonne (0.04 oz/ton) gold. The "C zone" to the east, intersected in 2 holes, was traced for over 200 m along strike. The "B zone" was encountered in deeper drilling in 1944 below the "A zone". Within the "A zone" there is a higher grade "core" grading 4.2 g/tonne (0.122 oz/ton) gold that is about 100 m long and 7 m wide (Bakra Resources Ltd. Release March 13, 1989, and Northern Miner, July 17, 1989)

History of Exploration and Development:

The Hunter Group of claims were staked in 1934 and assigned to Normandy Mines Ltd. who opened up two deposits. In 1944 Sannorm Mines acquired the property and conducted magnetic surveys and diamond drilling. The Sangold Mines Ltd. property to the north was purchased in 1947 and a 2 level shaft at 38 m (125 ft) intervals was sunk, but further work was suspended in 1948.

Consolidated Sannorm Ltd. assumed the property in 1952. Geophysical surveys were conducted between 1961 and 1971 and drilling in 1974 and 1978.

Dragon Energy Corporation and Orenda Resources Ltd. conducted a 50-50 program in 1986 and were approached by Inco regarding a joint venture (Northern Miner, Feb. 10, 1986).

The Homestead group of companies, including Orenda and Bakra Resources Ltd. gained control of the property in 1989 and conducted a 14 hole drilling program. From 12 drillholes (1310 m) that intersected the "A zone", Bakra outlined a single tabular body of gold mineralization over 90 m long with an average width of 4.5 m (thickening to 7 m in the central portion) and a geological reserve, to about 150 m depth, of 177 457 t (195 653 tons) grading 4.2 g/tonne (0.122 oz/ton) gold (Bakra Resources Ltd., Release March 13, 1989).

Selected Biography: Theyer (1994a)

Mirage

Location: 3 km east of Long Lake

Map reference: Map 86-1-1, Location 23

Description of Deposit

The deposit (Fig. 19) is hosted by the leucocratic upper portion of a 500 m differentiated gabbro sill that extends from Long Lake towards Stormy Lake (Weber, 1971b). Gold occurs in quartz- ankerite veins in and around a complex network of shear zones. Brommecker (1991) identifies two types of gold-bearing veins in the deposit area (Fig. 20): 1) steeply dipping veins in shear zones and 2) shallowly dipping "flat" veins resembling the ladder veins of the stockwork veining in the San Antonio deposit.

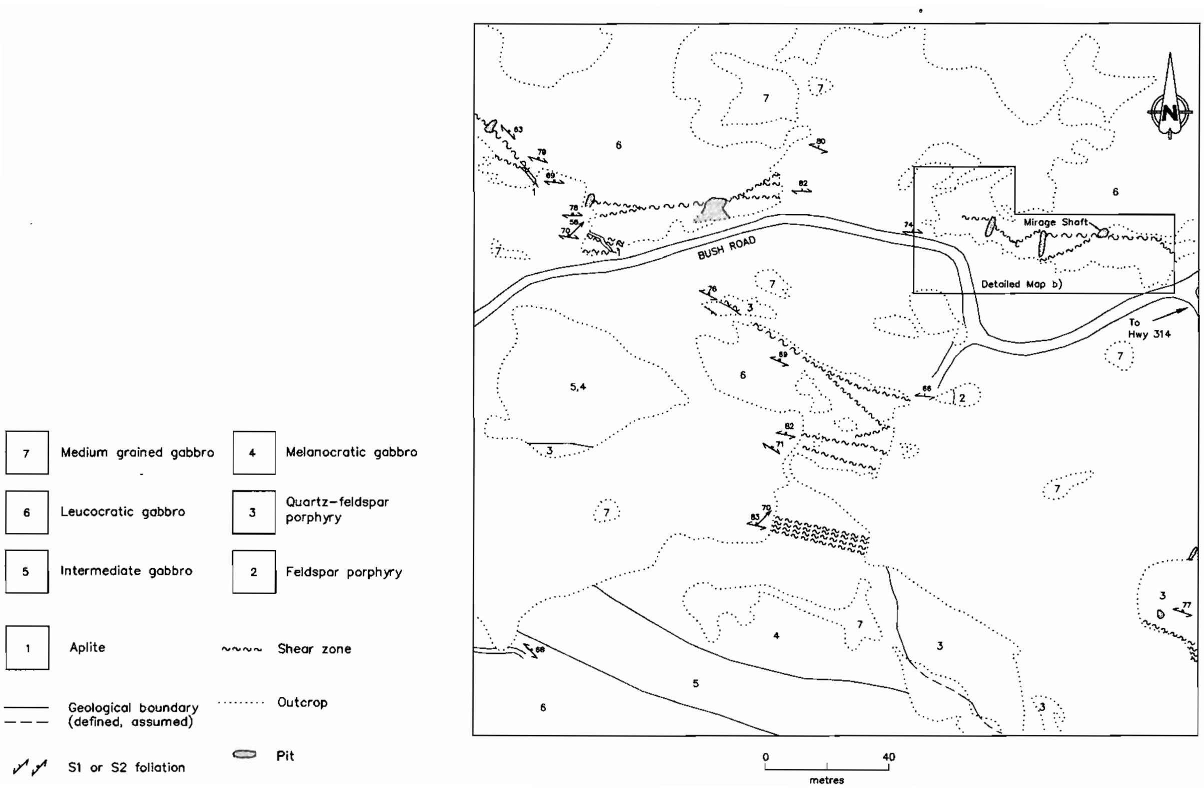


Figure 19: Geology of the Mirage deposit area (after Keith, 1988 and Brommecker, 1991)

The steeply dipping veins occur as lenses, pods, and tabular bodies along W to NW striking shear zones (Fig. 20). The flat veins are 1-5 cm wide continuous veins. They occur near, and commonly extend away from, the shear zones and display structural features of extensional veins (Brommecker, 1991). Some of these shallow veins have been folded into steep shear zones. Gold is more abundant in the flat veins than in the shear zone hosted veins (Keith, 1988; Grant, 1987). Preliminary drilling by Esso Minerals Canada indicates that the zone of mineralized flat veins near the Mirage shaft plunges shallowly to the west (Grant, 1987). Ankerite, sericite and chlorite are the main alteration minerals (Stephenson, 1971). Sulphides, mainly pyrite are subordinate.

History of Exploration and Development

The Mirage deposit was first staked in 1924. A 9 m shaft was sunk in 1928-29 along with some trenching and pitting. Additional trenching was carried out between 1978 and 1981. Late in 1986 Pronto Exploration Ltd. and Esso Minerals Canada entered into a 50-50 agreement on Esso's properties around the old Mirage shaft to spend $500 000 on stripping, sampling and diamond drilling. 33 holes were drilled in early 1987. Earlier assays from surface yielded 3.4-24.7 g/tonne (0.1-0.72 oz/ton) gold over a 2 meter wide zone (Northern Miner, Dec. 8, 1986 and March 2, 1987).

Selected Biography: Brommecker (1991); Keith (1988); Grant (1987): Poulsen *et al.* (1996); Stephenson (1971, 1972); Stockwell (1945a); Theyer and Ferreira (1990); Weber (1971b).

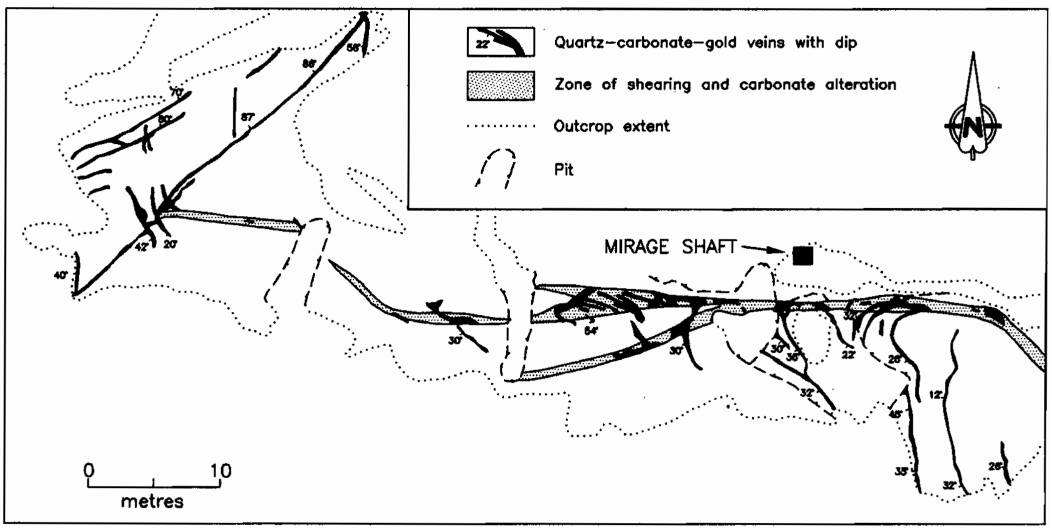


Figure 20: Sketch of veins and alteration at the Mirage shaft (after Brommecker, 1991)

TABLE 5: SUMMARY OF MAIN GOLD DEPOSITS/OCCURRENCES IN THE RICE LAKE GREENSTONE BELT

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
SAN ANTONIO RL1 Map ER86-1-1	Past producer 1932-68 and 1982-83: 42 000 kg (1 350 300 oz) gold Re-opening 1997	1995 geological reserves: 3 389 459 tonnes grading 9.5 g/tonne (0.277 oz/ton)	quartz-albite ankerite veins in shear zones and stockwork; in differentiated diabase sill; gangue minerals: pyrite, chalcopyrite, sphalerite, galena, tellurides.	Rea Gold Corporation (1996)
CENTRAL MANITOBA RL2 Map ER86-1-1	Past producer 1928-1938: 4287 kg (137 817 oz) gold	unknown	quartz veins in shear zone within and at margin of differentiated gabbro; gangue minerals: pyrite, chalcopyrite, pyrrhotite.	Mid-North Resources Ltd. (1996)
GUNNAR RL3 Map ER86-1-1	Past producer 1936-1941: 3101 kg (99 697 oz) gold	unknown	quartz veins/lenses/stockwork in shear zones in pillow basalt where cut by porphyry dykes and lamprophyre dykes; gangue minerals: pyrite, chalcopyrite, sphalerite, galena, marcasite.	W. Bruce Dunlop Ltd. (1996)
OGAMA-ROCKLAND RL4 Map ER86-1-1	Past producer 1942 and 1948-51: 1410 kg (45 332 oz) gold	Potential reserves: No.4 vein: 30 137 t grading 11.66 g/t (0.34 oz/ton) gold	quartz veins and veinlets of ankerite in shear zone within quartz diorite; gangue minerals: pyrite, chalcopyrite, arsenopyrite pyrrhotite, sphalerite.	Mid-North Resources Ltd. (1996)
JEEP RL5 Map ER86-1-1	Past producer 1947-1950: 16 319 tonnes were milled to produce 430 kg (13 824 oz) gold	unknown	quartz veins/stringers in shear zones within gabbro; gangue minerals: pyrite, arsenopyrite.	Augusta Gold Mines Limited (1996)
DIANA RL6 Map ER86-1-1	Past producer 1928-32; 1934-36; 1937-38; 1940-41: 236 kg (7587 oz) gold	1976: 27 000 to 45 000 tonnes 4.25 g/t (0.12 oz/ton)	stockwork of calcite stringers and quartz stringers and veins in shear zones within pillowedbasalt, and gabbro; gangue minerals: pyrite, chalcopyrite, pyrrhotite and galena	1153731 Ontario Inc. (1996)
SOLO-ORE GRANDE RL10 Map ER86-1-1	Past producer 1932-34; 1938-40: 161 kg (5176 oz) gold	Estimated reserves from surface to the 150m level 29 290 t grading 10.29 g/t (0.30 oz/ton) gold	quartz-carbonate lenses and stringers in shear zone within leucogabbro; gangue minerals: chlorite, pyrite, chalcopyrite, sphalerite, pyrrhotite.	W. Bruce Dunlop Ltd. (1996)
LOTUS RL7 Map ER-86-1-1	Past producer 1982: 8287 tonnes milled at San Antonio grading 4.56 g/t (0.13 oz/ton) gold	unknown	quartz vein in shear zone within tonalite gneiss; gangue minerals: pyrite, chalcopyrite, tetradymite.	W. Bruce Dunlop Ltd. (1996)
POUNDMAKER RL8 Map ER86-1-1	Small past producer 1923-24: 12.4 kg (399 oz) 1980-82-83: 7.6 kg (244 oz) gold	unknown	quartz-chlorite± fuchsite± ankerite veins in shear zones within quartz diorite and mafic dykes; gangue minerals: pyrite, fuchsite.	Augusta Gold Mines Limited (1996)
CRYDERMAN RL9 Map ER86-1-1	Small past producer 1931-32: 11.6 kg (373 oz) gold	1959: 80 m x 1 m grading 19.2 g/t (0.56 oz/ton)	quartz±carbonate veins and lenses in axial planar shear zone in pillowed basalt; gangue minerals: pyrite, pyrrhotite, chalcopyrite	Mid-North Resources Limited (1996)
ELORA RL12 Map ER86-1-1	Small past producer 1922: 113 tonnes produced 3.21 kg (103 oz)gold	unknown	quartz lenses in shear zone within greywacke and felsic gangue minerals: arsenopyrite, porphyry dyke; chalcopyrite, pyrite.	Mid-North Resources Limited (1996)
ONONDAGA RL13 Map ER86-1-1	Small past producer 1933-24: 1 kg (32 0z)gold	unknown	quartz-ankerite lenses and ankerite stringers in shear zone within pillowed basalt; gangue minerals: chlorite, pyrite	Mid-North Resources Limited (1996)

TABLE 5: SUMMARY OF MAIN GOLD DEPOSITS/OCCURRENCES IN THE RICE LAKE GREENSTONE BELT (cont.)

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
GRAND CENTRAL RL14 Map ER86-1-1	Small past producer 1933: 0.93 kg (30 oz)gold	unknown	quartz veins in sheared quartz diorite; gangue minerals unknown.	Doug Jansen (1996)
PACKSACK RL15 Map ER86-1-1	Prospect 1985: A small unknown amount of gold obtained	1979: 272 155 tonnes at 10.3 g/t (0.3 oz/ton)	quartz stringers and veins in shear zone within porphyritic dacite; gangue minerals; pyrite, chalcopyrite.	Augusta Gold Mines Limited (1996)
WOLF RL16 Map ER86-1-1	Prospect	1981: **Fox Vein** prob./poss. 14 035 tonnes at 6.86 g/t. (.2 oz/ton) **West Fox**. prob./poss 5990 tonnes 16.8 g/t.(0.49 oz/ton) **Prime Vein** poss. 2993 t, 25.71 g/t(0.75 oz/ton)	quartz veins in shear zones within intermediate volcanic and sedimentary rocks of the Bidou Lake Subgroup; gangue mineral: pyrite	Fortune Energy Inc. (1996)
RANGER RL17 Map ER86-1-1	Prospect 1914: shaft to depth of 18m 1934: diamond drilling	1981: 1787 tonnes at 13.7 g/tonne (0.40 oz/ton)	quartz±carbonate veins and lenses in shears within intermediate to felsic volcanic rocks; gangue minerals: chlorite, pyrite	Canadian Gold Mines Ltd.
WINGOLD RL18 Map ER86-1-1	Prospect: shallow shafts 1936: drilling 6349 tonnes at 7.2 g/t (.21 oz/ton) gold on dump	1935: 6535 tonnes at 13.95 g/t (0.41 oz/ton) and 6349 tonnes at 7.2 g/t (0.21 oz/ton) in surface dump	tourmaline-bearing quartz veins and quartz-carbonate veins in shear zones within dacite to rhyodacite; gangue minerals: chlorite, pyrite	Rea Gold Corporation (1996)
EVA RL19 Map ER86-1-1	Prospect shaft to depth of 18 m	1981: 15 964 tonnes at 6.17 g/t (0.18 oz/ton)	quartz±ankerite±tourmaline vein in shear zone within quartz diorite; gangue minerals: pyrite, chalcopyrite, sphalerite, magnetite.	John Henrikson (1996)
MIRAGE 23 Map ER86-1-1	Prospect shaft to depth of 9 1987: 33 drill holes	3-22 g/t (0.09-0.64 oz/ton) over 2m on surface	quartz ankerite veins in network of shear zones within differentiated gabbro; gangue mineral: pyrite	Imperial Oil Resources Limited (1996)
SANNORM 22 Map ER86-1-1	Prospect drilling in 1944 and 1989	1989 geological reserves: 177 457 tonnes, 3.8 g/t (0.11 oz/ton) to 150 m vertical depth	quartz veins/lenses in shear zone in mafic sill.	Hugh Wynne (1996)

STEVENSON LAKE-BIGSTONE LAKE-ISLAND LAKE AREA

REGIONAL GEOLOGY

Introduction

The Stevenson Lake-Bigstone Lake-Island Lake area is part of the Island Lake domain that is bounded to the north by the Molson Lake domain and to the south by the Berens River domain (Fig. 5; Map ER86-1-2). The Island Lake domain contains two distinct greenstone belts, the Island Lake greenstone belt and the Bigstone Lake greenstone belt (Map ER86-1-2). The Island Lake greenstone belt is a *circa* 250 km long, narrow easterly trending greenstone belt that extends from 50 km southwest of Stevenson Lake to Island Lake in the east, where it widens, and narrows down again in Sagawitchewan Bay towards the Ontario border (Map ER86-1-2). The Bigstone Lake greenstone belt is 50 km long and underlies the Bigstone-Knight lakes area (Map ER86-1-2).

Traditionally the supracrustal rocks of the Island Lake area have been divided into the Hayes River Series or Group comprising volcanic and sedimentary rocks, and the unconformably overlying sedimentary rocks of the Island Lake Series or Group (Wright. 1928; Quinn, 1960: Godard. 1963). Mapping in the early 1980's by Manitoba Energy and Mines (*cf.* Weber *et al.,* 1982) combined with U-Pb zircon age determinations (Turek *et al.,* 1986; Turek and Weber, 1987; Stevenson and Turek. 1992 and Wanless *et al.,* 1979) have established a more detailed geological framework for the Island Lake and Bigstone Lake greenstone belts (Table 6).

Hayes River Group

The Hayes River Group contains predominantly mafic flow rocks. Intermediate to felsic volcanic rocks occur locally. In the stratigraphically higher portion of the Hayes River Group sedimentary rocks dominate (Weber *et al.,* 1982). The sedimentary rocks include greywacke turbidites, conglomerates and chemical sediments, including oxide facies iron formation (Gilbert and Weber, 1983). The sequence is capped by a debris flow type polymictic conglomerate. The clasts of this unit are derived mainly from pre-existing sediments, possibly as a result of doming caused by the intrusion of syn-to post-volcanic plutons (Bella Lake pluton). This debris flow unit had previously been assigned to the Island Lake Group *(cf.* Map ER86-1-2).

Delaney (1976) identified alternating tholeiitic and calc-alkaline basalts in the Hayes River Group of the Island Lake area, which suggests an island-arc environment during Hayes River Group volcanism (Delaney, 1976). Rb-Sr and Nd studies suggest that the magma that produced Hayes River Group mafic flows was contaminated during subduction by older crustal material of *circa* 3 Ga, either in the form of an older sialic crustal slab or by sediments from an older platform (Stevenson and Turek, 1992).

A similar geochemical signature and conclusion in respect to the tectonic setting was obtained for the earliest volcanic rocks (the "evolved arc" assemblage) in the Flin Flon belt (see below).

TABLE 6: LITHOSTRATIGRAPHY OF THE ISLAND LAKE AND BIGSTONE LAKE GREENSTONE BELTS
(after Weber *et al.,* 1982; Neale, 1985; Stevenson and Turek, 1992; Turek *et al.,* 1986; Syme *et al.,* 1993)

Lithostratigraphic Subdivision	Age	Lithology	Tectonic setting
Post-tectonic Intrusions	<2699-2680 Ma	granite, granodiorite	Cratonic magmatism
Late Intrusive suite	2729-2699 Ma	tonalite, quartz-feldspar porphyry, mafic dykes	
		Intrusive contact	
Island Lake Group	2740?-2729 Ma	quartz wacke, conglomerate, turbidites	Successor arc basin
		Unconformity	
Late supracrustals	2748?-2729? Ma	arkosic wacke, conglomerate, mafic to felsic volcanic rocks*	
		Conformity?	Successor arc magmatism and sedimentation
Early Intrusive suite and supracrustals	2768?-2729? Ma	Quartz-feldspar porphyries and related volcanic rocks	
	age unknown	Gabbro, ultramafic intrusions and flows	accretion
Early plutonic rocks	2893 -2778 Ma	tonalite, gabbro	arc plutonism
Hayes River Group	2900-2861 Ma	mafic to felsic volcanic rocks, wacke, conglomerate, Iron formation, mafic-ultramafic sills	arc/oceanic volcanism

*" Late supracrustals" have only been identified in the Bigstone Lake greenstone belt.
Note: Several zircon U-Pb ages have large errors. 12 ages have been determined, but only 7 ages have errors of less than 10 Ma;, 3 age determinations have errors of between 22 and 43 Ma, leaving uncertainties as to the age of the intervals with question marks in Table 3.

Early Plutonic Rocks

Early Plutonic rocks are predominantly tonalitic in composition. They intrude Hayes River Group rocks in the greenstone belt, *e.g.,* the 2886±15 Ma Bella Lake pluton at Garden Hill, and along its margin (*e.g.* the 2778±5 Ma Wassagomach tonalite at the southwestern margin; Turek *et al.,* 1986; Stevenson and Turek, 1992). These plutons range in age from 2893±9 to 2778 Ma (or 2748 Ma) and are syn-to post volcanic, based on the ages presently known for the Hayes River Group mafic to felsic volcanic rocks (Table 6). This is a very long period of plutonism after volcanism, similar to long periods of plutonism behind subduction zones along major plate margins (Stevenson and Turek, 1992).

Early Intrusive Suite and associated supracrustal rocks

This sequence of rocks occurs in the western part of Island Lake. Several pre-Island Lake Group subvolcanic porphyries, felsic volcanic and derived epiclastic rocks were identified. They range in age from 2768-2729 Ma. Intermediate to felsic volcanic and epiclastic rocks are associated with the intrusions, but the supracrustal rocks are highly carbonatized and the relationships with adjacent units of the Hayes River Group are poorly exposed and as yet not well understood.

Ultramafic rocks locally occur within the Hayes River Group in the Island Lake area. They are predominantly massive serpentinized peridotites and are spatially closely associated with gabbro, suggesting that they are part of a differentiated intrusive suite (Weber *et al.,* 1982). Rarely spinifex textured ultramafic rocks were identified (Theyer, 1977). They are spatially associated with coarse grained meta-peridotite, gabbro and basalts and indicate mafic-ultramafic magma intrusion and extrusion.

The low amount of continuous outcrop in the largely water-covered Island Lake area has not allowed definitive placement of the ultramafic rocks into one (or several?) stratigraphic position. It is possible that there is more than one ultramafic-mafic magma pulse (Weber *et al.,* 1982), one as part of the basaltic volcanism and associated gabbroic intrusions of the Hayes River Group and one as part of a younger mafic/ultramafic magmatism of the Early Intrusive Suite.

Theyer (1978) proposed that the ultramafic flows and intrusions are even younger, emplaced within sedimentary rocks at the base of the Island Lake Group. However, mapping by Weber *et al.* (1982) could not confirm this. The smaller occurrences of ultramafic rocks form scattered lenses along the Savage Island Deformation Zone (Fig. 21) within the Hayes River Group and close to the (here tectonic) contact with the Island Lake Group. These ultramafic lenses may have been tectonically re-emplaced. Mafic-ultramafic occurrences in the Hayes River Group elsewhere form generally larger bodies (Weber *et al.,* 1982). The association of ultramafic rocks with a deformation zone in the Island Lake area is similar to the equivalent association of serpentinites with the Wanipigow fault in the Rice Lake belt. These serpentinites have been interpreted as having been tectonically emplaced (Scoates, 1971).

Late Supracrustals

The "Late Supracrustals" have only been identified in the Bigstone Lake area. They include volcaniclastic wacke and conglomerate derived from and overlying conformably Hayes River Group volcanic rocks, dacitic tuffs and mafic, intermediate and felsic volcanic rocks (Neale, 1985). The "Late Supracrustals" probably correlate with the supracrustal rocks associated with the Early Intrusive Suite in the Island Lake area (Neale, 1985).

Island Lake Group

The Island Lake Group unconformably overlies the Hayes River Group rocks and Early Plutonic rocks and is composed of a lower alluvial-fluvial sequence and an upper turbidites sequence (Neale, 1984). The alluvial-fluvial sequence overlies a regolith and includes quartz wacke and cobble/boulder conglomerate. The regolith and lower sequence and unconformably underlying Bella Lake pluton and Hayes River Group volcanic rocks is well exposed at the western margin of the pluton ((Fig. 21; Herd and Ermanovics, 1976; Neale and Weber, 1981a,b; Neale, 1984) and near its eastern margin, near Loonfoot Island (Gilbert, 1985). The upper turbidite sequence consists of wacke grading into argillite, and rhythmically layered argillite and siltstone (Weber *et al.,* 1982; Neale, 1984) indicating a deepening of the sedimentary basin.

Nd data indicate the onset of a second cycle of mantle contribution during deposition of the Island Lake Group (Stevenson and Turek, 1992), possibly as a result of accretion southwards against the Berens River domain at *circa* 2.73 Ga (as postulated for northern Superior greenstone belts in Ontario by Thurston and Davis, 1991).

Late Intrusive Suite and Post-tectonic Intrusions

The Late Intrusive Suite consists of tonalite, quartz diorite, mafic dykes and plagioclase and quartz-phyric felsic dykes. The youngest rocks are 2680 Ma post-tectonic granites in the Molson Lake domain (Syme *et al.,* 1993).

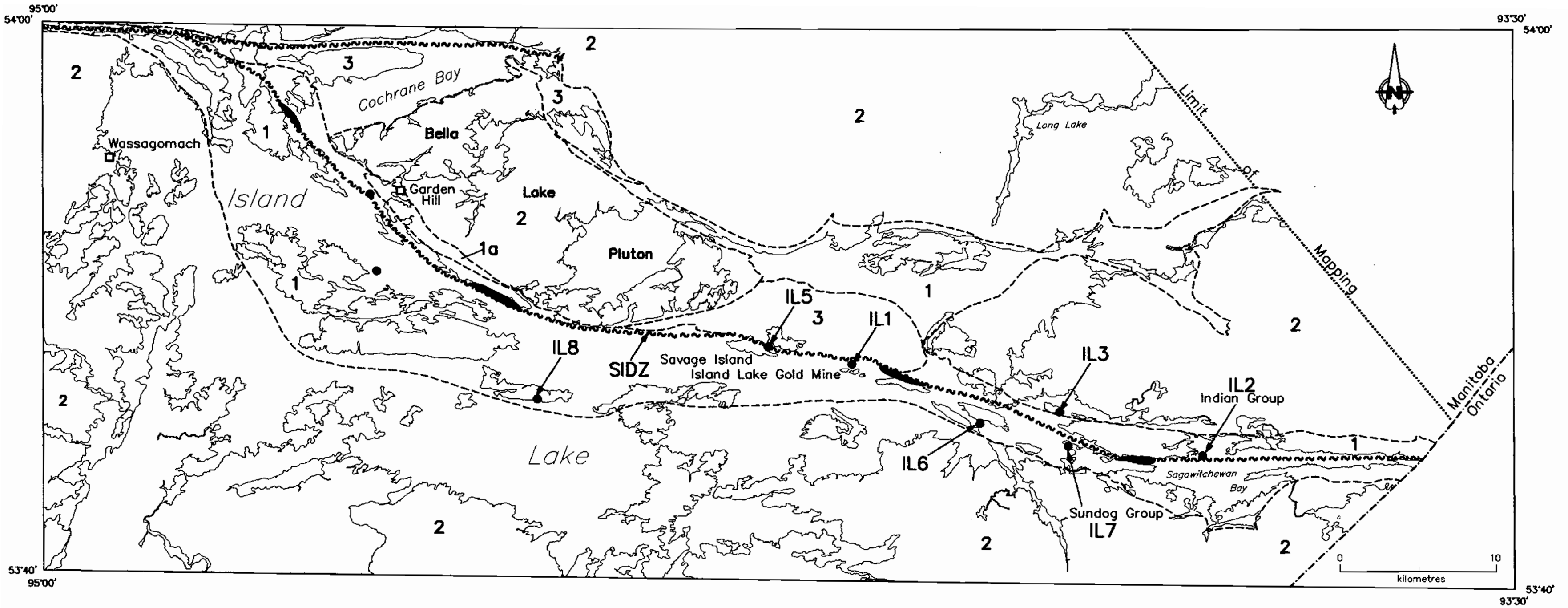
STRUCTURE

Godard (1963), Weber *et al.* (1982), Neale (1984) and Gilbert (1985a) recognized two phases of folding: 1) F_1 folds produced tightly folded synclinoria that trend west to northwest in the Stevenson Lake and Island Lake areas and northeast in the Bigstone Lake area; and 2) major F_2 folds wrap F_1 folds around northeast- to northwest-trending axes in the Bigstone Lake and eastern Island Lake areas.

Numerous early deformation zones are parallel or subparallel to the axial planes of F_1 folds. A major deformation zone runs along the northern margin of the Island greenstone belt (Fig. 21; Map ER86-1-2). The Savage Island Deformation Zone (SIDZ) is located in the central part of Island Lake (Fig. 21, Map ER86-1-2). It represents a long-lived deformation zone possibly initiated as early as during the doming of Early Plutonic rocks (Weber *et al.,* 1982). The SIDZ is a 100 to 500 m wide zone with tight isoclinal folding, strong transposition of primary layering and locally intense carbonatization. Along the northern margin of the SIDZ rocks of the Island Lake Group are juxtaposed with Hayes River Group rocks.

Late northeast- to northwest-trending faults cut early structures at high angles. The most prominent fault produces an apparent dextral displacement of *circa* 5 km in the Bigstone Lake-Knight Lake greenstone belt (Map ER86-1-2).

Island Lake Gold mine, 1934, Mine Island in the central part of Island Lake, Manitoba



3 Island Lake Group alluvial–fluvial and turbidity current deposits
2 Early plutonic rocks, synvolcanic
1 Hayes River Group volcanic and sedimentary rocks
   a) debris–flow conglomerate

Major deformation zone; SIDZ Savage Island Deformation Zone
Zone with intense carbonatization
Geological boundary (approximate)
Gold occurrences

Figure 21: General Geology and gold deposits of the Island Lake area *(after Theyer 1981; Weber et al., 1982)*

MINERALIZATION

In the Stevenson Lake-Bigstone Lake-Island Lake area the two deposits and sixteen occurrences (Map ER86-1-2) can be divided into three groups: 1) those along the SIDZ. Theyer (1981) described this zone as a stratigraphic horizon marking the "Hayes River Group-Island Lake Group interface". However, recent mapping (Weber *et al.,* 1982) suggests a tectonic juxtaposition of these two groups and not a primary contact (see above). The deposits are in fact all within the Hayes River Group; 2) those associated with extensive areas of silicification in the Hayes River Group rocks (Fig. 22); and 3) narrow discontinuous quartz and carbonate veins within shear zones.

Gold mineralization associated with the SIDZ includes: Island Lake Mine (IL1), Indian (IL2), Sundog (IL3), Cowan (IL4) and Savage Island (IL5) occurrences (Fig. 21).

Gold mineralization associated with extensive areas of silicification occurs at the southeast end of Island Lake where a 100-150 m wide silicification halo in Hayes River Group mafic rocks extends from the southeast tip of Okay Island (IL6) to Reahil Island (IL7) in the east (Fig. 22). At the core of the silicification halo is a sulphide-bearing quartz vein that has contains up to 129.58 g/tonne (3.78 oz/ton) gold (Theyer, 1982).

The remaining occurrences in the area consist of gold and sulphide-bearing quartz-carbonate veins that occur in shear zones. Of these, eight occur in Hayes River Group mafic to felsic volcanic and sedimentary rocks, three occur in quartz veins in Late Plutonic rocks adjacent to volcanic-intrusive contacts (including High Rock Island, IL8) and one occurs in a felsic dyke.

Analyses of grab samples (Theyer, pers. comm. 1986) give no indications that conglomerates and crossbedded sandstone of the Island Lake Group may have potential for paleoplacer gold deposits, as proposed by Weber *et al.* (1982).

PAST PRODUCER

Island Lake

Location: 470 km northeast of Winnipeg, 240 km east of Norway House, on Mine Island in the central part of Island Lake.

Map Reference: ER86-1-2, location IL1.

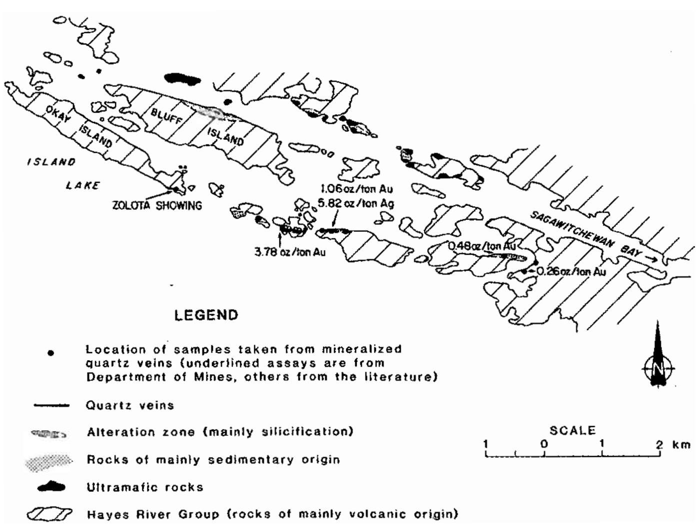


Figure 22: Gold mineralization at the eastern end of Island Lake (after Theyer; 1982)

Description of Deposit:

The Island Lake mine area is underlain by isoclinally folded and carbonatized turbidites of the Hayes River Group. These rocks are intruded by quartz porphyry and mafic dykes.

McMurchy (1944) was the first to describe the mineralization in the mine area; the underground workings were inaccessible and many of the trenches had collapsed, limiting his mapping to outcrops. He observed several sulphide-bearing quartz veins up to 1.5 m wide, an "area" with numerous lenses and stringers of quartz, and two "large masses" of "sparsely mineralized" quartz. Theyer (1981) mapped the surface geology and described several zones of intense silicification, pyritization and carbonatization. Mineralization consists predominantly of pyrite and pyrrhotite with lesser amounts of galena, arsenopyrite and locally sphalerite. Muck piles by the shaft contain some visible gold.

The rocks in the mine area are isoclinally folded and display a well developed axial planar foliation, which is typical for the Savage Island Deformation Zone. Theyer (1981) suggested that the gold may have been concentrated in quartz veins in the hinges of folds. Thorpe (1983, pers. comm.) determined a model lead age of 2680-2710 Ma from galena suggesting a relatively young period of mineralization. A study of gold and silver distribution from a sample of "waste" (Gasparrini, internal report) that contains several ounces gold and silver per ton suggests that at least 80% of the gold and silver bearing grains are coarse enough for liberation by grinding.

History of Exploration and Development:

Island Lake Gold Mines, Limited was formed in 1928 to explore a prospect on a group of four islands in east-central Island Lake. In 1931, 31 drillholes intersected mineralization over a strike length of 519 m. Ventures Limited, under option from Island Lake Mines Limited, sank a 2-compartment shaft to a depth of 83 m with levels established at 43 m and 73 m. The mine produced 186.2 kg (5986.6 oz.) of gold from April 1934 to March 1935, before known reserves were depleted. A 5-hole underground drill program was carried out to locate more ore; the results were as follows:

Set Up	Hole No.	Direction	Width	Assay g/tonne	(oz/ton) gold
1	1	+45°/N	1.07 m	104.58	(3.05)
	2	+30°/N	1.43 m	36.00	(1.05)
	3	0°/N	1.22 m	8.57	(0.25)
			2.14 m	7.54	(0.22)
2	1	+45°/N	0.76 m	17.14	(0.5)
	2	+30°/N	1.16 m	6.17	(0.18)

(Source: Manitoba Mines Branch Annual Report 1934-1935, p 60-61)

Although the results were encouraging, further work was not carried out.

From 1959 to 1981 the property was staked by a number of individuals including P. Smerchanski, T. Hamilton, R. McKenzie, C. Wass and W. Miller.

In 1981 W.B. Dunlop staked the area and optioned it to BP Canada. BP in joint venture with St. Joe Canada Inc. carried out diamond drilling in 1982, 1983 and 1984. The option was dropped in 1985.

History of Production:

Year	Tonnes milled	Grade g/tonne(oz/ton)	Production kg(oz.)gold
1934	6336	20.92 (0.61)	133.36 (4287.6)
1935	1483		*52.84 (1699)
Total	7819		186.2 (5986.6)

* estimate based on bullion and concentrate receipts of $59 483 (Manitoba Mines Branch, Annual Report, 1935).

Selected Bibliography: Gilbert (1985a); Godard (1963); Manitoba Mines Branch, Mineral Inventory File (53 E/16 Au1); McMurchy (1944); Theyer (1980, 1981, 1982, 1985); Weber *et al.* (1982); Wright (1928).

DEPOSIT

High Rock Island

Location: near the southeast shore of High Rock Island on Island Lake.

Map Reference: ER86-1-2, location IL8.

Description of Deposit:

The deposit consists of gold-bearing quartz veins that strike at right angles across the intrusive contact between a granitoid pluton (of the Early Plutonic Rocks) and Hayes River Group mafic volcanic rocks.

Five gold-bearing structures were found on the property-the 'Main Vein', 'Juniper', 'Climpy', 'Rex', 'Rod' and 'Jack'. The 'Main vein strikes 355°, dips 85°E and averages about 1.2 m in width. However, mineralization extends up to 1.5 m into the wall rocks. Drilling indicated a minimum strike length of 520 m and a minimum depth of 245 m for the vein. Drill results suggest that mineralization was emplaced along zones with diabase dyke intrusions. Mineralization consists of free gold, pyrite, chalcopyrite, galena and tellurides. Gold occurs as fine grains within the sulphide minerals and as coarse specks and 'nuggets'.

The 'Juniper' consists of a complex zone of diabase dykes, silicified granodiorite and a 9-18 m wide stockwork of pyritiferous quartz-carbonate veins and stringers. The gold is associated with galena and chalcopyrite in narrow quartz veinlets.

The 'Climpy' structure is a 0.6 to 6 m wide zone of quartz vein stockwork within granitoid rocks intruded by diabase. The structure was traced for a strike length of 415 m and a depth of 110 m and is open in all directions. Pyrite and molybdenite occur in the granitoid 'matrix' of the stockwork. The quartz veins contain pyrite, chalcopyrite and gold. The best drillholes ranged from 4.3 to 43 grams (0.14 to 1.4 ounces) gold per tonne (Wydmar Annual Report, 1987).

History of Exploration and Development:

The property was first staked in 1934 by J. Wass. Later in 1934 Ministik Lake Gold Mines Limited acquired an interest in the property and carried out trenching and sampling. A series of eleven channel samples were taken from a quartz vein for 137 m along strike. The samples assayed 44.23 g/tonne (1.29 oz/ton) gold over an average width of 0.61 m. A 2-compartment shaft was sank to a depth of 72 m with levels established at 38 m and 69 m. Work was discontinued later in 1937. The claims were then allowed to lapse.

Ministik Lake Gold Mines restaked the property in 1950 and carried out a 3-hole 393 m diamond drill program. Assays of vein material ranged from 0.34 g/tonne (0.01 oz/ton) to 1.71 g/tonne (0.05 oz/ton) gold.

A Manitoba Mines Branch field party took grab samples of the vein in 1951 that yielded assays of 74.06 g/tonne (2.16 oz/ton) gold (Godard, 1963, p. 41).

R. McKenzie staked the property in 1978. In 1985, Midway Lake Mines Ltd. of Saskatoon began a program of mapping, geophysics, trenching and sampling financed by Wydmar Resources Ltd. and Silver Acorn Mines Ltd. Wydmar and Bighorn Development Corporation later optioned the property to earn 40% interest each. The property consisted of 77 claims covering 62 square miles. By May 31, 1987 Wydmar Development Corporation and Bighorn had spent $2 008 998 to earn 80% interest in the property, with an option to purchase the remaining 20%. The program included 139 diamond-drill holes (10 517 metres), surface stripping, trenching, channel and bulk sampling, dewatering of the old Ministik mine shaft (70 metres deep), rehabilitation of the 34 metre drift on the 67 metre level, underground channel and bulk sampling and the construction of a 23 tonne per day test mill. Most of this work was done on the "Main Vein" of the property with 72 drill holes intersecting the vein over a 520 metre strike length and a depth of 245 metres. The surface channel and bulk sampling in 1986 established on average grade of 9 g/tonne (0.26 oz/ton) gold across 1.3 metres at 94 sites along a 174 metre strike length. The four large bulk samples (average 382 kg each) gave on average grade of 19.4 g/tonne (0.57 oz/ton) gold. The company considered these results justified the establishment of the 23 tonne per day custom mill (Wydmar Development Corporation 1987 Annual Report). In their 1987 Annual Report, Bighorn Development Corporation stated that the "drill indicated reserves from the "Main Vein" alone are 5 160 kg (165 120 oz) of gold in about 390 000 tonnes grading 12 g/tonne (0.35 oz/ton) gold per tonne over a length of 518 metres, a depth of 253 metres and an average width of 1.7 metres. This estimate included 30% wastage and 15% dilution." During November and December 1986 the old mine was rehabilitated. Channel sampling and three 360 kg bulk samples from underground were taken. Unfortunately the three bulk samples were "lost" during transportation to the test mill. By mid-1988 the custom mill had been completed and Millar Engineering Ltd. was contracted to mine and mill a 450-900 kg underground bulk sample. This work was to begin by November 1988. (Bighorn Development Corporation Release Oct. 12, 1988). The Northern Miner March 21, 1988 issue reported that Bighorn and Wydmar intended to process a 2700 tonne bulk sample in their 23 TPD test mill, 450 tonnes from surface and 2270 from underground. The companies stated they had spent $5 million on the property and had proven and drill-indicated reserves of 454 000 tonnes at 9 g/tonne (0.26 oz/ton) gold with an additional 1.36 million tonnes inferred at the same grade. Later indications were that the October 1987 stock market crash, the reduction in flow-through share mining investment and flattening gold prices caused the discontinuation of operations at the High Rock Island Property. A Northern Miner April 16, 1990 item stated that Wydmar would focus its efforts on its Island Lake Property where geological reserves were estimated at 404 000 tonnes grading 9 g/tonne (0.26 oz/ton) gold. The property has since been inactive (up to mid-1996).

TABLE 7: SUMMARY OF MAIN GOLD DEPOSITS IN THE ISLAND LAKE BELT

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
ISLAND LAKE IL1 Map ER86-1-2	Past producer 1934-35: 186 kg (5980 oz)	unknown	quartz veins, lenses, stringers in isoclinally folded greywacke, quartz porphyry and mafic dykes within major deformation zone; gangue minerals: pyrite, pyrrhotite, galena, arsenopyrite, sphalerite, carbonate.	W. Bruce Dunlop Limited (1996)
High Rock Island IL8 Map ER86-1-2	Prospect 1986-88: drilling	geological reserves 1987: 404 000 tonnes 9 g/t (0.26 oz/ton)	quartz vein/quartz-carbonate veins and stringers near contact between granite and mafic volcanic rocks; gangue minerals: pyrite, chalcopyrite, galena, tellurides	Bighorn Development Corp. and Wydmar Development Corp. (1996)

OXFORD LAKE-KNEE LAKE-GODS LAKE-KISTIGAN LAKE AREA

REGIONAL GEOLOGY

Introduction

The Oxford Lake, Knee Lake, Gods Lake and Kistigan Lake areas are part of the Gods Lake domain in the northern part of the Superior Province in Manitoba (Map ER86-1-2). This domain contains several east-southeasterly trending loosely connected Archean greenstone belts. The major greenstone belt area occurs in the Oxford Lake-Knee Lake and Gods Lake region. It is hereby called the Oxford Lake greenstone belt. Smaller greenstone belts in the Atik and Bear Lake areas northwest of Oxford Lake and the isolated greenstone belt near Silsby Lake further north are considered part of the Oxford Lake belt, as are the greenstone belts in the Kistigan Lake and Twin Lakes area near the Manitoba/Ontario border.

The contact of the Gods Lake domain with the Cross Lake domain is largely defined by a fault that in large parts also forms the southern boundary of the Oxford Lake greenstone belt (Hubregtse, 1985; Martin, 1992; Map ER86-1-2). These two domains are treated separately for this report, but are otherwise commonly treated as one subprovince, the Gods Lake Subprovince (*cf.* Fig. 5). Along its northern boundary the Gods Lake domain borders the Pikwitonei granulite domain. This boundary is defined as the 'orthopyroxene-in' isograd of prograde Late-Archean metamorphism (Weber and Scoates, 1978; Mezger *et al.,* 1990; Weber and Mezger, 1990). This isograd is oblique to regional structures, such as the greenstone belt near Silsby Lake. This implies that the granulite facies supracrustal rocks in the Pikwitonei domain are probably also part of the Oxford Lake greenstone belt.

Wright (1928) and Barry (1959,1961) divided the supracrustal rocks of the belts into two groups: 1) the predominantly volcanic rocks of the Hayes River Group; and 2) the overlying predominantly sedimentary rocks of the Oxford Lake Group (Table 8). Granitoid plutons and batholiths intrude Hayes River Group rocks in the area between Knee Lake and Gods Lake, and along the margins of the various belts.

More detailed mapping in the early 1980's (Hubregtse, 1985; Gilbert, 1985b; and Martin, 1992) and U-Pb zircon ages (Manitoba Energy and Mines, 1992b) refined the geological frame work as shown in Table 8.

Hayes River Group

The Hayes River Group comprises mainly volcanic rocks: mafic flows with abundant gabbroic sills, intermediate to felsic flows and pyroclastic rocks, and minor ultramafic rocks in the form of sills, spinifex textured flows, and fault-bounded peridotites. Hubregtse (1978) recognized six volcanic cycles in the Knee Lake area, defined by a lower mafic tholeiitic section and an upper calc-alkaline intermediate to felsic section. Plagiophyric to megaphyric basalt is common in the Oxford Lake area, Knee Lake area and Atik Lake area. Phinney *et al.* (1988) concluded that these basalts are a mixture of 1) a fractionated melt that was derived from a primitive mafic melt during high pressure fractionation and which ascended into low pressure magma chambers (at 1-2 kb) where plagioclase phenocrysts crystallized in anorthosite complexes, and 2) unfractionated mafic melts that tapped into the anorthosite chambers and extruded as a melt mixture having plagioclase phenocryst of 80-85% Anorthite content and matrix plagioclase of 60-70% Anorthite content. Trace element data favour an ocean floor environment for the basalts of the Hayes River Group (Hubregtse, 1978).

The northern portion of the greenstone belt terrane, the Atik Lake and High Hill Lake belts are slightly different from the main greenstone belt

TABLE 8: LITHOSTRATIGRAPHY OF THE OXFORD LAKE-KNEE LAKE-GODS LAKE - GREENSTONE BELT
(after Hubregtse, 1985; Gilbert, 1985b; Martin, 1992; Syme *et al.;* 1993)

Lithostratigraphic Subdivision	Age	Lithologies	Tectonic setting
Post-Oxford Group Intrusive Rocks	*ca.* ≤2690 Ma	Granite, granodiorite	Cratonization: continental plutonism
Oxford Lake Group	*ca.* 2706 Ma	polymictic conglomerate, mafic to felsic shoshonitic volcanic rocks, tuff; sandstone, argillite, minor gabbro, iron formation	successor basin volcanism and sedimentation
		——Unconformity——	
Bayly Lake Complex	*ca.* 2883-2730 Ma	tonalite, granodiorite syenite, gabbro	Successor arc magmatism (plutonism and volcanism)
Lynx Bay assemblage	*ca.* 2730? Ma	intermediate to felsic volcanic, volcanoclastic and epiclastic rocks	
			accretion
Hayes River Group	*ca.* 2830 Ma	mafic to felsic volcanic rocks related epiclastic rocks, mafic and felsic dykes and sills, iron formation, sandstone, argillite, minor conglomerate, minor ultramafic rocks	Arc/oceanic magmatism (volcanism and plutonism)

terrane in the Oxford-Knee-Gods lakes area. Mafic flow rocks make up a much higher proportion(>90%) of the volcanic rocks than in the Oxford Lake area; intermediate rocks (<10%) are less abundant and felsic volcanic rocks are lacking. However, banded iron formation is more prevalent; oxide, silicate and sulphide facies iron formation are known and sandstones and conglomerates appear to be more common than in the Oxford Lake-Gods Lake area (Weber, 1974, 1975; Manitoba Energy and Mines, 1992b, 1995)

The supracrustal sequence in the northern greenstone belts in the Gods Lake domain are similar to those in the 3.0 Ga Wallace Lake Subgroup of the Rice Lake belt, although quartz arenites and conglomerate make up a smaller portion in the northern belts. The main greenstone belt terrane of the Gods Lake domain is lithologically and geochronologically similar to the Island Lake long lived 2.86-2.76 Ga arc terrane (Table 6), based on the present geological knowledge of these two areas.

Bayly Lake Complex

The Bayly Lake Complex was defined by Hubregtse (1985) and Gilbert (1985b). after granitoid rocks around Bayly Lake between southern Knee Lake and northern Gods lake (Map ER86-1-2). The Bayly Lake Complex comprises tonalitic to granodioritic intrusions and gneisses that intruded rocks of the Hayes River Group, but are older than the Oxford Lake Group. The complex also includes the Lynx Bay assemblage, a sequence of supracrustal rocks that are closely associated with the plutonic rocks of the Bayly Lake Complex. Three ages, 2883 Ma, 2783 Ma and 2730 Ma have been obtained from granitoid rocks of Bayly Lake Complex. The oldest age is probably synvolcanic to Hayes River Group; 2783 Ma is the age for the porphyritic Bayly Lake granodiorite and may be post volcanic. The age of 2730 Ma was obtained from a tonalitic rock at the south shore of Oxford Lake near Lynx Bay and may date the Lynx Bay assemblage.

Lynx Bay assemblage

The Lynx Bay assemblage has been defined in the western part of Oxford Lake (Hubregtse, 1985) and comprises intermediate to felsic generally highly porphyritic volcanic and related epiclastic rocks. They are spatially closely associated with tonalites of the Bayly Lake Complex in the Lynx Bay and have been interpreted as the extrusive phase of the structurally underlying tonalites of the Bayly Lake Complex (Hubregtse, 1985). Rocks of the Lynx Bay area have undergone extensive faulting, shearing and pervasive hydrothermal alteration, including carbonatization (Hubregtse, 1985).

Oxford Lake Group

The Oxford Lake Group overlies rocks of the Hayes River Group and Bayly Lake Complex with an angular and erosional unconformity (Hubregtse, 1985; Gilbert, 1985b; Martin, 1992). The group comprises a lower, largely volcanic subgroup of limited aerial extent that is overlain by an upper sedimentary subgroup. The Oxford Lake Group was interpreted as to represent deposits of a fault-bounded, extensional graben (Hubregtse, 1985). This graben extends, although broken up by younger faulting, for over 200 km from Oxford Lake to Little Stull Lake and Kistigan Lake (Corkery, 1981; Map ER86-1-2). The volcanic rocks of the lower volcanic subgroup are of the shoshonite to high -K andesite-dacite-rhyolite series, comparable to modern analogues formed in convergent plate-tectonic settings (Brooks *et al.,* 1982). Trace element data support the interpretation that the Oxford Lake Group volcanism represents the terminal magmatism in a matured arc setting (Brooks *et al.,* 1982).

METAMORPHISM

The majority of rocks have mineral assemblages indicative of metamorphic facies ranging from lower greenschist to middle amphibolite facies. Amphibolite facies metamorphism is restricted to narrow highly deformed segments of the greenstone belts (Hubregtse, 1985).

Hubregtse (1985) and Gilbert (1985b) recognized two events of prograde metamorphism the Oxford Lake-Knee Lake-Gods Lake area: an M_1 upper greenschist to amphibolite facies metamorphic event predating Bayly Lake Complex and Oxford Lake Group rocks, and an M_2 amphibolite facies metamorphic event that postdates deposition of the Oxford Lake Group rocks.

Regionally metamorphism increases in grade in a northwesterly direction, towards the Pikwitonei granulite domain (Weber and Scoates, 1978) from 575°, 3 kb at Atik Lake to 750°, 7 kb at Cauchon Lake, 30 km further northwest (Map ER86-1-2; Mezger *et al.,* 1990; Weber and Mezger, 1990). The orthopyroxene isograd that marks the contact between Gods Lake domain and Pikwitonei domain is oblique to the regional structures and cuts through greenstone belts such as the one at High Hill Lake. Supracrustal rocks mapped in the Pikwitonei granulite domain and shown on Map ER86-1-2 are thus high grade equivalents of the greenstones in the Gods Lake domain.

STRUCTURE

Gilbert (1985b) recognized five periods of deformation. A D_1 deformation accompanied M_1 metamorphism and is characterized by: 1) a northwest-trending synclinorium (F_1) in the Knee Lake area; 2) east-northeast to east-southeast-trending tight isoclinal folds (F_1) in the Gods Lake area; and 3) east-northeast trending foliation (S_1) parallel to primary layering in the Munro Lake area. Post-Oxford Lake Group D_2 deformation consisted of: 1) tight steeply-plunging isoclinal folds (F_2) with east-northeast to east-southeast axial traces within Oxford Lake Group rocks and 2) tightening of earlier formed F_1 folds within Hayes River Group rocks. The D_3 deformation produced tight F_3 folds with moderate to steeply-dipping axial planes trending east-northeast to east-southeast, sub-parallel to the F_2 folds. The D_4 deformation produced subhorizontal F_4 folds with vertical axial planes normal to F_3 folds. The D_5 deformation produced brittle conjugate fractures, faults, *en echelon* dilation fractures and shear zones parallel to regional foliation.

In the Oxford Lake area Hubregtse (1985) recognized a Pre-Oxford Lake Group deformation, based on the unconformable relationship between Hayes River Group and Oxford Group rocks, These structures possibly had subhorizontal thrust-related? orientation, but have no regional expression due to later structural overprint. The main deformation (D_2) occurred after deposition of the Oxford Lake Group and was associated with the M_2 metamorphism. Hayes River Group monoclines and Oxford Lake Group rocks were folded into southwest-trending isoclinal (F_2) folds and synclinoria. The D_3 deformation produced dextral and sinistral wrench faults trending east to northeast.

MINERALIZATION

The four deposits and twelve gold occurrences are characterized by three types of mineralization: 1) gold bearing quartz±carbonate veins hosted by shear zones 2) concordant gold mineralization in shear zones or fracture zones, confined to certain lithologic units, and 3) stratiform synvolcanic exhalative sulphide-gold mineralization in chert of iron formation.

1) Shear zone-associated gold mineralization

At Monument Bay (Map ER86-1-2, GL14) gold mineralization is associated with a regional deformation zone that has been traced for more than 30 km. Gold occurs in sericitized and silicified zones, and quartz veins within sheared felsic volcanic rocks.

Gold-bearing quartz veins and quartz-carbonate stringers occur in shear zones within Hayes River Group mafic volcanic rocks intruded by quartz±feldspar porphyry dykes at Jowsey Island (GL5), Knee Lake Gold Mines Limited (GL6), Johnston Knee Lake Mines Limited (GL7) and Midas 54 (GL9).

Shears zones up to 18.3 m wide in mafic volcanic rocks contain narrow discontinuous quartz veins and stringers at Painkiller Bay (GL10), Big Lynx (GL11), LMD (GL12) and Neda (GL13). Mineralization consists predominantly of pyrite or pyrrhotite with lesser to trace amounts of chalcopyrite, sphalerite, galena, arsenopyrite, and locally visible gold.

2) Concordant gold mineralization in fractured or sheared rocks

At the God's Lake Gold Mine (Map ER86-1-2, GL1; Fig. 23) disseminated sulphides and gold-bearing quartz stringers occur in a brecciated layer within a highly altered, silicified sedimentary unit that strikes along the margin of a gabbroic unit for several hundred metres. At the Smelter (GL2), Pickle No. 1 and No. 2 (GL3) and Gold Group occurrences (GL4) gold-bearing quartz stringers and veins occupy shear zones in tuffaceous rocks.

At Little Stull Lake (Map ER86-1-2, GL8) gold-bearing quartz veins and stringers occur in a shear zone along or near the contact between Hayes River Group mafic volcanic rocks and Oxford Lake Group sedimentary rocks. Iron formation has been mapped along the contact.

At the Rusty Zone (GL3) gold mineralization occurs in a shear zone associated with iron formation.

3) Synvolcanic gold mineralization

At Atik Lake (Map ER86-1-2, GL15) auriferous chert and sulphides are part of an iron formation with underlying Noranda type volcanogenic hydrothermal alteration zone. This and geochemical characteristics indicate that the deposition of gold was synvolcanic, similar to recent gold-enriched volcanogenic massive sulphides deposited on the sea-floor.

PAST PRODUCER

God's Lake

Location: 560 km northeast of Winnipeg, on the northwest shore of Elk Island of Gods Lake.

Map Reference: Map ER86-1-2, location GL1.
Description of Deposit:

The following description is from Baker (1935). The area is underlain by basalt flows and fine grained tuffs that are intruded by a gabbro (average 100 m thick and at least 15 km long) and quartz-feldspar porphyry dykes (Fig. 23). Gold mineralization occurs intermittently within a 3 m thick 'tuff unit' in the hanging wall of the gabbro and a strike length of about 400 m. The 'tuff unit' is described to consists of three distinct sub-units: 1) a very fine grained, black and slaty textured unit that usually forms the walls of the ore shoots (see below); 2) a basic, coarse grained variety composed of chlorite-hornblende schist (similar to schistose gabbro or greenstone); and 3) 'an acidic very coarse grained unit with a range in colours including black, reddish-brown, jade-green, or light pearly grey tuffs locally showing well defined bedding planes'.

The type 3 tuff unit consistently has the highest percentage of gold-bearing quartz (average 25%) and the ore bodies invariably occur in this unit. This tuff unit has been "very frequently fractured and then cemented together by dark bluish or grey quartz". The gold mineralization is located in quartz stringers within fractured and silicified tuff. The highest gold values came from grey to bluish quartz. Sulphides are weakly disseminated throughout the type 3 tuff unit host rocks. Pyrrhotite is the predominant sulphide with lesser amounts of pyrite, arsenopyrite, galena and chalcopyrite.

The gold mineralization forms ore shoots that occur in a zone that plunges 15° to the west. Individual ore shoots plunge 30-70° to the west and have a vertical height of 100-200 m (Fig. 24). The ore shoots were found only were the main tuff unit is wide, dominantly in the centre of the unit, and only in steeply dipping zones.

Theyer (1984b), based on surface mapping, described the sedimentary unit hosting the gold mineralization at the God's Lake mine as fine grained volcanogenic(?) detrital and chemical sedimentary rocks. Theyer (1992) places the gold mineralization at the contact between aphanitic felsic (silicified?) rocks with chert fragments and overlaying basalt flows.

History of Exploration and Development:

In 1932 R.J. Jowsey and A. MacDonald made the original discovery in the Gods Lake area at Jowsey Island. On the strength of the original discovery a total of 148 claims were staked and God's Lake Gold Mines Limited[1] was incorporated to develop the claims. Trenching, diamond drilling and underground development outlined a deposit with reserves of 69 000 tonnes grading 14.74 g/tonne (0.43 oz/ton) gold. The mine went into

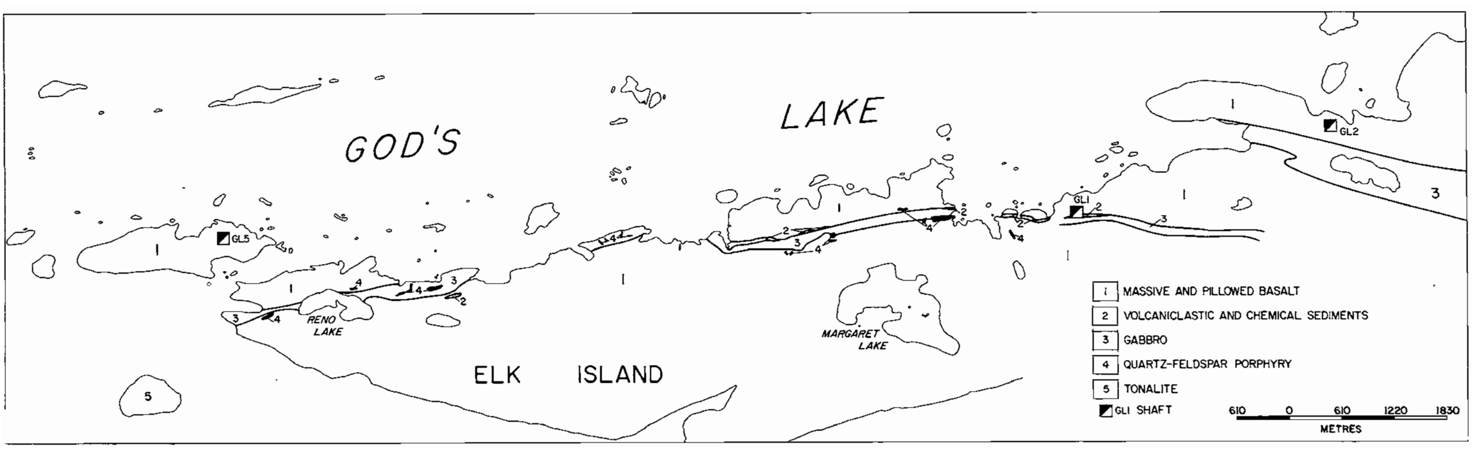


Figure 23: Geology in the area of the Gods Lake Mine (after God's Lake Gold Mine Ltd., company map).

production in 1935. During mine development additional reserves were discovered that extended the life of the mine until 1943; in total 490 866 tonnes of ore were mined to a depth of 267 m (Fig. 24).

[1] The lake name is spelled Gods Lake, the company name is spelled God's Lake.

The property was transferred to Lingman Lake Gold Mines Limited in 1948. Between 1987 and 1992 W. Bruce Dunlop Ltd. acquired most of the ground around God's Lake mine. Exploration work was carried out in 1994-95 (Manitoba Mines Branch records, 1996).

History of Production:

Year	Tonnes milled	Gold produced kg (oz.)
1935	13 616	117.5 (3 779)
1936	49 441	567.0 (18 231)
1937	55 766	553.0 (17 781)
1938	64 155	690.0 (22 183)
1939	65 860	802.9 (25 814)
1940	65 101	644.1 (20 711)
1941	66 130	681.8 (21 922)
1942	66 082	508.6 (16 353)
1943	44 715	425.4 (13 677)
Total	490 866	4990.3 (160 451)

Source: God's Lake Gold Mines Limited, Annual Reports 1935-1947

Selected Bibliography: Baker (1935); Brooks *et al.* (1982); Clark and Cheung (1977); Gilbert (1985b); Hubregtse (1985); Manitoba Mines Branch, Corporation File (God's Lake Gold Mines Limited), Mineral Inventory File (53L/9NE Au2); Southard (1977); Theyer (1984, 1991b, 1992); Wanless *et al.* (1966); Wright (1932).

DEPOSITS

Jowsey Island

Location: 560 km northeast of Winnipeg, Jowsey Island, Gods Lake.

Map Reference: Map ER86-1-2, location GL5.

Description of Deposit:

The deposit consists of two parallel quartz veins, the 'A' vein and Akers vein that occur within a 10 m wide shear zone hosted by Hayes River Group mafic flow rocks and quartz-feldspar porphyry dykes (Theyer, 1992). The Jowsey or A vein is at least 96 m long and has an average width of 1.36 m. The Akers vein is 1672 m long and up to 3 m wide. The veins are composed of grey to black quartz with disseminated pyrite, arsenopyrite, chalcopyrite, minor pyrrhotite and traces of visible gold. Theyer (1991b, 1992) describes intense pervasive silicification, carbonatization and sericitization along the shear zone.

History of Exploration and Development:

The initial discovery was made in 1932 by R.J. Jowsey, A. McDonald and R. Howie. In 1934 Jowsey Island Gold Mines Limited sank a 70 m shaft with levels at 30 m and 61 m. Drifting on the Jowsey vein outlined two mineralized zones on the 30 m level and one zone on the 61 m level. Following are assay results from these zones:

Mineralized Zone	Length	Width	Assay g/tonne (oz/ton) gold
1-A1	34.4 m	1.67 m	16.12 (0.47)
1-A2	34.7 m	1.10 m	6.86 (0.20)
2-A	23.7 m	1.95 m	8.23 (0.24)

A series of 15 horizontal drillholes were collared to the north and south of the 61 m level without intersecting significant mineralization. Operations were discontinued in July 1936.

W. Bruce Dunlop Ltd. acquired the Jowsey Island occurrence in the late 1980's. Exploration work was carried out in 1994-95 (Manitoba Mines Branch records, 1996).

Selected Bibliography: Baker (1935); Barry (1961); Quinn and Currie (1961); Davies *et al.* (1962); De Wet (1936); Dix (1951); Gilbert (1985b); Manitoba Mines Branch, Corporation File (God's Lake Gold Mines, Limited, Jowsey Island Gold Mines, Limited), Mineral Inventory File (53L/9NW Au1); Marten and Gilbert (1973); Theyer (1991b, 1992); Wright (1932).

Monument Bay (Twin Lakes/Seeber River)

Location: 100 km east of Gods Lake Narrows

Map Reference: Map ER86-1-2, location GL14

Description of Deposit:

With the exception of referenced information, the following data was

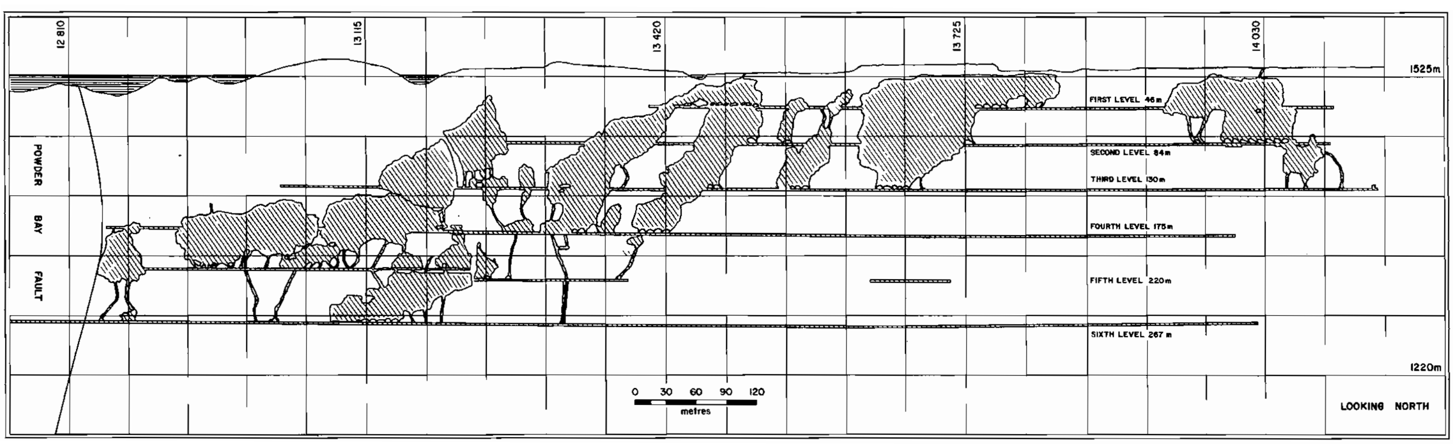


Figure 24: Longitudinal section of the Gods Lake Mine (after God's Lake Gold Mines Ltd., company longitudinal section).

Gods Lake Gold Mine Ltd., circa 1934, Elk Island on Gods Lake, Manitoba

supplied courtesy of Battle Mountain Canada Ltd. The Twin Lakes gold-bearing mineralization was discovered by Noranda Mining and Exploration Inc. in 1989. Follow-up diamond drilling in 1990-1991 outlined gold mineralization in the Twin Lakes Deposit (A and B Zones) and, 2 km to the west, in the Seeber River Deposit (C Zone). The Twin Lakes and Seeber River deposit areas have been tested along a total strike length of 3.5 km and depths ranging from 20 to 460 metres. Gold with accessory disseminated pyrite and arsenopyrite occurs in zones of pervasive silicification and/or quartz vein development within sericitized and silicified, felsic volcanic rocks. Both deposits occur within the 'Twin Lakes - Monument Bay deformation zone' that has been traced for more than 30 km (George Cross Newsletter Ltd., October 29, 1990).

Twin Lakes:

The Twin Lakes gold bearing zone has been tested by 22 diamond drillholes (total 7 518m) along a strike length of 1.2 km and depths ranging from 25 to 450 metres during 1989, 1990 and 1991.

The mineralized zones consist of a heterogeneous assemblage of sericitized and silicified, felsic to intermediate, massive and fragmental volcanic rocks with pyrite and arsenopyrite. The mineralization at Twin Lakes is characterized by discontinuous high grade shoots of auriferous mineralization within a large tonnage low grade envelope. High-grade intersections, within, and on both sides of the low-grade envelope consist of gold-bearing, massive, blue-grey quartz veins. Low-grade intersections range from 0.48 to 3.06 g/tonne (0.014-0.09 oz/ton) gold over 2.0 to 34.0 metres (true width). Higher grade intersections in the B Zone range from 6.73-24.16 g/tonne (0.2-0.7 oz/ton) gold over 1.4 to 3.4 metres.

Seeber River:

The Seeber River mineralized zone has been tested by 24 diamond drill holes (total 9 151 m), along a strike length of 2 km and vertical depths ranging from 20 to 460 metres during 1990 and 1991.

Host rocks to the Seeber Zone consist of undulose, pervasively silicified and sericitized, felsic volcanic rock with accessory pyrite and arsenopyrite. The Seeber River C Zone consists of a large low grade zone that contains a number of high grade shoots. Low-grade intersections range from 0.46 to 2.24 g/tonne (0.014-0.06 oz/ton) gold over 4.0 to 52.0 metres (true width). Higher grade intersections within the C Zone range from 5.9 to 16.4 g/tonne (0.17-0.48 oz/ton) gold over 3.0 to 6.7 metres

History of Exploration and Development:

The Twin Lakes gold-bearing zone was discovered by diamond drilling by Noranda Mining and Exploration Inc. under an area of highly altered boulders. Follow-up diamond drilling in 1990 and 1991 intersected mineralization in two deposits - the Twin Lakes A and B Zones and the Seeber River C Zone (Battle Mountain Canada Ltd., 1996). Bellex Mining Corporation and Hemlo Gold Mines Inc. became joint venture partners on the Monument Bay property in early 1991. Bellex could earn 50% in the property by spending $7 million over 5 years. At that time the property was reported (George Cross Newsletter Ltd., October 29, 1990) to have drill indicated geological reserves of 18 660 kg (600 000 ounces) of gold. Expenditures by Hemlo Gold Mines Inc. of $3.5 million had identified 3 gold-bearing zones; the Twin Lakes A and B Zones about 20-30 metres apart containing geological reserves of 2.5 million tonnes at 2.8 g/tonne (0.08 oz/ton) gold in the A Zone and 520 000 tonnes grading 15.77 g/tonne (0.46 oz/ton) gold in the B Zone. The Seeber River C Zone, 2 km to the west, had 650 000 tonnes at 9.87 g/tonne (0.29 oz/ton) (George Cross Newsletter Ltd., October 29, 1990).

In total the Twin Lakes and Seeber River Zones have been tested by 46 drillholes (16 669 metres), 22 in the Twin Lakes Zone (1989, 1990, 1991) totaling 9151 metres (Battle Mountain Canada Ltd., 1996).

In the Bellex-Hemlo Gold Mines Inc. drilling, a new zone, 1100 metres west of the Seeber Zone, was discovered. Hole 91-60 intersected 2.9 metres grading 96 g/tonne (2.8 oz/ton) gold (Northern Miner, June 3, 1996).

Estimated preliminary reserves at Monument Bay were reported to be; Twin Lake A Zone - 2.45 million tonnes grading 2.5 g/tonne (0.07 oz/ton) gold, Twin Lakes B Zone - 472 000 tonnes grading 14.3 g/tonne (0.42 oz/ton) gold and Seeber River C Zone 590 000 tonnes grading 9 g/tonne (0.26 oz/ton) gold (Northern Miner, April 3, 1991).

In early 1992 Dasserat Development Ltd. entered into an agreement to gain 50% of Bellex's interest in Monument Bay, but following a due diligence review Dasserat elected not to proceed (Northern Miner, March 9, 1992).

Selected Bibliography: Battle Mountain Canada Ltd., written communication, 1996; George Cross Newsletter Ltd., October 29, 1990; Northern Miner reports 1991, 1992).

Rusty Zone (Oxford Lake)

Location: 43 km SW of Oxford House, north shore of Oxford Lake

Map Reference: Map ER86-1-2, location GL3

Description of Deposit:

The Rusty Zone mineralization is associated with a long narrow gossan zone within Hayes River Group volcanic rocks at the west end (north shore) of Oxford Lake and occurs within a narrow (1.5 to 5.5 metres), well mineralized east-west zone of shearing associated with iron formation (Battle Mountain Canada Ltd., per comm. 1996; Northern Miner, April 23, 1990).

History of Exploration and Development:

The wide spread gossans, mostly exposed along shorelines, were known for many years and received sporadic exploration over 20-30 years. Noranda Exploration Company Limited began a comprehensive program in 1986 that included detailed ground geophysical, geochemical and geological surveys, prospecting and diamond drilling. At least 25 holes were drilled by 1989 into the Rusty Development Project and an indicated reserve of 800 000 tonnes grading 6 g/tonne (0.18 oz/ton) gold was outlined (Battle Mountain Canada Ltd., per comm., 1996; Northern Miner, April 23, 1990).

Early in 1990 the Lithium Corp. of Canada entered into an agreement with Hemlo Gold Mines Inc. to earn 50% interest in the property by spending $5 million over 4 years. The existing gold zone on the property, the Rusty Zone, was reported to have a strike length of at least 400 metres (Northern Miner, January 29, 1990). A drilling program tested the Rusty

Zone at depth and along strike. Narrow zones of mineralization, including 2.1 metres grading 5.7 g/tonne (0.17 oz/ton), were intersected in two holes at depths of 600 and 700 metres, 200 metres below the maximum depth previously drilled. Two kilometres east, along strike from the Rusty Zone, several narrow, low-grade mineralized zones as well as a 2 metre section grading 10 g/tonne (0.29 oz/ton) gold were intersected by diamond drilling (4 diamond drillholes; Northern Miner, April 23, 1990). Lithium Corp. indicated they would continue drilling in the area (Northern Miner, May 8, June 11, 1990). However, the property has been inactive since 1990.

Selected Bibliography: Manitoba Energy and Mines (1987)Bedrock Geology Compilation Map Series, Oxford House, NTS 53L; Battle Mountain Canada Ltd., written communication, 1996; Northern Miner reports 1990).

Little Stull Lake

Location: 115 km east of Gods Lake Narrows

Map Reference: Map ER86-1-2, location GL8

Description of Deposit:

The Little Stull Lake deposit was found in 1986 by Westmin Resources Ltd. in joint venture with Tanqueray Resources Ltd. Very little is known of the geology of this area and the deposit. Downie (1936) divided the supracrustal rocks in the Little Stull Lake area into the lower, mainly volcanic Hayes River Group and upper, mainly sedimentary derived Oxford Group. The main contact between these Groups occurs along the southern shore of Little Stull Lake. He also recorded minor iron formation in the region. Downie (1936) documented pronounced zones of shearing along the volcanic - sedimentary (Hayes/Oxford Groups) contact along the south shore of Stull Lake. Within these sheared zones Downie observed bodies of quartz and feldspar porphyry and lenticular bodies of blue quartz and quartz stringers with pyrite that, locally, carried visible or panned gold. Corkery (1981) reported that at Little Stull Lake the Hayes River Group is composed predominantly of mafic to intermediate pillowed to massive volcanic flow rocks and the Oxford Group mainly greywackes, polymictic conglomerates and feldspathic greywackes with minor intermediate to felsic volcanic rocks. The Hayes River Group rocks are highly deformed. Westmin Resources Ltd. and Tanqueray Resources Ltd. staked the area in 1984 and in 1986-88 outlined five gold bearing zones trending NW-SE, with steep to vertical dips, along a major zone of deformation, the “Little Stull Break”, that occurred mainly within volcanic rocks at or near the contact with the overlying sedimentary rocks. The gold bearing structure was traced for over 8 kilometres. Gold mineralization at Little Stull Lake is associated with disseminated arsenopyrite and pyrite, and as fine grained native gold, within a carbonatized sequence of mafic basalt flows, tuffs and iron formation (Northern Mine September 4, 1989). The “Break” is marked by a chlorite-calcite schist and narrow parallel iron formation layers in the vicinity of the mineralization (Fig. 25).

History of Exploration and Development:

Barringer Magenta Ltd. investigated a number of greenstone belts in

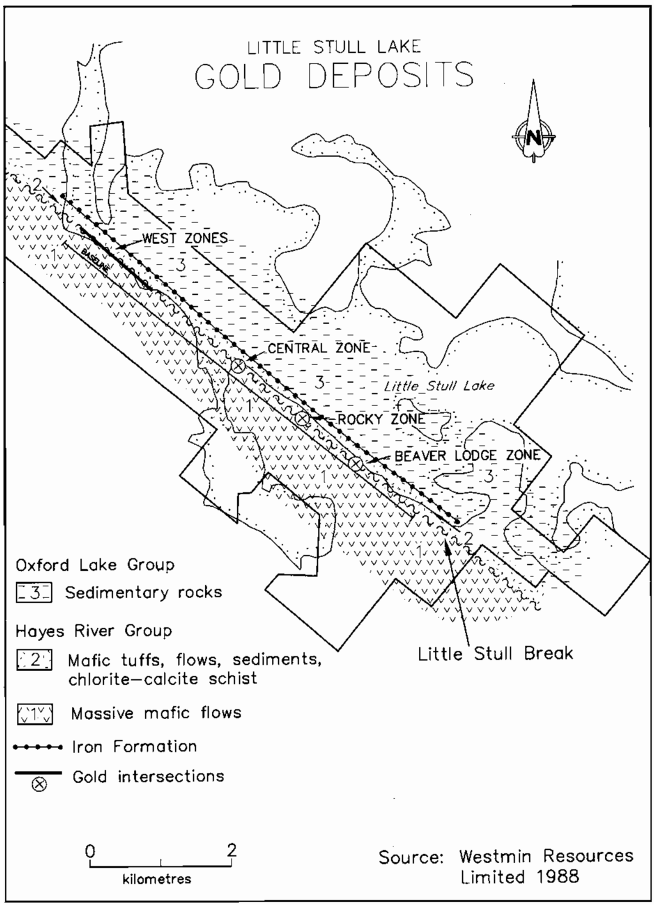


Figure 25: Geology of the Little Stull Lake gold deposit (after Westmin Resources Ltd., 1988).

the Oxford - Gods region in the early 1980's. Westmin Resources Limited made a deal with Barringer (10% NPI) and staked 13 claims in the Little Stull Lake area in 1984. Later Tanqueray Resources limited and Estaurum Mines Ltd. became joint venture partners. From 1986 to 1989 Westmin and partners spent over $5 million on their 2700 hectare property, mainly on 202 diamond drillholes (30 537 metres), and outlined a gold bearing structure over 8 km long, the "Little Stull Break". Within the "Break", five gold zones have been encountered from SE to NW - 'Beaver Lodge', 'Rocky', Central, West and Otter Zones. To date the best zone appears to be the West Zone with an estimated geological inventory of 7800 kg of gold (250 000 ounces) in about 750 000 tonnes grading 9.3 g/tonne (0.27 oz/ton) gold down to the 300 metre level. This represents about 25% of the strike length. All zones are open at depth and in most cases along strike (Tanqueray Resources Ltd. Release Oct. 12, 1992).

In 1989 forest fires raged through much of northern Manitoba and destroyed the Little Stull camp and drill core facilities (Westmin Resources Limited 1989 Annual Report). In an agreement signed August 1, 1991 Tanqueray could obtain 100% interest in the property from Westmin by continuing exploration, issuing shares and giving a royalty interest. The agreement expires December 31, 1996. Tanqueray intended to conduct a complete review of all work and planned to do underground exploration.

Selected Bibliography: Manitoba Mine Branch Corporation File (Tanqueray Resources Ltd.); Downie (1936); Corkery (1981).

Atik Lake

Location: Mistuhe Island, Atik Lake (formerly Utik Lake)

Map Reference: Map ER86-1-2, location GL 15.

Description of Deposit:

The following description is from Bernier and Maclean (1989). Gold mineralization is associated with sulphides in poorly banded chert (Fig. 26) that forms part of banded iron formation (BIF) that caps tholeiitic, in part glomeroporphyritic basalts of the Hayes River Group. Metamorphic grade is lower amphibolite facies (*circa* 575°C, 3 kb, Mezger *et al.,* 1990). At least 5 layers of BIF occur within the southerly facing homocline of the Atik Lake greenstone belt (Weber, 1974).Three types of iron formation occur in three of those Layers: 1) auriferous sulphide-bearing chert with small massive sulphide lenses (pyrrhotite, pyrite, sphalerite and chalcopyrite) containing chert and schist fragments, commonly associated with thin argillite interlayers; 2) banded chert-magnetite; and 3) banded chert-grunerite-magnetite. More than one facies may occur together. Several basalt flows have stratiform hydrothermal alteration (up to 15 m thick) below the capping iron formation(Fig. 26), but only a glomeroporphyritic unit has several fracture controlled alteration pipes (up to 30 m wide) perpendicular

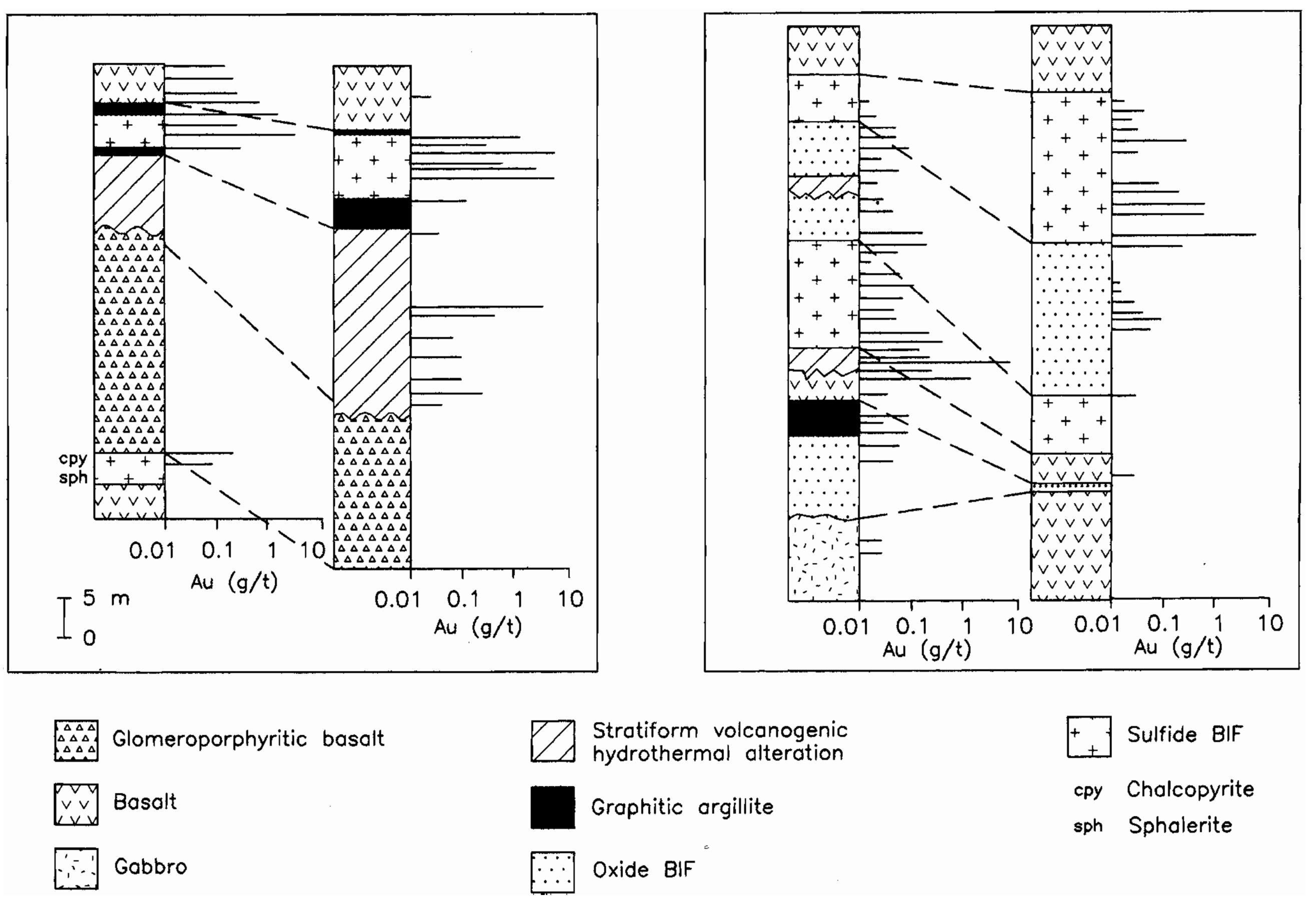


Figure 26: Detailed sections of banded iron formation and auriferous chert from two locations at Atik Lake. Gold contents are on a logarithmic scale (after Bernier and Maclean, 1989).

to the flow (Fig. 27). It is the iron formation above these pipes that has the highest gold values (Fig. 26), 1 km along strike from the pipes. The alteration pipes have different zones (from outer contact to inner conduit; Fig. 27): 1) bleached glomeroporphyritic basalt; 2) cordierite-gedrite-garnet zone; 3) andalusite-rich zone; and 4) pipe conduit filled with chert and disseminated sulphide (pyrrhotite, loellingite, arsenopyrite, chalcopyrite, sphalerite), and fragments of the overlying BIF slumped into the upper part of the conduit

Mass and element changes calculated by Bernier and Maclean (1989) in the altered rocks of the pipes are similar to those in alteration associated with Noranda-type volcanogenic massive sulphide deposits (Morton and Franklin, 1987). The fact that some samples of the stratiform alteration have elevated gold values and the association of the gold with a specific suite of trace metals (As, Zn, Cu, Ba, and Sb), which is identical to that in recent siliceous, gold-enriched massive sulphides deposited on the sea floor (Hannington *et al.,* 1986), indicate that the formation of auriferous chert was most likely syngenetic, contemporaneous with volcanogenic hydrothermal alteration.

History of Exploration and Development:

In 1987 a joint venture between Westmin Resources Ltd., Barringer Magenta Ltd. and Polestar Exploration Inc. began an exploration program at Atik Lake. An earlier trench into the iron formation at Mistuhe Island returned an assay of 8.4 g/tonne (0.29 oz/ton) gold over 2 metres. A 456 line kilometer airborne EM-Mag. survey was flown and 12 holes were drilled (1130 m) along about 1.5 km of the iron formation. The first hole beneath the trench penetrated three sections returning 3 g/tonne (0.09 oz/ton) gold over 1 metre and 3 metres, and 3.7 g/tonne (0.10 oz/ton) over 1 metre. Hole 11, 500 m east of the trench, intersected 3.6 g/tonne (0.11 oz/ton) gold over 0.7 metre. The other holes reported weak gold values. Additional drilling was planned near mineralized areas, on several soil anomalies and where surface grab samples of sulphide bearing chert from BIF returned as high as 25 g/tonne (0.73 oz/ton) gold. In all 36 holes were completed and Westmin reported that gold assays ranging from 3-5 g/tonne (0.09-0.15 oz/ton) gold were cut by four of the holes (Northern Miner, April 27, July 13 and Sept. 14, 1987).

Selected Bibliography: Bernier and Maclean (1989); Weber (1974)

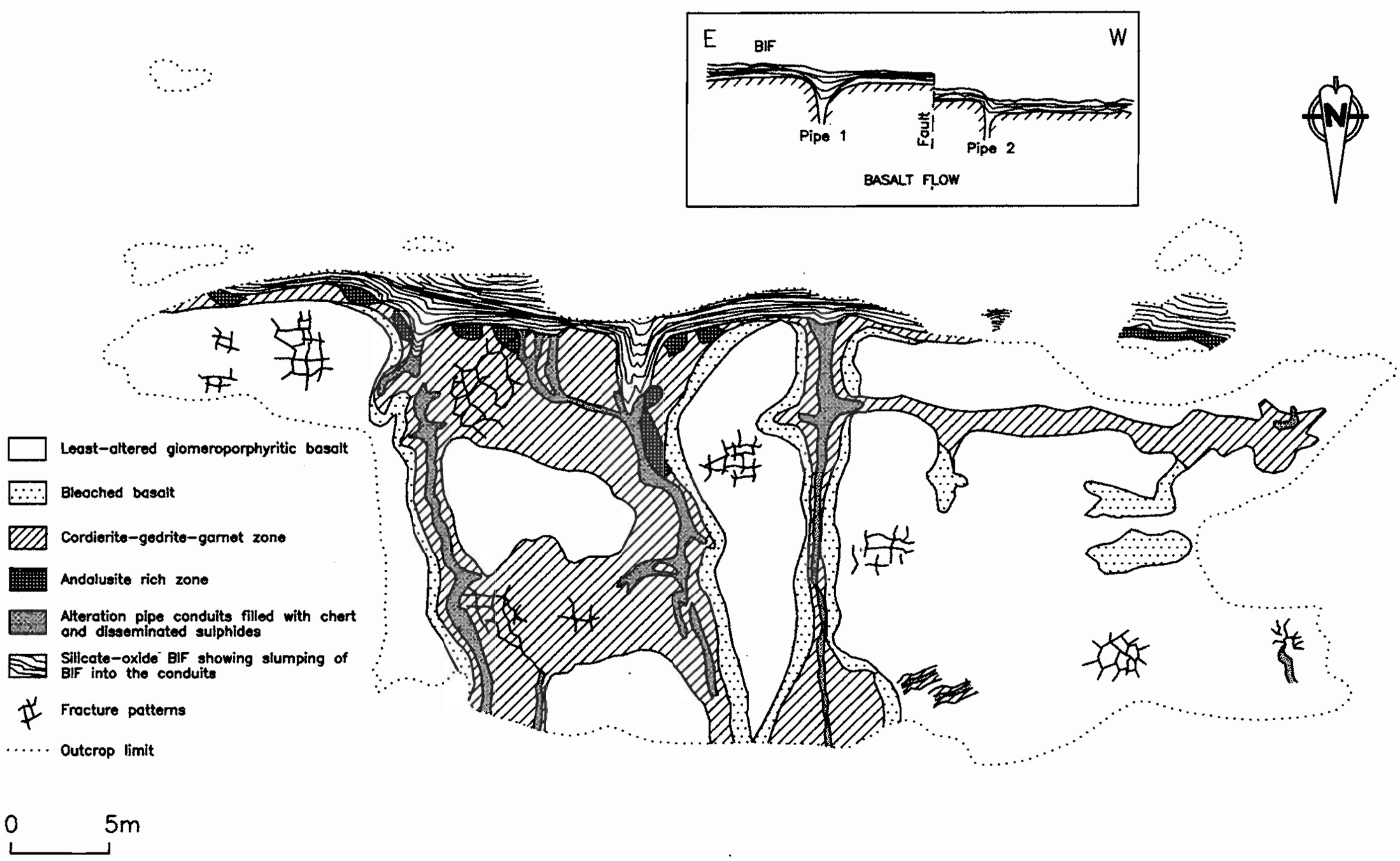


Figure 27: Outcrop map of a volcanogenic hydrothermal alteration pipe, Atik Lake. The inset is a schematic diagram showing the relationship between pipe 1, pipe 2, stratiform alteration (hatched), and banded iron formation (after Bernier and Maclean, 1989).

TABLE 9: SUMMARY OF MAIN GOLD DEPOSITS/OCCURRENCES IN THE OXFORD LAKE-KNEE LAKE-KISTIGAN LAKE AREA

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
GODS LAKE GL1 Map ER86-1-2	Past producer 1935-43: 490 866 tonnes at 9.7 g/t (0.28 oz/ton) gold mined to 267 m depth; 4990 kg (160 428 oz) gold produced.	unknown	quartz veins/stringers in fractured/silicified 'tuff' unit along contact with gabbro; gangue minerals: pyrrhotite, pyrite, arsenopyrite, galena, chalcopyrite	W. Bruce Dunlop Limited (1996)
JOWSEY ISLAND GL5 Map ER86-1-2	Prospect 36.7 m deep exploration shaft	2 ore shoots about 34 m x 1.5 m, grades from 6.9 to 16.1 g/tonne (0.20-0.47 oz/ton)	quartz veins in carbonatized shear zone in mafic volcanic rocks and quartz -feldspar porphyry dykes; gangue minerals: pyrite, arsenopyrite, chalcopyrite, pyrrhotite	W. Bruce Dunlop Limited (1996)
MONUMENT BAY GL14 Map ER86-1-2	Prospect 1989-91: 16 670 m drilling in 46 holes	1991 geological reserves: "Twin Lake A Zone" 2.45 million tonnes, 2.5 g/t (0.07 oz/ton); "B Zone" 472 000 tonnes, 14.3 g/t (0.42 oz/ton) and "Seeber River C Zone" 590 000 tonnes, 9 g/t (0.26 oz/ton)	quartz veins/zones of silicification within felsic volcanic rocks; gangue minerals: pyrite, arsenopyrite	Battle Mountain Canada Ltd. (1996)
LITTLE STULL LAKE GL8 Map ER86-1-2	Prospect 1986-89: 30 537m drilling in 202 holes	1989 "West Zone" 750 000 tonnes at 9.3 g/t (0.27 oz/ton)	quartz veins/stringers in carbonatized sheared zone along or close to contact between volcanic rocks and sedimentary rocks, including iron formation; gangue minerals: pyrite, arsenopyrite	Westmin Resources Limited and Tanqueray Resources Limited (1996)
RUSTY ZONE GL3 Map ER86-1-2	Prospect 1987-89: at least 25 drill holes	1990: 800 000 tonnes at 6 g/t (0.18 oz/ton)	mineralization in zone of shearing within iron formation; gangue minerals: unknown	Battle Mountain Canada Ltd. (1996)
ATIK LAKE GL15 Map ER86-1-2	Prospect 1987: 36 drill holes	unknown	sulphide bearing chert of banded iron formation overlying basalt; associated sulphides: pyrrhotite, pyrite, chalcopyrite, sphalerite	Westmin Resources Ltd. (1996)

CROSS LAKE-PIPESTONE LAKE-ECHIMAMISH RIVER AREA

REGIONAL GEOLOGY

Introduction

The Cross Lake-Pipestone Lake-Echimamish River area forms part of the Cross Lake domain in the northern Superior Province of Manitoba (Map ER86-1-2). A greenstone belt hereby termed the Cross lake greenstone belt underlies Cross Lake, Pipestone Lake, and extends in an easterly direction along Echimamish River, through Robinson Lake, where it bifurcates into a greenstone belt through Munro Lake and another greenstone belt striking through Goose Lake (Map ER86-1-2).

General Geology

The Cross Lake area has been previously described by Alcock (1920a), Horwood (1934), Rousell (1966), and more recently by Corkery (1983, 1985a), Corkery and Lenton (1984), and Corkery *et al.* (1992). Tanton (1937) and Weber and Schledewitz (1980) conducted mapping in the Echimamish River-Robinson Lake area.

Similar to the Island Lake and Oxford Lake greenstone belts, the Cross Lake greenstone belt was divided into an older sequence of volcanic and sedimentary rocks, the Hayes River series that was intruded by granitoid rocks and unconformably overlain by a younger sedimentary sequence termed the Cross Lake series (Horwood, 1934). Rousell (1966) found no evidence for an unconformity within the supracrustal rocks and assigned the entire sedimentary and volcanic sequence to the Cross Lake Group. Recent mapping, started in the early 1980's (Corkery, 1983), redefined the main two-fold subdivision within the supracrustal sequences. Corkery (1986) renamed the older sequence of volcanic and sedimentary rocks the Pipestone Lake Group. The Pipestone Lake Group has been intruded by syn- to post volcanic 'Early Intrusive rocks' and Kenoran plutons (Table 10). All of these rocks are unconformably overlain by the Cross Lake Group that includes predominantly sedimentary and minor volcanic rocks; granite plugs, related rare element-enriched pegmatites, and mafic plugs are part of 'Late intrusive rocks'. Later, Corkery *et al.* (1989) recognized a third distinct volcano-sedimentary sequence assemblage, the Gun Point Group, in the Cross Lake area (Table 10).

Results from the most recent mapping, *i.e.,* the lithostratigraphic subdivisions, characteristic lithologies and relative age relationships between various lithostratigraphic subdivisions, as well as recent U-Pb zircon age determinations are listed in Table 10 and provide a frame work indicative of the evolution of the Cross Lake greenstone belt.

The eastern extension of the Cross Lake belt comprises mainly mafic flows of the Pipestone Lake Group. Interlayered gabbro is locally glomeroporphyritic, *e.g.* on Robinson Lake. Felsic volcanic rocks reported from the Echimamish River area (Tanton, 1937) are probably, at least in part, silicified mafic flows (Weber and Schledewitz, 1980), but geochemical data are lacking.

Several isolated occurrences of serpentinized peridotites have been mapped or drilled in the Munro Lake greenstone belt and the Goose Lake belt (Manitoba Energy and Mines, 1987). These bodies have a linear distribution and may be have been re-emplaced into deformation zones. Arenites and conglomerates at Goose Lake (Manitoba Energy and Mines, 1987) may be part of the Cross Lake Group or they are part of the older 3.0 Ga platform sequence found elsewhere in the Superior Province, *e.g.* in the Wallace Lake Subgroup in the Rice Lake belt (this report) and in several greenstone belts in the Sachigo Subprovince (the eastern extension of the Gods Lake Subprovince in Ontario) *(cf.* Thurston *et al.,* 1991).

TABLE 10: LITHOSTRATIGRAPHY OF THE CROSS LAKE-PIPESTONE LAKE AREA
(after Corkery *et al.,* 1992; Syme *et al., 1993)*

Lithostratigraphic Subdivision	Age	Lithologies	Tectonic setting
Late Intrusive Rocks*ca.*	2664-2634 Ma	granite plugs and REE pegmatites, quartz-feldspar porphyries, gabbro plugs	Major deformation and metamorphism
	——Intrusive contact——		
Cross Lake Group	2719-2709 Ma	conglomerate, sandstone, shoshonitic mafic flows, minor felsic pyroclastic rocks, sandstone/siltstone/shale	rifting volcanism, sedimentation in a fault-bounded basin
	——Unconformity——		
Kenoran plutons	≥ 2719 Ma	granodiorite-tonalite plutons	Kenoran metamorphism and deformation, plutonism
	——Intrusive contact——		
Gunpoint Group*ca.*	2732-2718 Ma	fragmental rhyodacite, conglomerate, sandstone/mudstone	
	——Unconformity——		accretion?
Early Plutonic Rocks	*ca.* 2765-2747 Ma	tonalite, gabbro-anorthosite and dunite gabbro layered intrusions	arc plutonism
	——Intrusive contact——		
Pipestone Lake Group	≥ 2758 Ma	high-magnesium basalt and komatiite flows, plagiophyric tholeiitic basalt, greywacke/argillite, minor iron formation	back arc/oceanic volcanism

METAMORPHISM AND STRUCTURE

The supracrustal rocks of the Cross Lake greenstone belt exhibit mineral assemblages indicative of upper greenschist to middle amphibolite facies grade metamorphism. To the northwest, near the Pikwitonei domain the metamorphic grade increases to granulite facies (Rousell, 1966).

Deformation prior to deposition of the Cross Lake Group is poorly documented due to later structural overprint. It includes the initiation of major linear shear zones (Corkery *et al.,* 1992). Corkery *et al. 1988)* recognized 3 periods of major deformation in the Cross Lake greenstone belt that postdate deposition of the Cross Lake Group. D_1 deformation is characterized by isoclinal to open folding of compositional layering (S_0) with steep axial planes generally parallel to the boundaries of the greenstone belt, and with moderately to steeply-plunging fold axes. The second period of deformation (D_2) is marked by the generation of extensive ductile shear zones parallel to the greenstone boundaries in a compressive stress regime. The shear zones had a dextral sense of movement and a vertical component resulting in relative uplift of the granitoid terranes south and northwest of the Cross Lake greenstone belt. D_2 shear zones are commonly re-activated during later deformation. In the northeast-trending branch of the Cross Lake belt the east-trending greenstones were folded in a northeasterly direction and intensely compressed. F_1 related structures were refolded by tight Z-folds with steep axial planes and steeply plunging axes. The D_3 episode of deformation Z-folds D_1 and D_2 related structures in the northwest Cross Lake area. Ductile to brittle faults were generated in the supracrustal belt and the adjacent granitoid terrane during D_2 and later representing a compressive regime and uplift at high crustal levels (Corkery *et al.,* 1988).

MINERALIZATION

Gold has been found at two locations in the Cross Lake area: 1) the O'Day occurrence (CL1), 15 km east of Butterfly Lake and northeast of the easternmost bay of Birch Lake; 2) the Scott No. 1 occurrence (CL2), located on an island in the central part of Cross Lake (Map ER86-1-2, Fig. 28). Alcock (1920a) also reported that quartz veins on the north shore of Pipestone Lake contain trace amounts of gold.

At the O'Day occurrence a quartz vein in chlorite schist contains disseminations of arsenopyrite, pyrrhotite, chalcopyrite and up to 1.3 mm diameter gold grains (Tanton, 1937). A channel sample of the quartz vein assayed 77.15 g/tonne (2.25 oz/ton) gold over a width of 1.2 m. In 1984 and 1985 joint venture partners Kennco Explorations Ltd. and Claude Resources Inc. carried out prospecting, mapping and geophysical surveys in the Butterfly Lake-Echimamish River area.

The location and geology of the Scott No. 1 occurrence is poorly documented. Tanton (1937) observed the presence of gold, pyrite, pyrrhotite and arsenopyrite in quartz-filled shear zones in the area of the hook-shaped island on Cross Lake (Fig. 28). The mineralization may occur within or southeast of an area that Corkery and Lenton (1984) described as an arcuate tectonic zone 50 to 100 m thick consisting of irregularly spaced 1 to 4 m wide shear zones that were probably formed during the D_2 deformation episode and may have been later re-activated.

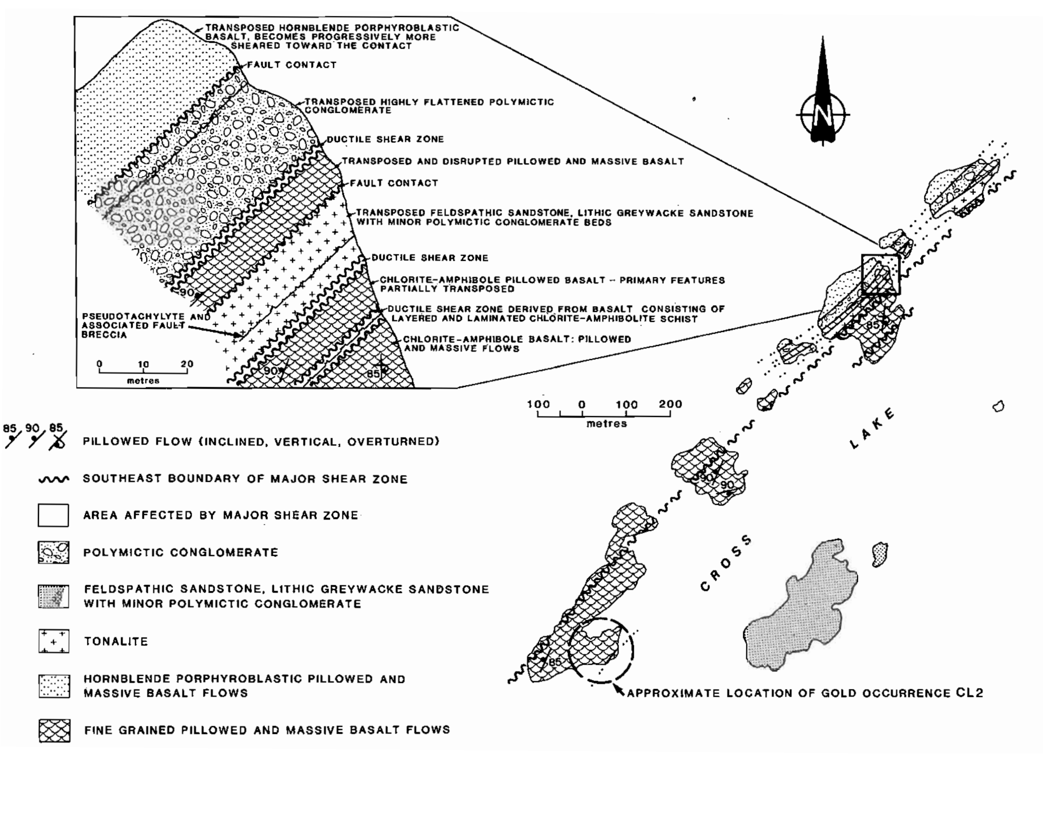


Figure 28: Geology in the area of the Scott No.1 occurrence (after Corkery and Lenton, 1984).

CHURCHILL-SUPERIOR BOUNDARY ZONE

REGIONAL GEOLOGY

The Churchill-Superior Boundary Zone in Manitoba is a 10-35 km wide belt of variably reworked Archean gneisses and Paleoproterozoic cover rocks. This reworking is a structural and metamorphic overprint that has been interpreted as a result of overriding of the Superior margin by the adjacent Churchill plate during Hudsonian collision tectonics (Weber, 1990; Bleeker, 1990a,b). Recent reflection seismic data indicate that the Superior plate wedged itself into the Churchill plate during the final stages of the this collision (White and Lucas, 1994).

The Churchill-Superior Boundary Zone has been divided into three segments along its extent in Manitoba (from southwest to northeast): Thompson belt, Split Lake block and Fox River belt (Map ER86-1-2).

The north and northwest margin of the boundary zone is in fault or thrust contact with gneisses of the Churchill Province. The southern and southeastern contact is placed at the outer limit of the Hudsonian overprint, *i.e.,* where granulite facies rocks of the Pikwitonei Domain grade into their overprinted equivalents of the boundary zone (Weber and Scoates, 1978; Map ER86-1-2), or along faults near this transition zone, *e.g.* along the southern boundary of the Split Lake block (Map ER86-1-2).

The Thompson belt is underlain predominantly by amphibolite facies migmatitic and layered felsic gneisses, minor amphibolite and metagabbro that have been derived largely from Pikwitonei type granulites. These gneisses are unconformably overlain by Paleoproterozoic supracrustal rocks of the Ospwagan Group. The Ospwagan Group rocks occur as narrow elongate lenses within the migmatites and gneisses along the western margin of the Thompson belt (Map ER86-1-2).These lenses of supracrustal rocks have been interpreted as parts of nappes that have undergone 3 phases of folding; F_1 and F_2 recumbent folding during nappe emplacement from the northwest and F_3 upright folding during sinistral transpression with southeast and northwest plunging fold axes (Bleeker, 1990a,b, 1991).

The Ospwagan Group comprises a lower section of sedimentary rocks divided into four formations and upper sequence, the Ospwagan Formation which consists of mafic and ultramafic volcanic rocks (Bleeker, 1990b). The sedimentary rocks of the lower Ospwagan Group comprise: conglomerate and quartzose sandstone (Manasan Formation), calcareous metasediments (Thompson Formation), pelitic metasediments, and oxide-, silicate- and sulphide-facies iron formations (Pipe Formation) and aluminous and quartzose metasandstones (Setting Formation). Ultramafic rocks occur as dykes and sills within the Archean gneisses and the Ospwagan Group. They host the nickel deposit of the Thompson Nickel belt. The richest deposits are associated with sills that intruded into sulphide facies iron formations of the Ospwagan Group. However, some of the massive nickel sulphides have separated from the original ultramaf.ic host during the intense deformation in the belt (Bleeker, 1990b).

The age of the Ospwagan Group rocks is yet unknown. They are older than 1883 Ma Molson dykes (Heaman *et al.,* 1986), which intrude F_2 fold structures in the sedimentary rocks. A model lead age on sulphides has yielded 2015±15 Ma (Cumming *et al.,* 1982). Hudsonian metamorphism was determined to have lasted in the Thompson belt from *circa* 1810 Ma to 1720 Ma (Machado *et al.,* 1990).

The Split Lake block comprises reworked and retrogressed Pikwitonei type rocks, similarly to the Thompson belt. Rocks of the Split Lake block include tonalitic gneiss, tonalite, anorthosite, amphibolite and gabbro, and Late Archean granitoid rocks. The boundaries with the Churchill Province and the Pikwitonei domain are marked by intense mylonite zones (Corkery, 1985b). Slivers of supracrustal rocks of Churchill Province and Ospwagan Group affinities occur in these fault zones (Manitoba Energy and Mines, 1991)

The Fox River belt is an Paleoproterozoic supracrustal belt that comprises a north-facing homoclinal succession and is in probable lower and upper thrust contact with Superior Province gneisses and Churchill Province paragneiss, respectively. The belt contains: Lower sedimentary and Lower volcanic formations, a Middle sedimentary formation, into which the over 250 km long Fox River differentiated ultramafic-mafic sill intruded, and Upper volcanic and Upper sedimentary formations (Scoates, 1981). The Lower sedimentary formation includes iron formation, carbonates, sandstone and conglomerate. The Upper sedimentary formation contains carbonaceous siltstone and shale. The Lower and Upper volcanic formations are similar and comprise basalt and komatiitic basalt. The ultramafic-mafic extrusive rocks and differentiated sill are considered consanguineous (Scoates, 1990). Zircons from the sill yielded a U-Pb age of 1883±2 Ma (Heaman *et al.,* 1986). Metamorphic grade ranges from prehnite-pumpellyite facies at the top to lower greenschist facies at the base of the succession (Weber and Scoates, 1978).

MINERALIZATION

Gold mineralization occurs in the Split Lake block within a mylonitic zone at the north end of Assean Lake, 105 km northeast of Thompson. At the Dunbrack and the Lindal occurrences (Map ER86-1-2, locations SL1, SL2; Manitoba Energy and Mines, 1991) mineralization occurs in discontinuous quartz veins that parallel cataclastic structures in the host rocks comprising biotite gneiss, *lit-par-lit* gneisses, quartzofeldspathic mylonites and cataclastic amphibolite representing a supracrustal sliver of Ospwagan Formation (Manitoba Energy and Mines, 1991). The mineralization includes galena, sphalerite, chalcopyrite, pyrite, and locally visible gold (Haugh, 1969).

Sherritt Gordon Mines Ltd. drilled eleven holes along the Dunbrack vein in 1938. Of these, eight intersected a quartz vein that yielded assays ranging from 4.11 to 33.60 g/tonne (0.12 to 0.98 oz/ton) over widths of 0.49 to 0.92 m (Manitoba Energy and Mines, Mines Branch, Mineral Inventory File, 64 A/1 Au1). In 1983 Nor-Acme Gold Mines, Limited and joint venture partner Arbor Resources Inc. were active in the area and completed an exploration program that consisted of trenching, sampling and diamond drilling. In 1986 Homestake Mineral Development Company optioned Nor-Acme's Assean Lake property and completed a winter drill program.

FLIN FLON-SNOW LAKE GREENSTONE BELT

REGIONAL GEOLOGY

Introduction

The Paleoproterozoic Flin Flon-Snow Lake greenstone belt is situated in the southeastern part of the (exposed) Churchill Province in the Reindeer Zone of the Trans-Hudson orogen, of the Canadian Shield (Fig. 4,5). The greenstone belt has approximate dimensions of 250 km east-west by 50 km north-south and extends from 30 km east of Snow Lake Manitoba to 50 km west of Flin Flon, Manitoba into Saskatchewan (Map ER86-1-3; Fig. 29).

The Flin Flon-Snow Lake greenstone belt has gradational and/or fault or thrust contacts with the Kisseynew gneiss domain to the north and is unconformably overlain by Ordovician dolomites and limestones along its southern margin. The study of drillhole data and interpretations of aeromagnetic data indicate that the greenstone belt extends south underneath Paleozoic cover, although faulting has brought lower crustal level gneisses into juxtaposition with higher levels greenstones in the southwestern part of the unexposed Flin Flon belt, south of Athapapuskow Lake (Leclair *et al.,* 1993; Manitoba Energy and Mines, 1992).

Historically the supracrustal rocks of the Flin Flon-Snow Lake belt have been divided into the volcanic and derived sedimentary rocks of the Amisk Group and the unconformably overlying continental sedimentary rocks of the Missi Group (Bruce 1918; Harrison, 1951b). Numerous felsic-mafic dykes, stocks and sills and granitic batholiths intrude the Flin Flon-Snow Lake greenstone belt.

Amisk Group

On the basis of detailed mapping in the Flin Flon region Bailes and Syme (1989) have determined that the basic structural pattern in that area is dominated by numerous fault-bounded blocks, each characterized by a unique stratigraphic sequence of Amisk Group rocks that cannot be correlated with sequences in adjacent blocks.

Stauffer *et al.* (1975) estimate that approximately 85% of the Amisk Group in the Flin Flon area consist of mafic to intermediate volcanic rocks. Felsic volcanic rocks occur at numerous stratigraphic levels (Syme *et al.,* 1982). Volcanogenic greywacke, siltstone, mudstone and chert layers are relatively rare but occur throughout the volcanic rock sequences (Bailes and Syme, 1989).

In the Elbow Lake area McGlynn (1959) estimated that the Amisk Group comprises up to 5700 m of dominantly mafic volcanic flows and associated pyroclastic units; felsic volcanic rocks and siliceous iron formation are locally important intercalations. More recently Galley *et al.* (1985) divided the supracrustal rocks in the Elbow Lake area into three zones, each characterized by a unique lithologic sequence: 1) mafic flows with minor pyroclastic rocks; 2) tuffaceous rocks now altered to chlorite-carbonate + sericite schists with minor iron formation; and 3) well layered tuffs, gradational into mafic volcanic rocks. The Amisk Group in the File Lake-Snow Lake area comprises mafic to felsic volcanic rocks with intercalated volcanogenic sedimentary units that become dominant near the top of the succession (Harrison, 1949; Froese and Moore, 1980; Bailes, 1980; Walford and Franklin, 1982). In the File Lake area Bailes (1980) estimated that the dominantly volcanic succession is at least 2000 m thick

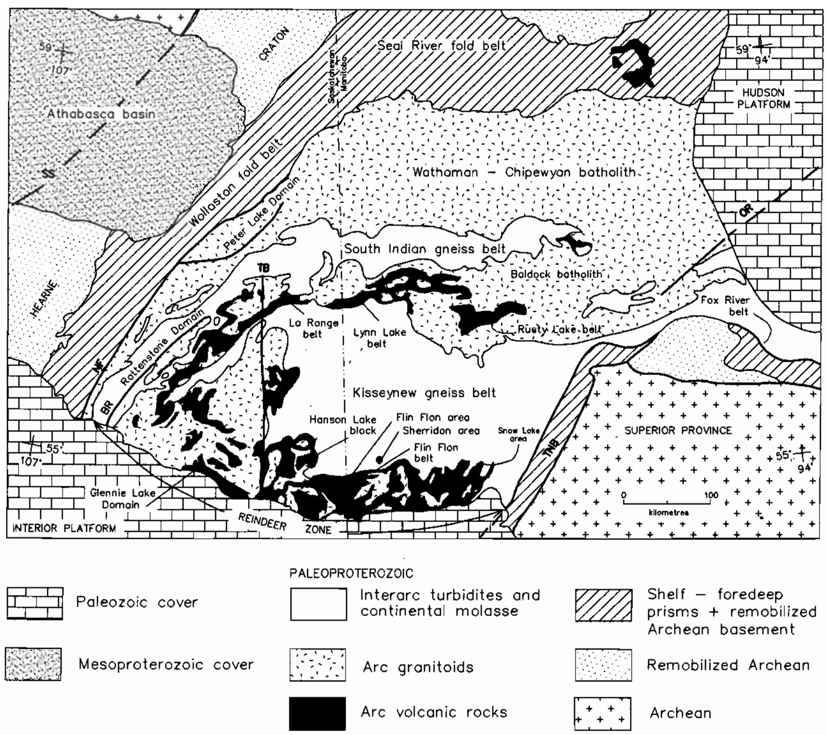


Figure 29: *Lithotectonic domains of Trans-Hudson orogen, Manitoba-Saskatchewan (after Hoffman, 1988). SS-Snowbird shear zone; NF-Needle Falls shear zone; BR-Blrch Rapids shear zone: TB-Tabbernor fault; TNB-Thompson Nickel belt; OR-Owl River shear zone*

and consists of 80% mafic flow rocks and related breccias with thick accumulations of felsic volcanic rocks constituting the remainder. At Snow Lake felsic volcanic rocks are as abundant as mafic volcanic rocks within the Amisk Group (Walford and Franklin, 1982). Up to 1000 m of Amisk Group volcanogenic sandstone/mudstone turbidites overly the volcanic rocks (Froese and Moore, 1980; Bailes, 1980). These turbidites and the substantial volume of felsic rocks, particularly in the immediate vicinity of Snow Lake, distinguish the Amisk Group in this area from that in the Flin Flon region (Syme *et al.,* 1982).

Chemically, the Amisk Group volcanic rocks exhibit both tholeiitic and calc-alkaline affinities (Stauffer *et al.* 1975; Fox, 1976). The prevalence of pillowed lavas, mafic to felsic volcanism, submarine volcaniclastics and turbidite deposits and the tholeiitic chemical affinity displayed by the least altered mafic volcanic rocks suggest deposition in an island-arc tectonic environment (Stauffer *et al.,* 1975; Fox, 1976; Syme *et al.,* 1982).

Missi Group

The Missi Group is the youngest supracrustal succession in the Flin Flon greenstone belt. It comprises up to 3000 m of thin bedded to massive sandstone, pebbly sandstone and/or polymictic conglomerate. The lensoidal nature of units, their generally arkosic composition, ubiquitous presence of accessory hematite and/or magnetite, variations in sorting, small- to medium-scale crossbedding, scour and fill structures and lack of fine sedimentary material, ripple marks and flute casts indicate deposition in an alluvial/fluvial environment (Mukjerhee, 1971; Stauffer, 1974; Bailes and Syme, 1983).

In the Flin Flon area Bailes and Syme (1983) have delineated a major angular unconformity between the Amisk and Missi Groups that truncates at least 2500 m of Amisk strata. The unconformity is marked locally by a hematitic regolith up to several metres thick.

At Snow Lake Froese and Moore (1980) describe rocks of the Missi Group succession as a monotonous sequence of metamorphosed lithic arenites. The Missi Group of the File Lake and Snow Lake areas differs from the Missi Group at its type localities in the Flin Flon region by the relative absence of conglomerate layers and apparently conformable deposition over turbiditic greywacke units rather than subaerially weathered volcanic rocks (Bailes, 1980; Froese and Moore, 1980).

Volcanic rocks that include welded tuffs have been identified in the Missi Group east of Wekusko Lake in the Snow Lake area (Shanks and Bailes, 1977; Gordon and Gall, 1982). The volcanic rocks are predominantly fragmental felsic units; however, massive intermediate flows and related breccias occur locally. The lack of pillow structures and presence of welded tuffs led Shanks and Bailes (1977) and Gordon and Gall (1982) to infer a subaerial environment of deposition.

Intrusive Rocks

Intrusive rocks of various ages and compositions occur throughout the Flin Flon-Snow Lake belt. The earliest intrusions recognized are synvolcanic mafic to felsic sills and dykes, and granitoid, commonly porphyritic plutons that are restricted to the Amisk Group and related to Amisk volcanism (Bailes and Syme, 1980, 1984; Baldwin, 1980; Walford and Franklin, 1982). Numerous strongly differentiated gabbroic sills, some possibly synvolcanic, occur throughout the belt and have been documented in the Flin Flon (Bailes and Syme, 1989), File Lake (Bailes, 1980) and Snow Lake (Williams, 1966) areas.

Evidence of a plutonic event occurring after the cessation of Amisk volcanism and prior to deposition of the Missi Group is suggested by Stauffer (1974) who identified a heterogeneous granitoid complex unconformably overlain by Missi strata near Flin Flon. In addition, the widespread occurrence of granitic clasts in the Missi suggests that plutonism, uplift and erosion took place prior to Missi Group sedimentation.

Larger granitic-granodioritic plutons of up to batholithic dimensions intrude and, in places, segment the belt. These intrusions are considered to be largely syntectonic as their margins are broadly concordant with stratigraphy of the adjacent greenstone belt and contain the same foliation as the supracrustal rocks (Price, 1977). Late granitic and pegmatitic intrusions cut all earlier rocks.

METAMORPHISM

Regional metamorphism began after deposition of the Missi Group. The majority of supracrustal rocks in the Flin Flon area have undergone lower to middle greenschist grades of metamorphism; however, volcanic rocks that exhibit subgreenschist (prehnite-pumpellyite) mineral assemblages have been identified in the southwestern part of the belt (Bailes and Syme, 1983; Syme, 1985b; Bailes and Syme, 1989). Regional metamorphism generally increases northwards from greenschist to amphibolite facies towards the Kisseynew gneiss belt (Harrison, 1949; McGlynn, 1959; Bailes and McRitchie, 1978; Froese and Moore, 1980). Locally, east-trending prograde metamorphic isograd reactions within pelitic rocks have been mapped north into the Kisseynew gneisses (Harrison, 1949; Bailes and McRitchie, 1978; Froese and Moore, 1980).

Grades of metamorphism in the Snow Lake area are generally higher than those documented elsewhere in the belt. Froese and Moore (1980) recognized four metamorphic zones in this area that range from a lower amphibolite zone north to an upper amphibolite zone.

STRUCTURE

Based on observations within rocks of the Missi Group near Flin Flon, Stauffer and Mukherjee (1971) recognized three periods of folding. Bailes *et al.* (1987) recognized five phases of folding that include one phase of pre-Missi folding and four that postdate deposition of the Missi Group. During the last folding event major faults were initiated that bound major stratigraphic blocks and dominate the structural fabric of the Flin Flon area (Bailes *et al.,* 1987).

In the File Lake-Snow Lake area three periods of folding have been recognized, all considered post-Missi (Bailes, 1980; Froese and Moore, 1980). Early isoclinal folds have been refolded about northeasterly trending open folds (for example, the Threehouse Syncline at Snow Lake). At File Lake Bailes (1980) has recognized a third folding event consisting of easterly-trending open flexural folds. Deformation associated with minor folds that postdate the second phase of folding in the Snow Lake area were observed in the immediate vicinity of gneissic domes on the north margin of the belt and are considered to be related to increased tightening of second phase folds (Froese and Moore, 1980). The McLeod Lake thrust fault (Russell, 1957), a major structural break in the Snow lake area, is interpreted to represent an early nappe structure associated with the early isoclinal folding (Froese and Moore, 1980).

MODERN PLATE-TECTONIC MODEL

Detailed geological mapping conducted in the Flin Flon-Snow Lake greenstone belt and Kisseynew gneiss belt by Manitoba and Saskatchewan Provincial survey geologists over the last 15 years and its integration with laboratory research, undertaken as part of a 1990-96 Canada-Manitoba-Saskatchewan NATMAP program has revealed a highly complex history of assembly of the greenstone belt and the adjacent Kisseynew gneiss domain, analogous to modern plate tectonics.

The Flin Flon belt between the Sturgeon-Weir River (Saskatchewan) and Reed Lake (Manitoba) is now recognized as a collage (termed Amisk Collage) of distinct 1.92-1.88 Ga tectonostratigraphic assemblages, derived from a variety of (plate-) tectonic settings (Syme et *al.,* 1996, Lucas *et al.,* 1996; Fig. 30). These assemblages amalgamated to form an accretionary collage. This was followed by the emplacement of 1.87-1.83 Ga voluminous granitoid plutons and coeval volcanic rocks which were associated with younger successor arcs and basins imposed on the

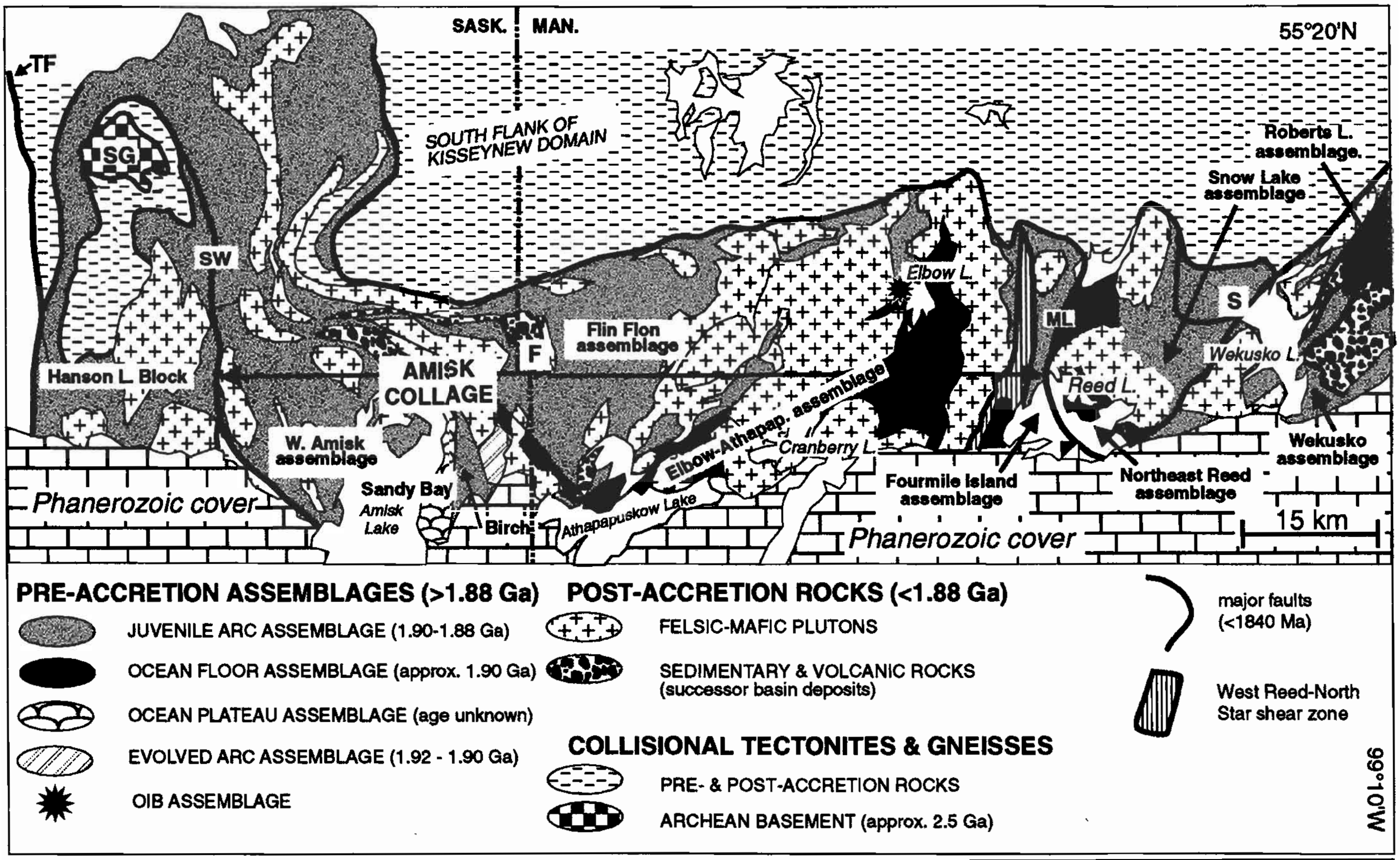


Figure 30: Geology of the Flin Flon belt, showing the extent of the Amisk collage, tectonostratigraphic assemblages and major plutons (after Lucas et al., 1996). ML: Morton Lake fault; SW: Sturgeon-Weir shear zone; F: Flin Flon; S: Snow Lake

collage, resulting in a microcontinent by 1.85-1.84 Ga. Seismic reflection studies undertaken as part of LITHOPROBE Trans-Hudson orogen transect have shown that the microcontinent was subsequently (1.83-1.69 Ga) segmented into strike-slip fault blocks, that were internally highly deformed, during collision with Archean cratons (Lucas *et al.,* 1993; Lewry *et al.,* 1994; White *et al.,* 1994). The Archean cratons include the Superior and Hearne cratons and an Archean microcontinent in east central Saskatchewan that is exposed in the Pelican window (Heaman *et al.,* 1993), but extends considerably in lower crustal levels, as indicated by results from LITHOPROBE reflection seismic surveys (Lucas *et al.,* 1993).

Amisk Collage

Introduction

The Amisk collage (Fig. 30) is bounded by collisional thrusts on its west (Sturgeon-weir shear zone), north (at the south flank of the Kisseynew domain) and east sides (Morton Lake fault; Ashton and Lewry, 1994; Zwanzig, 1990; Lucas *et al.,* 1996; Norman *et al.,* 1995; Syme *et al.,* 1995)

The Flin Flon belt east of Reed Lake (east of the Amisk collage) includes the Snow Lake, Roberts Lake and Wekusko assemblages (Syme *et al.,* 1996). These assemblages have similarities with the assemblages of the Amisk collage, but their history and relationship with the Amisk collage are not resolved yet. In this report the three assemblage of the Snow Lake area are grouped under the informal term 'Snow Lake arc segment'.

Building blocks of the Amisk collage

Four main tectonostratigraphic assemblage types have been recognized in the Amisk collage (Syme, 1990; Syme and Bailes, 1993; Watters *et al.,* 1994; Stern *et al.,* 1995a, 1995b); 1) isotopically juvenile oceanic arc (1.90-1.88 Ga), 2) ocean floor *(circa* 1.90 Ga), 3) oceanic plateau/ocean island (age unknown), and, 4) isotopically-evolved arc (1.92-1.90 Ga)

In addition small slices of Archean rocks *(circa* 2.5 Ga) have locally been recognized *(e.g.* in the Northeast Arm shear zone, 12 km east of Flin Flon). The term "juvenile" and "evolved" are used with respect to the Nd-isotopic composition of rocks within the assemblages (Lucas *et al.,* 1996). Most of the supracrustal rocks are part of assemblages 1) and 2); assemblages 3) and 4) are relatively limited in extent.

Formation of the Amisk collage

The Amisk collage is interpreted to have evolved as shown in Figure 31.

Early (1.92-1.90 Ga) tholeiitic arc sequences were rifted, creating intra-arc basins in which oceanic basalts, turbidites and calc-alkaline and shoshonitic volcaniclastics accumulated at 1.89-1.88 Ga (Syme and Bailes, 1993: Reilly *et al.,* 1994; Stern *et al.,* 1995a). The various assemblages were juxtaposed during intra-oceanic accretion at *circa* 1.88-1.87 Ga, probably as a result of arc-arc collision (Table 11, Fig. 31; Lucas *et al.,* 1996).

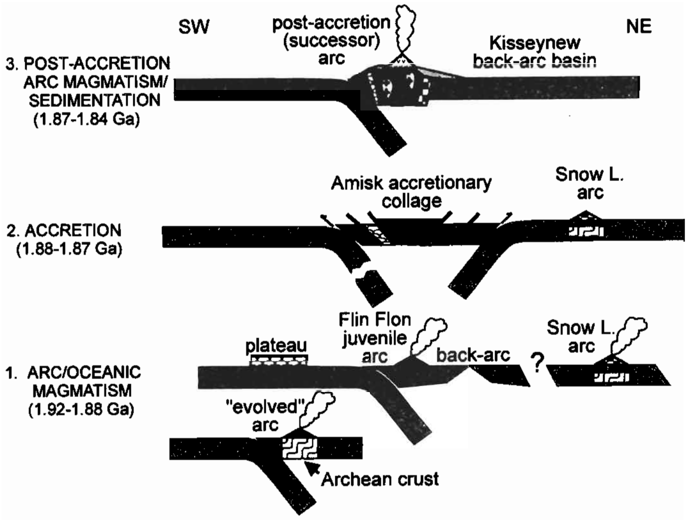


Figure 31: Schematic diagram showing the tectonic evolution of *the Flin Flon belt (from Lucas et al.; 1996).*

Accretionary collage structures are largely obliterated by subsequent deformation and metamorphic events. At 1.86-1.84 Ga large plutons intruded into the collage forming a successor arc. Coeval subaerial successor arc volcanism is recorded in *circa* 1.87-1 .85 calc-alkaline to shoshonitic volcaniclastic sequences (Syme, 1988; Lucas *et al., 1996).* Unroofing of the accretionary collage and deposition into alluvial-fluvial successor basin (including the Missi suite; Bailes and Syme, 1989; Holland *et al.,* 1989) occurred at 1.85-1.84 Ga (Ansdell *et al.,* 1992; Ansdell, 1993), coeval with the waning stages of successor-arc magmatism. Development of the Kisseynew turbidite basin was synchronous with, or slightly younger (1.84-1.83 Ga) than, the successor basin sedimentation in the Flin Flon belt (David *et al.,* 1993, 1996; Machado and Zwanzig, 1995; Machado *et al.,* 1996). After extension, the Kisseynew basin collapsed during collision with the Flin Flon belt at *circa* 1.84 Ga. The Kisseynew basin turbidites (Burntwood suite; Zwanzig, 1990; Zwanzig and Schledewitz, 1992) and their basement (Amisk collage, Snow Lake arc segment) now structurally overlie the Amisk collage and the Snow Lake arc segment along the south flank of the Kisseynew domain (Fig. 30; Map ER86-1-3; Harrison, 1951 a: Zwanzig, 1990; Lucas *et al.,* 1996; Norman *et al.,* 1995; Connors, 1996)

Tectonostratigraphic Assemblages of the Flin Flon-Snow Lake area

Juvenile Arc assemblages

Juvenile arc rocks in the Flin Flon belt in Manitoba are divided geographically into segments, each of which is 15-50 km wide. In Manitoba these are the Flin Flon and Fourmile Island segments or assemblages (of the Amisk collage) and the Snow Lake and Wekusko assemblages (of the Snow Lake arc segment, see below). These assemblages are separated by major faults or intervening ocean-floor, turbidite, or older basement. The individual segments are internally complex and comprise numerous fault-bounded and folded volcanic suites *(e.g.* Bailes and Syme, 1989).

The Flin Flon assemblage contains mostly subaqueous tholeiitic mafic volcanic rocks (basalt and basaltic andesite). Calc-alkaline rhyolite flows and associated volcaniclastic rocks occur sporadically. A small unit of shoshonitic tuff has been identified at Vick Lake (12 km southeast of Flin Flon; Syme *et al.,* 1996).

Metamorphic grade is generally greenschist, but increases

TABLE 11: DEFORMATION EPISODES IN THE AMISK COLLAGE (after Syme *et al.* 1996)

Episode	Structures	Magmatism	Metamorphism	Age (Ma)	Tectonic context
D_1	S_1, L_1 (tectonites, mylonites)	None (?)	?	1880 - 1870	Intraoceanic accretion
D_2	S_2, F_2 (Vick Lake synform) S_1/S_2 (tectonites, mylonites)	Mafic to felsic dykes, sheets, plutons	Subgreenschist to amphibolite ('contact' to regional)	1870 - 1840	Intra-arc shortening, uplift/erosion of Amisk collage; development of Kisseynew back-arc basin
D_3	S_3, F_3; shear bands (sinistral and dextral); high-angle shear zones; SW -vergent thrusts (*e.g.*, Morton Lake thrust zone)	None (1840 - 1830 magmatic belt in Snow Lake assemblage, S flank of Kisseynew Domain)	Regional peak metamorphism (subgreenschist to amphibolite facies) at 1820-1805 Ma	1840 - 1805	Regional collisional shortening and thickening via SW-vergent thrusts and folds; high-angle shear zones in Amisk collage
D_4	SW-vergent thrusts (*e.g.*, Sturgeon-weir shear zone); F_4 folds and kinks, high-angle shear zones	Pegmatites, leucogranites	Retrograde	1805 - 1770 (?)	Post-collisional thrusting, folding; transpression of Amisk collage
D_5	Brittle to ductile shear zones/faults	None	Retrograde	1770 - 1690	Post-collisional NW-SE shortening and longitudinal extension

northwards to amphibolite facies, towards the Kisseynew domain.

The Fourmile Island assemblage forms a narrow segment trending north from Reed Lake, between the Flin Flon segment and the Snow Lake segment (Fig. 30). The Fourmile Island assemblage comprises dominantly mafic flows and minor felsic-intermediate volcaniclastic units (Syme *et al.,* 1995).

Ocean-Floor assemblages

Ocean-floor assemblages include basalt sequences and related mafic-ultramafic complexes. The main occurrence is the Elbow Lake - Athapapuskow Lake assemblage forming a 100 km long and 25 km wide, semi-continuous belt between Elbow Lake and Athapapuskow Lake. Kilometre-scale layered mafic-ultramafic intrusions within this assemblage (Syme *et al.* 1995; Williamson and Eckstrand, 1995) may represent dismembered syn-volcanic plutonic complexes.

Geochemically the Elbow Lake-Athapapuskow Lake ocean-floor basalts are dominantly subalkaline with MgO contents of 6-10 wt.%, typical of modern MORB's.

The Northeast Reed and Roberts Lake assemblages (Fig. 30) of the Snow Lake arc segment comprise basalt sequences and related mafic-ultramafic complexes similar to the Elbow Lake-Athapapuskow Lake ocean-floor assemblage (Syme *et al.,* 1995b).

Ocean plateau and Ocean Island Basalt (OIB) assemblage

A mafic, volcanic clast conglomerate at Elbow Lake has geochemical characteristics of ocean island basalt. Ocean plateau geochemical signatures have been obtained from basalts flows with synvolcanic sills in the Saskatchewan section of the Flin Flon belt (Stern *et al.,* 1995b).

Isotopically-evolved Proterozoic rocks/Archean rocks

Tonalite, granodiorite and diorite with geochemical signatures of isotopically-evolved (arc-plutonic) rocks have been found in the Mystic Lake assemblage along the Saskatchewan/Manitoba border.

Archean crustal fragments occur as fault-bounded lozenges within the Northeast Arm shear zone within the Flin Flon assemblage.

Accretion

Juxtaposition (accretion) of the arc and oceanic assemblages is dated by the age of the youngest volcanic rocks and oldest "stitching" plutons, respectively, at between 1882 and 1866 Ma (Stern and Lucas, 1994). In the Amisk collage the plutons range from gabbro to granite in composition and in age from 1866 to 1838 Ma. They form part of the successor arcs. Successor basins of sedimentary and volcanic rocks span the age range of the plutons (1.86-1.84 Ga), as well as the sedimentation of voluminous turbidites in the adjacent Kisseynew domain.

1.87-1.84 Ga successor arc plutons

These plutons underlay large portions of the Flin Flon belt (Fig. 30; Map ER86-1-3). They are dominantly calc-alkaline diorite-tonalite-granodiorites. The plutons may have internal compositional variations or zoning (Whalen, 1993). Trace-element geochemistry indicates typical arc signatures (Lucas *et al.,* 1996).

1.87-1.84 successor arc basins (Missi suite, Burntwood suite and other unnamed sequences)

Erosional remnants of these basins, younger than the 1.92-1.88 Ga assemblages, occur in several places. They have been subdivided into two types: 1) older basins containing (>1.85 Ga) subaerial to submarine volcaniclastic and epiclastic deposits with unknown basement, and 2) younger basins with (<1.85 Ga) subaerial deposits (Missi suite; Bailes and Syme, 1989; Holland *et al.,* 1989; Stauffer, 1990) and synchronous marine turbidites (Burntwood suite; Ansdell *et al.;* 1995; Zwanzig *et al.,* 1996a,b; Machado *et al.,* 1996). Detritus of both suites is derived from erosion of successor arc volcanic and plutonic rocks and older assemblages. These deposits overly unconformably Amisk collage assemblages and successor arc plutons.

Snow Lake arc segment

The Snow Lake arc segment has not been studied to the same extent as the Flin Flon area or the Amisk collage, except for the Snow Lake assemblage (see below). Present data indicate that the area comprises two juvenile arc assemblages, the Snow Lake and Wekusko assemblages and the Northeast Reed and Roberts Lake ocean-floor assemblages (see above; Fig. 30). Documentation of the Wekusko assemblage is in progress (Bailes, unpublished).

The Snow Lake juvenile arc assemblage

The Snow Lake assemblage is lithologically similar to the Flin Flon assemblage except for a higher proportion of intermediate to felsic volcaniclastic rocks and higher metamorphic grade. The >6 km thick Snow Lake juvenile oceanic arc assemblage progressed from a primitive to an evolved arc, based on stratigraphic and geochemical data (Bailes and Galley, 1996). The lower primitive arc sequence is bimodal (basalt-rhyolite); basalts dominate. They are low-Ti tholeiitic and include high-Ca boninite. The rhyolites are geochemically similar to underlying tonalites with which they are consanguineous.

The evolved arc sequence is also bimodal and contains mafic and felsic flows and subvolcanic felsic intrusions, but in contrast to the lower section, a large volume of volcaniclastic deposits. In addition, boninites (high MgO, high SiO_2 contents) occur in the Snow Lake assemblage (Syme *et al.,* 1996)

Recent geochemical, isotopic and U-Pb zircon geochronology, structural and tectonostratigraphic studies indicate that although arc volcanic rocks at Snow Lake are similar in age (circa 1.89 Ga; David *et al.,* 1996) to those at Flin Flon (1.9-1.89 Ga) they differ because they:

1) have lower E Nd (<+3.1) than arc volcanic rocks at Flin Flon (Stern *et al.,* 1992, 1995a);
2) locally contain inherited Archean zircons whereas those at Flin Flon do not (David *et al., 1996);*
3) are structurally imbricated with 1.85-1.83 Ga sedimentary rocks that are not present at Flin Flon (David *et al.,* 1996; Kraus and Williams, 1994a; Syme *et al.,* 1995a);
4) are intruded by a prominent 1.84-1.83 Ga suite of calc-alkaline granitic magmas and are not intruded by the 1.87-1.85 Ga suite of "successor arc" granitic plutons that characterize the Flin Flon arc assemblage and the Amisk collage (Lucas *et al.,* 1996); and
5) exhibit metamorphic and structural features that are more akin to rocks of the Kisseynew domain than those of the Amisk collage of the Flin Flon belt (Syme *et al.,* 1995a).

The current interpretation is that the Snow Lake arc assemblage developed separately from that at Flin Flon, possibly upon an Archean microcontinent (Stern *et al.,* 1995a; Lucas *et al.,* 1996), and was tectonically juxtaposed against accreted rocks of the Amisk collage during 1.84-1.81 Ga southwest-directed collision of rocks of the Kisseynew domain with those of the Flin Flon belt (Syme *et al.,* 1995). During this collision event, tectonic slices of 1.85-1.83 Ga, post accretion sedimentary rocks (mainly Burntwood suite) were structurally imbricated with allochthons of pre-1 .88 Ga volcanic rocks. The most westerly slice of the post accretion sedimentary rocks (Burntwood suite unit W on Map ER86-1-3), that occupies the Morton Lake fault zone between File Lake and Reed

Lake (Fig. 30), is interpreted to be the structural contact between the Amisk collage and the various Kisseynew type allochthons that characterize the Snow Lake arc segment to the east (Syme *et al.,* 1995; Lucas *et al.,* 1996).

Deformation and Metamorphism, Amisk collage and Snow Lake arc segment

Five deformation episodes have been postulated in the Amisk collage (Table 11). D_1 is related to 1.9 Ga accretion, D_2 to 1.87-1.84 Ga intra-arc shortening and uplift, and formation of successor-arc basins; D_3 is related to 1.84-1.80 Ga collision, associated crustal shortening and thickening. The regional peak metamorphism occurred during D_3 at 1820-1805 Ma. D_4 and D_5 are related to 1.80-1.69 Ga post collisional thrusting and folding, NW-SE shortening and longitudinal extension, respectively, under retrograde metamorphic conditions.

In the Snow Lake arc segment the major deformation was younger and occurred during 1.84-1.78 collision. Four events have been recognized in the Snow Lake arc segment. The first event produced tight to isoclinal, 1.84 Ga, recumbent F_1 folds (Bailes, 1980; David, *et al.,* 1996) and related thrust faults (Connors and Ansdell, 1994; Connors, 1996). The second event produced isoclinal, 1.82-1.81 Ga, syn-to post-metamorphic F_2 folds and thrust faults (Kraus and Williams, 1994, 1995; Kraus and Menard, 1995). F_3 produced upright, open northeast trending (post-metamorphic) folds *(e.g.* Threehouse synform) and F_4 east trending open folds (Kraus and Williams, 1994). A series of brittle-ductile shear zones *(e.g.* Berry Creek fault) deformed and offset older structures.

MINERALIZATION

The Flin Flon belt in Manitoba and Saskatchewan hosts over 100 gold occurrences, most of which are located within supracrustal rocks and associated sills and dykes; the majority of these are situated in Manitoba (Map ER86-1-3). The gold occurrences are shear zone-hosted, epigenetic vein or disseminated, mesothermal deposits (Galley *et al.,* 1989). $^{40}Ar/^{39}Ar$ ages of 1790 and 1805 Ma obtained from hydrothermal muscovite associated with gold in the Flin Flon area (Fedorowich *et al.,* 1993) indicates that the mineralization took place after regional collision of the Amisk collage and probably during post-collisional thrusting and folding.

The exception to shear-hosted gold occurrences are the Phantom Lake deposits just west of the Provincial border that may be associated with gold-rich epithermal systems and high level intrusive complexes (Galley *et al.,* 1989).

Present and past producers occur in the Flin Flon, Elbow Lake, Snow Lake and Wekusko Lake areas. Gold is also associated with base metal massive sulphide deposits throughout the belt (Galley *et al.,* 1986; Franklin and Thorpe, 1982) and is commonly a by-product.

File Lake-Snow Lake area

In the File Lake-Snow Lake area primary gold mineralization occurs: 1) on the east shore of Wekusko Lake (Herb Lake Camp); 2) north of the town of Snow Lake; and 3) in the vicinity of North Star Lake. Descriptions of deposits in these areas include those by Alcock (1920b), Wright (1931), Stockwell (1935, 1937) and more recently Galley *et al.* (1986).

Wekusko Lake area

Gold mineralization occurs on the east shore of Wekusko Lake, in sedimentary and volcanic rocks of the Missi suite (Fig. 32; Map ER86-1-3). (The volcanic rocks are not part of the Wekusko assemblage as shown on Figure 30. Past producers include the Moose Horn (Ballast), Laguna (Rex), Bingo and Ferro Mines. Stockwell (1937) divided the gold occurrences in this area into two major groups: 1) those aligned along the north limb of the Herb (or Wekusko) Lake syncline, near the contact between sedimentary and volcanic rocks of the Missi suite; and 2) those aligned subparallel and in proximity to the axial trace of the syncline within Missi suite volcanic rocks (Fig. 32). The occurrences are all aligned along a series of shear zones that are subparallel to the axis of the syncline. Galley *et al.* (1989) characterize the occurrences as follows:

1) Gold occurrences along the north limb comprise gold-arsenopyrite mineralization within single, shear-hosted quartz veins (up to 1 m wide and 500 m long). These veins commonly occur where the shears intersect either quartz-feldspar or biotite porphyry stocks that intrude Missi suite sedimentary or volcanic strata.

2) Shear-hosted veins with gold-pyrite mineralization along the axis of the syncline are within mafic volcanic rocks and are more strongly deformed than 1) occurrences, with strong boudinage of individual veins. Individual shear zones can be intermittently traced for over 1700 metres. Wright (1931) reported minor amounts of arsenopyrite in old workings at the north end of the Rainbow Group occurrences (Fig. 32, location FF12).

Sericite and/or carbonate alteration is associated with the mineralization. Alteration within the felsic porphyritic units is poorly developed and in the shear zones usually occurs within 1 m of the quartz lenses and stringers. Galley *et al.* (1986) interpret the alteration event(s) to have overprinted the regional metamorphic mineral assemblages that Froese and Moore (1980) interpret as having developed during or later than the second major folding event.

Galley *et al.* (1989) conclude that the auriferous veins were formed within thrusts that display a dextral displacement component and developed after peak metamorphism.

Snow Lake area

Gold deposits in the Snow Lake area include the Squall Lake, Bounter and Snow Lake Mines Ltd. (formerly Gold Fields) prospects and New Britannia (formerly Nor-Acme) Mine. The Squall Lake deposit is discussed in the chapter dealing with Kisseynew gneiss belt. Descriptions of these deposits have been given most recently by Galley *et al.* (1986) and Bailes *et al.* (1987). Earlier geologic accounts of the Nor-Acme deposit include those by Wright (1931), Ebbutt (1944) and Harrison (1949).

The New Britannia-Nor-Acme, Snow Lake Mines and Bounter deposits occur within a block of Snow Lake arc assemblage mafic to felsic, largely fragmental, volcanic rocks that is bounded on the west and south by the McLeod Road thrust fault and in the northwest by the Birch Lake fault (Fig. 33). These faults and earlier isoclinal folds were later folded by the Threehouse syncline. All deposits exhibit a spatial association to faults that are subparallel to, merge with, and terminate on the McLeod Road thrust and may represent splays off the McLeod thrust (Fig. 33; Galley *et al.,* 1986). Most deposits occur where an inflection along the strike of the host fault coincides with the intersection of the fault with the nose of an early isoclinal fold (Galley *et al.,* 1989).

Bailes *et al.* (1987) list the following features to be common for the gold mineralization in most properties of the Snow Lake area:

1) a stockwork of auriferous veins and stringers that form a quartz-carbonate-plagioclase breccia with incorporated altered wall rock;
2) intense wallrock alteration, up to several metres from the mineralization characterized by biotite, chlorite, carbonate and tourmaline;
3) associated quartz-carbonate-tourmaline veins in both hanging wall and footwall; and
4) associated sulphide minerals that include arsenopyrite (acicular crystals are associated with the best gold values) with lesser amounts of pyrite, pyrrhotite, chalcopyrite, sphalerite and galena.

The Bounter occurrence is not a typical breccia deposit. The mineralization is disseminated within strongly altered wall rock, as part of an anastomosed shear zone, which is not located at an inflection along the shear, but formed at an intersection with a shear zone and the edge of a gabbro (Galley *et al.,* 1989).

Galley *et al.* (1989) suggests that gold mineralization in the Snow Lake

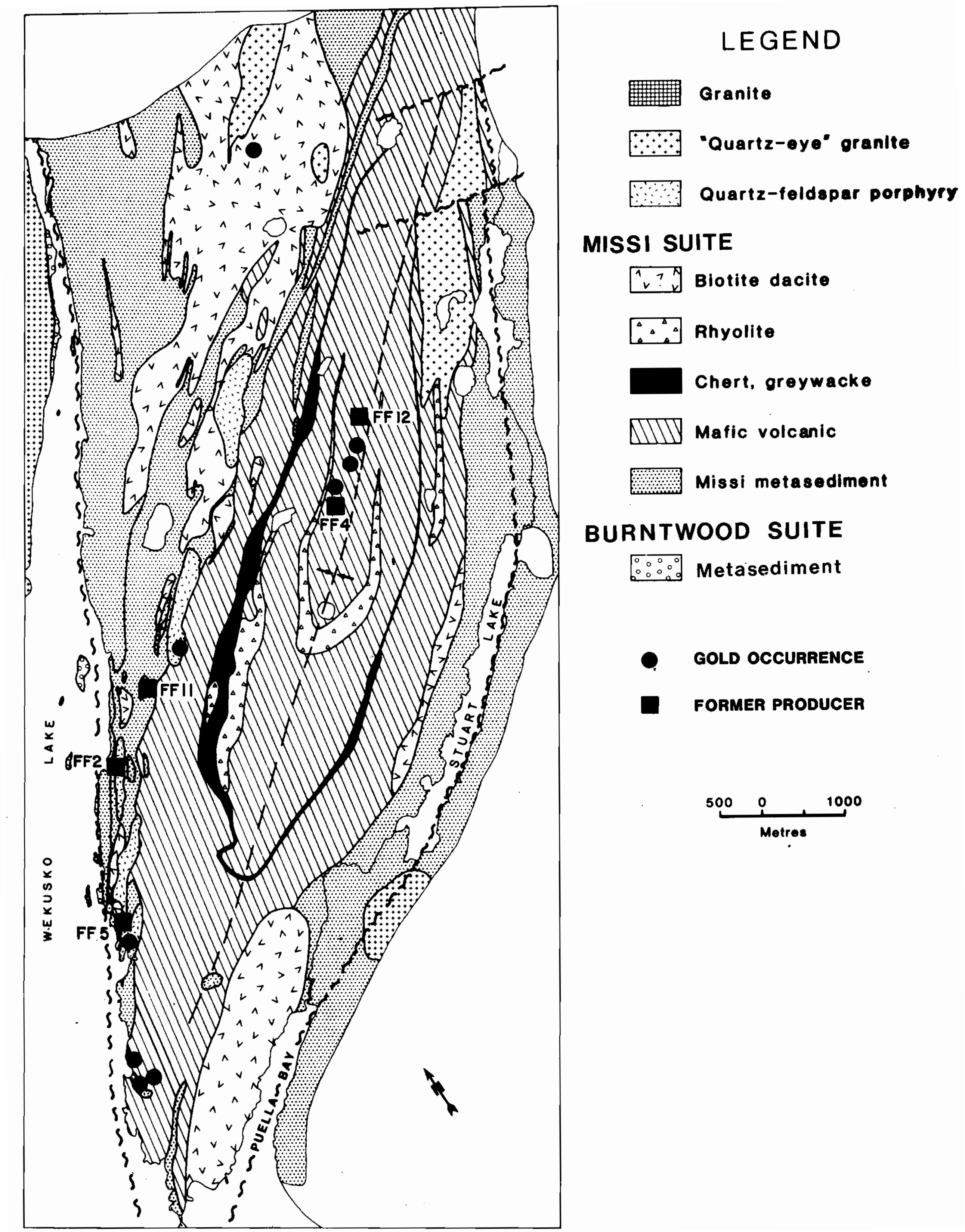


Figure 32: Geology and gold occurrences east of Wekusko Lake (after Stockwell, 1937).

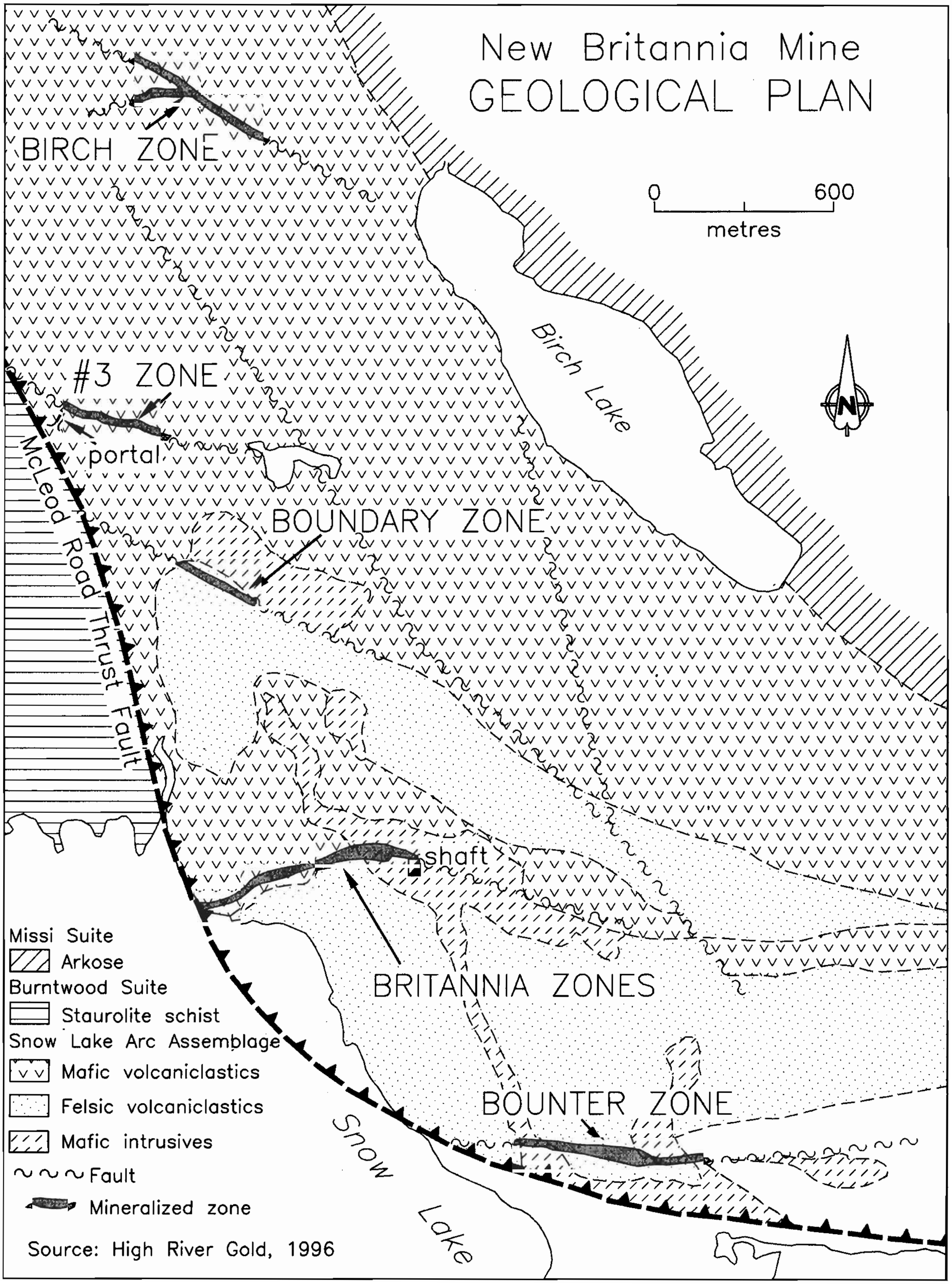


Figure 33: Geology and gold deposits of the New Britannia Mine (formerly Nor-Acme Mine) in the Snow Lake area (after High River Gold Mines Ltd., 1996).

area relate to a series of thrust faults that are miniature versions of regional scale faults that have been either reactivated or formed during a period of late folding.

Other gold occurrences in the Snow Lake area are described by Harrison (1949), Gonzales and Fedikow (1984), Eccles and Fedikow (1985) and Fedikow *et al.* (1986b). Isolated gold occurrences near File Lake have been documented by Stockwell (1935), Harrison (1949) and Ostry (1984).

North Star Lake area

Fifteen gold occurrences that are concentrated in an area immediately east and southeast of North Star Lake (6 km southwest of File Lake) are described in detail by Stockwell (1935). Mineralization consists of discontinuous lenses, veins and/or stringers of quartz that contain gold, pyrite and pyrrhotite. Sphalerite, chalcopyrite, galena, carbonate and incorporated wall rock are locally common constituents. All occurrences are hosted by sheared andesitic and dacitic flow rocks of the Fourmile Island assemblage. The volcanic rocks have been altered to chloritic schist and have locally been intruded by quartz-feldspar porphyry dykes and stocks, quartz diorite and granite. The mineralized zones are parallel to, or cut, the regional schistosity at a shallow angle and postdate the intrusion of the felsic dykes. Most mineralized zones range in width from several centimetres up to 5 m and locally pinch and swell for up to 250 m along strike.

Elbow Lake area

Gold mineralization in the Elbow Lake area has been described by Armstrong (1922), Wright (1931), Stockwell (1935), McGlynn (1959) and most recently Galley *et al.* (1989) divided the gold occurrences of this area into three groups:

1) occurrences that exhibit fault-controlled alteration and stockwork zones characterized by intense carbonate alteration with associated quartz-carbonate veins that form zones up to 20 m wide and 20-30 m long;
2) porphyry related occurrences that include the Century Mine (Map ER86-1-3, location FF7), characterized by disseminated arsenopyrite or quartz-carbonate veins associated with quartz-feldspar porphyry dykes; and
3) stratabound occurrences within sulphide-rich and cherty strata and oxide facies iron formation.

Gold mineralization is hosted by sulphide bearing quartz-carbonate-albite veins within late shear zones. Eleven occurrences are hosted by felsic dykes, nine by mafic intrusions, eight by ferruginous sedimentary rocks and eight by mafic or felsic tectonites (Galley *et al.,* 1989) indicating that there is no primary relationship between lithology and gold content. There is rather a competency control, since generally the host lithology to the gold mineralization is more competent than the surrounding rock, providing depositional sites during brittle deformation.

Flin Flon area

In the Flin Flon area of Manitoba numerous gold occurrences are indicated by Tanton (1941) and Bateman and Harrison (1945). Gale (1981) observed that these occurrences exhibited two major associations, namely: 1) near or at the margins of gabbroic intrusions; and 2) within felsic intrusions.

The majority of occurrences that exhibit the second association occur within high level synvolcanic intrusions that locally contain porphyry-type Cu-Mo mineralization (Baldwin, 1980). Most of the gold occurrences are associated with the network of anastomosing shears typical for the Flin Flon region (*cf.* Fedorowich *et al.,* 1991).

Gale's association type 1 includes the gold deposit at Tartan Lake and the gold occurrence at Alberts Lake (Map ER86-1-3, location FF14). At Tartan Lake the gold mineralization occurs in a shear zone network at the contact between a layered gabbro and intermediate to felsic volcaniclastic rocks of the Flin Flon arc assemblage (Fedorowich *et al.,* 1991; Peloquin *et al.,* 1985; Kreczmer and Deveaux, 1986; Peloquin *et al.,* 1986). The gold is associated with disseminated pyrite and chalcopyrite in quartz-carbonate-tourmaline veins that occur either as laminated central shear veins and as younger *en echelon* crosscutting extension veins within the shear zones (Fedorowich *et al.,* 1991). Alteration in the shear zones comprises carbonatization, silicification, chloritization and pyritization that may predate the shearing (Peloquin *et al.,* 1986). Fuchsite is common in the altered gabbroic rocks. Hydrothermal muscovite associated with gold was dated with the $^{40}Ar/^{39}Ar$ method and yielded an age of 1791 ±4 Ma for the mineralization (Fedorowich *et al.,* 1991), slightly younger than the peak-metamorphism at 1840-1805 Ma (Table 11).

The Gurney Mine (Map ER86-1-3, location FF3) is described by Hage (1944) and Stewart (1980). Mineralization comprises gold-quartz-carbonate veins that crosscut a sequence of volcanic and sedimentary rocks. The supracrustal rocks are surrounded by granitic intrusions. Associated ore minerals include pyrite, pyrrhotite, chalcopyrite and galena with minor sphalerite and molybdenite. Quartz-carbonate and biotite-epidote-chlorite-carbonate-tourmaline-sericite are common wallrock alteration mineral assemblages. The mineralization is considered to be related to fracturing and shearing of the sedimentary and volcanic rocks during emplacement of nearby felsic plutons (Hage, 1944).

Other gold occurrences in the Flin Flon area have been documented by Stewart (1977), Gale (1981), Parbery and Gale (1984) and Parbery (1986).

PRESENT PRODUCER

New Brittannia Mine (former, in part, Nor-Acme Mine)

Location: Snow Lake.

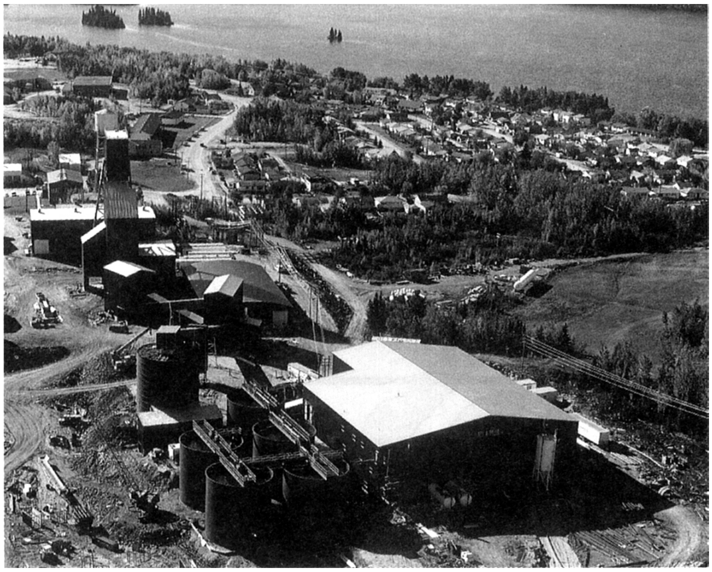
Map Reference: Map ER86-1-3, location FF1.

Description of Deposit

The Nor-Acme property is underlain by mafic to felsic fragmental rocks, massive and pillowed flows of the Snow Lake arc assemblage and biotite schist and staurolite schist of the Burntwood suite (Fig. 33; Map ER86-1-3). These rocks are intruded by post-accretion gabbro-pyroxenite dykes and irregular bodies.

Galley *et al.* (1986) observed that the gold-bearing zones occur subparallel to the Nor-Acme fault (formerly called the Howe Sound fault), an arcuate brittle ductile shear that splays from the McLeod thrust fault. The Nor-Acme fault strikes southwest at its western end and southeast at its eastern end and approximately parallels the contact between felsic pyroclastic rocks and mafic volcanic rocks. Gold mineralization forms an elongate body 300 m long on surface; however, at depth it occurs in four separate zones: the Toots, Dick, Ruttan and Hogg. The mineralization is associated with zones of intensely silicified, carbonatized, sheared or brecciated mafic and felsic rock around part of the Nor-Acme fault. The zones strike in an easterly direction, dip 40° north and plunge 030° to the northeast. Harrison (1949) and Galley *et al.* (1989) suggest that the mineralized zones occur where the Nor-Acme fault truncates the nose of the Nor-Acme anticline.

Mineralization consists of 2% arsenopyrite, $<$ 1% pyrrhotite and $<$ 0.25 % pyrite. Small amounts of chalcopyrite, cubanite, sphalerite, galena, ilmenite and scheelite are also present. Gold occurs as minute lenticular masses and veinlets in openings on crystal boundaries and fractures in arsenopyrite. Galley *et al.* (1986) reported that the highest gold contents occur where acicular arsenopyrite forms radiating masses around wall rock fragments.



New Britannia Mine, 1996, Snow Lake, Manitoba

Froese and Moore (1980) stated that the localization of ore along the contact between felsic pyroclastic rocks and mafic volcanic rocks suggests a syngenetic origin. Accordingly, they interpreted quartz and carbonate as products of chemical sedimentation rather than hydrothermal alteration. Galley *et al.* (1986), suggested that the gold mineralization was deposited during the waning stages of regional metamorphism and that large faults, such as the McLeod fault, acted as conduits channeling gold bearing fluids into secondary splay faults, such as the Nor-Acme fault.

History of Exploration and Development:

The property is covered by two claims, the Chums and Toots, both staked in 1925 by C.R. Parres. C.R. Parres, A.L. Parres and J. Parres carried out surface work from 1926 until 1938 when Nor-Acme Gold Mines Ltd. was formed to develop the property. Nor-Acme optioned the property to Howe Sound Exploration Company, Ltd (HSEC) who, during 1941 and 1942 drilled a total of 15 250 m on the property. This work outlined two orebodies containing an estimated 4 409 320 tonnes that averaged 5.14 g/tonne (0.15 oz/ton) gold to a depth of 305 m (Northern Miner, May 31, 1945). Production started on June 1, 1949 and continued until July, 1958. The mine was developed by a 600 m deep shaft with eight operating levels between 98 and 543 m.

On September 1, 1959 the property reverted to Nor-Acme Gold Mines Limited under the terms of the 1943 royalty-lease agreement with HSEC. Tests carried out in 1961 on a 227 000 tonne stockpile of arsenical concentrates indicated that it averaged 9.60 g/tonne (0.28 oz/ton) gold.

In 1980 Hudson Bay Exploration and Development Co. Ltd. (HBED) obtained a 2 year option, to acquire a 75% interest in the property. The 227 000 tonnes of arsenic concentrate was optioned by Bulora Corporation Limited and the option was subsequently taken over by Comiesa Corporation.

In 1981 HBED drilled 3880 m to test the downward extension of the deposit (Fig. 27). Significant drill intersections were as follows:

Hole	Interval	Assay g/tonne (oz/ton) gold
NA-236	5.58 m	3.09 (0.09)
NA-236 W-1	23.49 m	6.51 (0.19)
NA-236 W-1	1.53 m	3.43 (0.10)
NA-236 W-1	1.83 m	6.17 (0.18)
N-236 W-2	5.80 m	7.78 (0.23)

Source: Northern Miner; April 9, 1981; October 22; November 12,1981)

Based on the results of this drilling HBED estimated indicated reserves to total 2 510 889 tonnes grading 5.49 g/tonne (0.16 oz/ton) gold (Northern Miner, July 22, 1982).

In July 1982 HBED exercised its option on the Nor-Acme Mine through payment of a non-deductible installment of $100 000. The option was dropped in May 1986.

In 1986 Comiesa announced that an agreement was signed with Cobra Emerald Mines to build a gold recovery facility that will utilize bacterial leaching to process gold-cyanide-arsenic residues (Northern Miner, June 16, 1986, p. 1-2).

In 1989 Sikaman Gold Resources Ltd. acquired these residue concentrates mined but not milled during the earlier mining from 1949 to 1955. This surface stockpile is estimated to contain 236 000 tonnes grading 10 g/tonne (0.29 oz/ton) gold. Minproc Engineers Ltd. concluded in a feasibility that the residues can be treated over a 2 year period to recover 2930 kilograms of gold (94,500 oz), at a cost of US $95 per ounce (Canadian Mines Handbook 1990-91 p.401). The main Nor-Acme Mine was optioned in 1987 by High River Gold Mines Ltd. High River dewatered the shaft and workings and carried out a $4.5 million exploration program. Later, High River amalgamated with the former owner Nor Acme Gold Mines Ltd.. Inco Gold, a subsidiary of Inco Ltd. optioned the property from High River in 1988 and spent $6.5 million on underground exploration. Inco Gold identified a reserve of 3.8 million tonnes grading 6.5 g/tonne (0.19 oz/ton) gold and Wright Engineers Ltd. completed a feasibility study. Although technically feasible the study indicated higher gold prices were needed to justify the high capital costs. The mineralization was traced on surface for over 300 metres in two bodies, the “Toots” and the “Dick”. At depth gold mineralization occurs in two other bodies, the “Ruttan” and the “Hogg” (Fig. 34) (High River Gold Mines Ltd. 1989 Annual Report and Releases). Between 1990 and 1993 the property was on a care and maintenance basis and the mine was allowed to flood in 1991. Inco Gold combined with Consolidated TVX to form TVX Gold Ltd.. In 1994 TVX and High River commissioned a new feasibility study that confirmed the viability for production at lower capitai costs. A deep drilling program in 1993 confirmed depth extensions. One hole, 90 metres down plunge from the lowest 900 metre level intersected 7 metres true width grading 9.3 g/tonne (0.27 oz/ton) gold. It was estimated that depth extension could bring total mine inventory to 62 000 kg gold (2 million ounces). Also in 1993 the company received government exploration incentive grants and “New Mine Status” designation, whereby mining tax was not payable until profits paid off the capital investment to bring the mine into production. The 50-50 TVX-High River joint venture secured two adjoining properties in 1993 from W. Bruce Dunlop Ltd.. These properties hosted two satellite ore deposits northwest of the main mine, the “No. 3” and “Birch Zones” with combined reserves of 743 000 tonnes grading 8.3 g/tonne (0.24 oz/ton) gold above the 335 metre level (Northern Miner Sept. 27, 1993). They also optioned adjoining properties to the east that were owned by Hudson Bay Mining and Smelting Ltd.. To the north and south of the mine are the “Boundary” and “Bounter” zones. An additional 11 known gold occurrences are located within the combined properties. With combined reserves of 4.2 million tonnes grading 6 g/tonne (0.18 oz/ton) gold the mine contains 24 180 kg (780 000 ounces) gold. The new mine, named the “New Britannia Mine” was officially opened November 14, 1995 with a mill rate of 1800 tonnes per day. The mine is expected to produce 3100 kg (100,000 ounces) gold per year at an average cost of US $210 per ounce. Capital costs were about US $37 million. While the main mine is being rehabilitated and a new ramp is driven to access the “Dick” and “Ruttan” ore bodies and the shaft is being deepened from the 600 to 1000 metre level. Mill feed in the initial years will come form the satellite No.3 deposit 1 mile to the northwest where a decline to the 120 metre level has been completed. Over the next 3 years the company will conduct a $5 million exploration program (High River Gold Miner Ltd. Release March, 1996; Manitoba Mines Branch Corporation file, High River Gold Mines Ltd.).

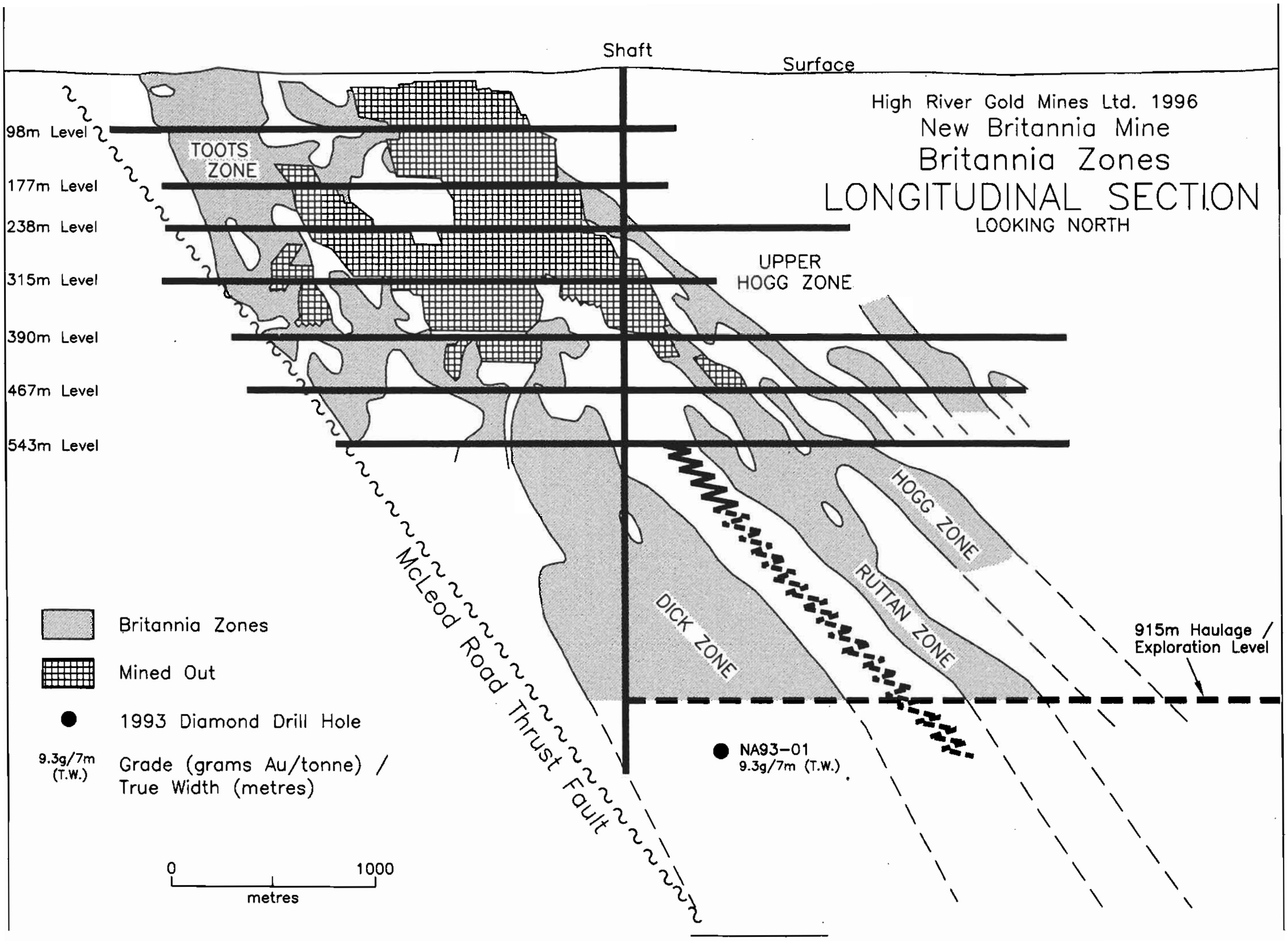


Figure 34: Longitudinal section of the New Britannia Mine (formerly Nor-Acme Mine) showing mineralized zones (after High River Gold Mine Ltd., 1996)

History of Production:

Year	Gold produced kg (oz.)
1949	1600 (51 468)
1950	2339 (75 188)
1951	2177 (69 994)
1952	2049 (65 861)
1953	2138 (68 737)
1954	2104 (67 659)
1955	2058 (66 152)
1956	1990 (63 990)
1957	1985 (63 813)
1958	1106 (35 569)
Total	19 546 (628 461)

Source: Nor-Acme Gold Mines Limited, Annual Reports (1949-1958).

Selected Bibliography: Bailes (1971); Davies *et al.* (1962); Ebbutt (1944); Galley *et al.* (1986; 1989); Harrison (1949); Hogg (1957); Manitoba Mines Branch, Corporation File (Nor-Acme Gold Mines Limited). Mineral Inventory (63K/16NE Au1); Russell (1957); Wright (1931).

PAST PRODUCERS

Laguna Mine (Rex)

Location: 19.5 km southeast of Snow Lake, near the east shore of Wekusko Lake.

Map Reference: Map ER86-1-3, location FF2.

Description of Deposit:

The property is underlain by stocks of quartz-feldspar porphyry that intrude Missi suite greywacke, conglomerate and arkose. Gold mineralization occurs in what Stockwell (1937) termed the “Main vein”. It occurs in a linear zone of schistose rocks along the western margin of a lenticular stock of quartz-feldspar porphyry. The vein has been traced in surface trenches for a distance of 460 m, averages 0.8 m wide, strikes northeast and dips 70° southeast. The vein consists of white and blue-white sugary and coarse grained quartz. Fine to coarse grains of gold coat fractures in the quartz, usually in association with arsenopyrite; other sulphides occur in minor amounts. Pyrrhotite forms 2.5 m long streaks within quartz. Chalcopyrite is rare and is found associated with pyrrhotite. Galena forms rare inclusions in arsenopyrite. Numerous quartz stringers parallel and crosscut the Main vein.

History of Exploration and Development:

The property was first staked in 1914. In 1916 the Makeever Brothers took over unregistered interest in the property and commenced shaft sinking. In 1918 the Makeevers and the original stakers formed Herb Lake Gold Mines, Limited to develop the property. The mine operated from May to December of 1918 and recovered 40.6 kg (1306 oz.) gold. In 1920 J.R. Campbell operated the mine for six months.

In 1924 Herb Lake Consolidated Mines, Limited, was formed to develop the property. A 64 kg sample of ore sent to Ottawa for testing yielded bulk assays that ranged from 30.86 to 37.58 g/tonne (0.90 to 1.10 oz/ton) gold (Parsons, 1937). Based on these results the mine and mill were reopened. The Rex main shaft was deepened to 129 m and the mill processed 8890 tonnes between March 1924 and December 1925. The average head grade was 22.6 g/tonne (0.66 oz/ton) gold.

The property was dormant until Laguna Gold Mines Limited acquired the claims in 1934 and deepened the shaft to a depth of 343 m. Production started in 1936 and continued until 1940. The claims were then allowed to lapse.

Marshall Ballard staked the property in 1944. A 2-hole 17 m drill program was carried out on the claims before their cancellation in 1968.

WB. Kobar staked the property in 1968. Trenching was carried out in 1977. In 1978 A.V. Harris Exploration Services acquired the property and undertook a program of Iinecutting and sampling. Norman Mines Ltd. acquired the property in 1980 but encountered financial problems that caused ownership to revert to A.V. Harris Exploration Services Limited who dealt it to Wekusko Gold Resources Limited. A biogeochemical survey was carried out in May 1984. In September 1984 Noranda Exploration Company Limited acquired the property as part of the Laguna-Bingo option. They undertook a $50 000 program of linecutting, geological mapping, lithogeochemistry, soil sampling and geophysical surveys.

History of Production:

Year	Tonnes milled	Grade g/tonne (oz/ton) gold	Gold produced kg (oz.)
1918			41.5 (1 337)
1920	387.3		7.4 (237)
1921			2.7 (87)
1924	2 420.9		
1925	6 772.7		136.2 (4 379)
1926			12.0 (387)
1936	8 176.6		137.7 (4 428)
1937	26 888.3	17.40 (0.51)	61.0 (14 822)
1938	29 458.1	17.61 (0.51)	508.9 (16 360)
1939	28 761.4		514.4 (16 540)
1940	6 623.		11.9 (385)
Total	109 488.3		1833.9 (58 962)

Source: Manitoba Mines Branch, Annual Reports.

Selected Bibliography: Alcock (1919); Bailes (1971); Bruce (1916); Davies *et al.* (1962); Harrison (1951a); Manitoba Mines Branch, Corporation Files (Herb Lake Gold Mines, Limited, Laguna Gold Mines Ltd., Mining Corporation of Canada), Mineral Inventory File (63J/13SW Au1), Non-confidential Assessment File (90120); Parsons (1937); Reid (1938); Stockwell (1937); Wright (1931).

Rex Laguna Mine, circa 1936, 19.5 km southeast of *Snow Lake, on the east shore* of *Wekusko Lake, Manitoba*

Gurney Mine

Location: 44 km east of Flin Flon, 1 km northwest of Brunne Lake.

Map Reference: Map ER86-1-3, location FF3.

Description of Deposit:

The property is underlain by the Elbow Lake-Athapapuskow Lake ocean-floor assemblage, which is intruded by granite and quartz diorite plutons (Map ER86-1-3). The supracrustal assemblage consists of andesite and basalt, and greywacke, arkose and quartzite interbedded with dacite to rhyolite. Mineralization consists of clusters of pyrite, chalcopyrite and galena in closely spaced quartz veins within shear zones; gold occurs as microscopic particles in quartz, associated with galena. Mineralization also occurs in quartz associated with drag folds within a tuff bed (Dawson, 1937).

History of Exploration and Development:

The property was first staked in 1919. Wylie-Dominion Gold Mines Ltd. was incorporated in November 1933 to develop the property and in 1934 a 3-compartment vertical shaft was sunk to a depth of 51 m with one level established at 38 m. About 244 m of drift and crosscut outlined two deposits; the first grading 23.19 g/tonne (0.68 oz/ton) gold over a width of 1.16 m and a strike length of 29 m; and the second grading 12.57 g/tonne (0.37 oz/ton) gold over a width of 1.34 m and a strike length of 21 m.

In 1935 Gurney Gold Mines, Limited purchased the assets of Wylie Dominion Mines, Limited and deepened the shaft to a depth of 199 m. The mine was in production from 1937 to 1939. During this period 1174 m of drift, 310m of crosscut and 2810 m of diamond drilling were completed. The Dominion claims lapsed in 1975.

The property was held by W.B. Dunlop from 1975 to 1977. Dunlop staked the area again in 1978. Kerr Addison Mines Limited optioned the property in 1978 and carried out Iinecutting, geophysical surveys and diamond drilling before the option was dropped in 1983.

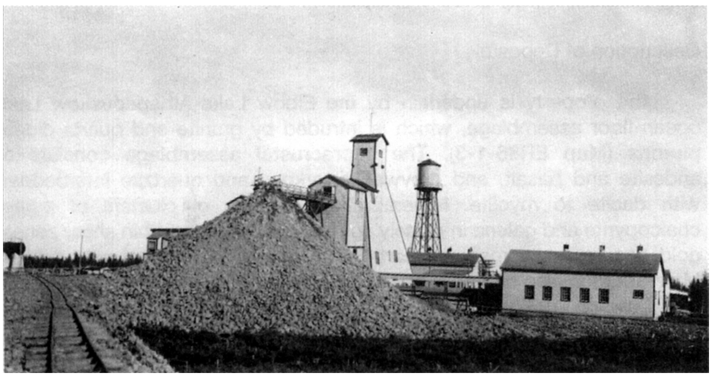
In 1988 Mid-North Resources Ltd., in joint venture with Granges Exploration Ltd., began a program of mapping, sampling, geophysics and drilling on the Gurney property with 89 holes planned at depth and along the shear zones. The best hole, Gur-7, cut 12.5 metres of 4.04 g/tonne (0.118 oz/ton) gold and 42.95 g/tonne (1.25 oz/ton) silver and hole 19 intersected 1.2 metres grading 6.86 g/tonne (0.2 oz) gold (Northern Miner Jan 25, 1988; Manitoba Energy and Mines Exploration Summary 1988; Mid-North Release Feb. 20, 1989). 28 diamond-drill holes were completed in 1989 on known zones and anomalies along the 5.5 kilometre zone of quartz-filled shears. One hole cut 8.8 metres of 5.3 g/tonne (0.15 oz) gold and another hole 580 metres to the east intersected 12 metres of 37 g/tonne (1.08 oz/ton) gold (Northern Miner April 17, 1989). Later in the year the best drill intersections were 7.25 metres grading 6.1 g/tonne (0.18 oz/ton) gold into the so-called "Gossan Hill Showing" and 9.6 metres of 5.46 g/tonne (0.16 oz/ton) gold in the "Contact Lake Showing" (Manitoba Energy and Mines Exploration Summary 1989). In 1990 Granges drilled 11 holes and the best intersection was 4.3 metres grading 4.5 g/tonne (0.13 oz/ton) gold and 15.1 g/tonne (0.44 oz/ton) silver (Granges 3rd Quarter Report 1990).

History of Production:

Year	Tonnes milled	Gold production kg (oz.)
1937	4202	30.94 (995)
1938	42 910	399.39 (12 841)
1939	47 538	441.95 (14 209)
Total	94 650	872.28 (28 045)

Source: Manitoba Mines Branch, Annual Reports 1937-1939

Selected Bibliography: Bailes (1971); Davies *et al.* (1962); Dawson (1937); Manitoba Mines Branch, Annual Reports (1937-1939), Corporation File (Gurney Gold Mines, Limited, Wylie-Dominion Gold Mines Ltd.), Mineral Inventory File (63K/11 NE Au2); Hage (1944); Podolsky (1951).



Gurney Gold Mine, 1939, 44 km east of Flin Flon, Manitoba

Ferro-Rainbow

Location: 23 km southeast of Snow Lake.

Map Reference: Map ER86-1-3, location FF4.

Description of Deposit:

Gold occurs in quartz-filled shear zones and tension fractures in Missi suite andesite. The shears and tension fractures are spatially associated with the northeast-trending Herb (Wekusko) Lake syncline and occur predominantly on the northwest limb, in proximity to the fold axis. Stockwell (1937) mapped ten shear zones in the area of the Ferro-Rainbow property. Within the shear zones the andesite is altered to quartz-biotite schist and contain several gold-bearing quartz veins, lenses and stringers up to 1 m in width. Mineralization consists of pyrite, pyrrhotite, chalcopyrite, free gold and traces of arsenopyrite. Buff weathered carbonate stringers occur in the wall rocks and in the quartz.

History of Exploration and Development:

The property consists of the Ferro Mine and the Rainbow group claims. Ferro Mine - The Ferro property was first staked in 1923. Work on the property up to 1940 consisted of surface sampling, trenching and operation of a small open cut that produced 16.28 kg (523.5 oz.) gold.

The Mining Corporation of Canada, Limited then acquired the property and in 1940 sank a vertical 3-compartment shaft to a depth of 52 m. Wekusko Consolidated Limited was formed in 1943 by several mining companies to develop the property. In 1947 the shaft was deepened to 166 m, with levels at 84, 122, and 160 m. Reserves were estimated to be 45 355 tonnes grading 8.57 g/tonne (0.25 oz/ton) gold (Northern Miner, October, 1947). Financial problems caused work to be discontinued in January 1948. Wekusko Consolidated Limited was renamed Explorers Alliance Limited. They conducted surface work and installed a mill that in 1959 was operating at 54 tonnes per day (Northern Miner, January 18, 1973). In 1962 the claim was transferred to J.C.L. Ferguson. Between 1962 and 1964 the mine produced a small amount of gold (Manitoba Mines Branch, Corporation File, Crowduck Bay Mines Prospectus, 1974).

In 1973 Ferro was assigned to Crowduck Bay Mines Ltd. who carried out an underground sampling program and began mining a small open pit. Indicated reserves were estimated at 36 284 tonnes averaging 9.43 g/tonne (0.28 oz/ton) gold, plus 4536 tonnes of surface material that averaged 8.57 g/tonne (0.25 oz/ton) gold (Canadian Mines Handbook, 1973-74). The mill was rehabilitated and operated sporadically until September 1974.

In 1979 Norman Mines gained an interest in the property and retained Prospection Limited to carry out a technical evaluation of all prior work on the Ferro property. Based on Prospection's recommendations Norman Mines initiated underground rehabilitation, mapping, chip sampling and sidewall sludge sampling. Surface work included mapping, geophysical surveys and diamond drilling. The results of this exploration are not known. Ownership of the Ferro property was transferred to Patrick Harrison Co. Ltd. in 1983.

Rainbow Group - The property was first staked in 1923. Several individuals and companies held the property in the 1920s and early 1930s including: A. Damour, A. Chartrand, and M.J. Hackett, The Mining Corporation of Canada, Limited and Hackett Gold Mining Company Limited. By 1931 about 549 m of stripping had been done and 45 tonnes of ore that was milled produced 0.93 kg (30.0 oz.) gold. The North British Mining and Milling Company, Limited optioned the claims in 1932. J.H.C. Waite optioned the property in 1935 and drilled 8 holes. The option was subsequently dropped.

Wekusko Consolidated Limited optioned the property in 1943 and by the end of 1944 had drilled at least 18 holes on Rainbow. Several of these holes averaged more than 6.86 g/tonne (0.2 oz/ton) gold across widths greater than 1.5 m (Wekusko Consolidated Limited, 1944 Annual Report). The following year four levels of the Ferro mine were driven onto the Rainbow claim. Following is a summary of the assay results from samples taken from the drifts:

Level	Length (m)	Width (m)	Grade g/tonne (oz/ton) gold
1	25.93	1.40	14.40 (0.42)
2	27.36	0.95	11.66 (0.34)
3	15.25	0.95	8.57 (0.25)
3	9.2	0.92	8.91 (0.26)
3	6.41	0.92	10.97 (0.32)

Source: Wekusko Consolidated Limited, 1947 Annual Report.

Exploration was discontinued in January 1948. Patrick Harrison and Company Limited acquired the claims in 1980 and later in the same year transferred ownership to Norman Mines Limited. Strider Resources Limited staked the Ferro mine area in 1987 and optioned the property to Pierce Mountain Resources Ltd. in 1988. Earlier reports put the proven and probable reserves at 66 000 tonnes grading 12 g/tonne (0.35 oz/ton) gold and an additional possible category of 10 000 tonnes at 10.6 g/tonne (0.31 oz/ton) gold (Northern Miner June 20, 1988). In 1989 Pierce Mountain completed a $2 million program, which included 10 300 metres of diamond drilling, mapping, geophysics (VLF, IP, and Mag.) and trenching (Canadian Mines Handbook 1990-91). Some notable intersections in the mine zone were 33 g/tonne (1.0 oz/ton) gold over 2.6 metres, 28 g/tonne (0.82 oz/ton) gold over 1.8 metres and 14 g/tonne (0.41 oz/ton) gold over 3.5 metres. A new gold zone, the "Gold Dust Shear" zone, was discovered in 1989, 460 metres south of the mine zone. The discovery hole encountered 23 g/tonne (0.67 oz/ton) gold over 4.5 metres and an other hole, 185 metres along strike, intersected 23 g/tonne (0.67 oz/ton) gold over 2.1 metres (Northern Miner Jan. 20 and April 10, 1989). Placer Dome Inc. optioned the property and drilled 37 holes in 1990, 19 of them into the Gold Dust Zone. This zone was traced 560 metres along strike and to a depth of 225 metres (Manitoba Energy and Mines Exploration Summaries 1989 and 1990). Golden Tag Resources Ltd. conducted reverse circulation drilling in the Ferro mine area in 1995 and planned diamond drilling for 1996 (Manitoba Energy and Mines Exploration Summary 1995).

History of Production:

Year	Tonnes milled	Gold produced kg (oz.)
1932	1005.8	16.28 (523.51)
1933		6.44 (207)
1962-64		3.73 (120)
1973-74	?	?
Total		26.45 (850.51)

Sources: Manitoba Mines Branch, Corporation File, Crowduck Bay Mines Ltd., Canadian Mines Handbook 1934

Selected Bibliography: Bailes (1971); Davies *et al.* (1962); Harrison (1951a); Manitoba Mines Branch, Corporation File (Crowduck Bay Mines, Explorers Alliance Limited, Mining Corporation of Canada, Norman Mines Limited, North British Mining Company, Wekusko Consolidated Limited), Mineral Inventory File (63J/13SE Au1); Stockwell (1937); Wright (1931).

Moose Horn (Ballast)

Location: 20 km southeast of Snow Lake, on the east shore of Wekusko Lake.

Map Reference: Map ER86-1-3, location FF5.

Description of Deposit:

The deposit consists of a gold-bearing quartz vein that occurs within sheared quartz-feldspar porphyry. The vein strikes 035°, dips 65° to the southeast, averages 0.45 m in width and consists of white, coarsely granular quartz. Mineralization consists of arsenopyrite, pyrite, chalcopyrite, galena, sphalerite, free gold and petzite.

History of Exploration and Development:

In 1914 R.A Hazelwood and H. Vickers staked the Ballast and Moose Horn claims. Northern Manitoba Mining and Development Company, Limited was organized in 1915 to develop the property. In 1917, 26 tonnes of ore shipped to Trail B.C. produced 3.4 kg (108 oz.) of gold. The Makeever brothers optioned the property in 1918. Ore sent to the Laguna mill produced 1.6 kg (52 oz.) of gold (Robinson, 1935).

In 1931 Robert Kerr mined 16 tonnes of ore that produced 1.1 kg (34.0 oz.) gold. In 1944 the claims were optioned to Wekusko Consolidated Limited who carried out diamond drilling before allowing the option to lapse in 1945.

Since 1945 the property has been controlled by McKenzie Oil and Gas Company Limited, Donald Kish, and most recently by Peter Dunlop.

History of Production:

Year	Tonnes mined	Tonnes milled	Gold produced kg (oz.)
1917	25.9	25.9	3.36 (108)
1918			1.62 (52)
1931	16.0	16.0	1.06 (34)
Total	41.9	41.9	6.04 (194)

Source: Robinson (1935), Manitoba Mines Branch, Annual Report on Mines and Minerals, 1931, p. 40.

Selected Bibliography: Alcock (1919); Bailes (1971); Davies *et al.* (1962); Manitoba Mines Branch, Annual Report on Mines and Minerals (1928, 1932), Corporation File (Kiskoba Mining Company Limited, Wekusko Consolidated Limited), Mineral Inventory File (63J/13SW Au4); Stockwell (1937); Wright (1931).

Bingo

Location: 18 km southeast of Snow Lake, just east of Wekusko Lake.

Map Reference: Map ER86-1-3. location FF11

Description of Deposit

Gold-bearing quartz veins occur in quartz-feldspar porphyry. The veins strike 018°, dip 75°NW, range in width from 0.2 to 0.6 m and contain pyrite, galena, arsenopyrite, tourmaline and visible gold.

History of Exploration and Development:

The property was first staked in 1915 by J. McCormack and was assigned to J.R. Campbell one year later. Surface work was done in 1916, 1917 and 1919. Several people held interest in the claim before it was assigned to H.R. Drummond-Hay in 1919. He assayed 6 samples that averaged 188.6 g/tonne ($110/tonne at $20/oz. gold) gold over a width of 0.15 m. Bingo Mines, Limited was formed to develop the property and from 1922 to 1944 sank a 122 m deep shaft, drove 183 m of drifts and 61 m of crosscuts (Stockwell, 1937). The company reported uniformly high gold grades were obtained from samples of the drifts and crosscuts. However, sampling done by Reid and Dresser (1925) failed to outline any economic areas of mineralization. As a result the company was accused of "salting" assay samples. The managing director of Bingo Mines, Limited was charged with making false statements and intent to defraud and was acquitted.

Bingo Mines, Limited was liquidated and its assets purchased by a new company, Bingo Gold Mines, Limited. In early 1926 a test mill was constructed and 425 tonnes of hand-cobbed ore was milled to produce 4.4 kg (128 oz.) gold. In 1927 drillholes were collared to test the veins at depth. Poor core recovery and abnormal hole flattening prevented the holes from reaching the desired depth; however, the assay results were reported to be encouraging (Manitoba Mines Branch, Corporation File, Bingo Gold Mines, Limited). In 1937 the mine workings were allowed to flood and the old test mill was sold.

In 1978 A.V. Harris Exploration Services acquired the property and undertook a program of linecutting and sampling of dumps. Norman Mines Ltd. acquired the property in 1980 and carried out linecutting and prospecting. In 1984, 100% interest of the property reverted back to A.V. Harris Exploration Services Ltd. who dealt it to Wekusko Lake Resources Ltd. A biogeochemical survey was carried out in May 1984. In September

1984 Noranda acquired the property as part of the Laguna-Bingo Option. Noranda undertook a program of linecutting, geological mapping, soil sampling, lithogeochemistry and geophysical surveys.

History of Production:

In 1926 the test mill produced a total of 4.4 kg (128 oz.) gold (Manitoba Mines Branch, Annual Report 1926).

Selected Bibliography: Galley *et al.* (1986); Reid and Dresser (1925); Manitoba Mines Branch, Mineral Inventory File (63J/13SW Au3); Robinson (1935); Stockwell (1937), Wright (1931).

Gold Hill

Location: 39 km southeast of Flin Flon, 1.3 km southeast of Cranberry Portage.

Map Reference: Map ER86-1-3, location FF6.

Description of Deposit:

The property is underlain by granite that is cut by a series of *en echelon* quartz veins and lenses with associated pyrite and chalcopyrite. The veins and lenses strike 080° and dip 70° S.

History of Exploration and Development:

The property was first staked in 1934. From 1935 to 1963 the property was worked by several companies including Gold Hill Development Syndicate Limited, Myrtle Gold Mines Limited, Bergold Development Company Ltd. and Cranberry Mines Ltd. Development work carried out included: a 40 m inclined shaft, 29 m of drifting and 360 m of diamond drilling. Total production for this period was 103 tonnes averaging 20.27 g (0.59 oz/ton) gold. Recently P. Dunlop carried out linecutting, trenching and geophysical surveys.

Selected Bibliography: Manitoba Mines Branch, Corporation File (Bergold Development Company Ltd., Cranberry Gold Mine Syndicate, Limited, Gold Hill Development Syndicate.), Mineral Inventory File (63K/11 SW Au3).

Century Mine

Location: 53 km west of the town of Snow Lake.

Map Reference: Map ER86-1-3, location FF7.

Description of Deposit:

The Century deposit is located near one of the major northerly-trending deformation zones through Elbow Lake (Map ER86-1-3). The deposit area is underlain by the Elbow Lake-Athapapuskow Lake ocean-floor assemblage. The rocks are massive and pillowed mafic volcanic rocks, that are intruded by quartz-feldspar porphyry. A quartz porphyry dyke, 0.92 to 3.05 m wide, was traced at intervals for a strike length of 92 m. Much of the porphyry is sheared and altered to sericite schist and contains disseminated pyrite and crosscutting veinlets and banded lenses of quartz up to 1.8 m long and 0.6 m wide. The quartz locally carries pyrite, galena, chalcopyrite and visible gold. Gold commonly occurs at the contact of quartz with altered wall rock. Patches of carbonate are also present in some of the quartz.

History of Exploration and Development:

The deposit was first staked in 1919. A 21 m shaft was sank and 24 m of development work carried out. In 1937 Century Mining Corporation deepened the shaft to 88 m and carried out 1387 m of drilling (Northern Miner, February 27, 1941).

In 1941 a 90-tonne mill was constructed but operated only until January 1942. Early in 1946 work resumed on the property. The shaft was deepened to 161 m with stations cut at depths of 114 and 153 m. In the spring of 1951 a 6-hole 2951 m drill program was completed; however, the results were never reported.

From 1955 to 1976 the property was held by A.D. MacPherson, Fairfield Projects Limited and Marwil Industries Ltd.

In 1979 Ram Petroleums Limited obtained an option on the property and carried out geological, geochemical, and geophysical surveys that indicated extensions of the known veins. Diamond drilling was carried out and indicated proven reserves of 272 000 tonnes grading 12.0 g/tonne (0.35 oz/ton) gold in the Webb-Garbutt zones (Ram Petroleums Limited, Interim Report, September 30, 1980).

History of Production:

The only recorded production was in 1942 when a gold bar weighing 1.85 kg (59.6 oz.) was produced.

Selected Bibliography: McGlynn (1959); Manitoba Mines Branch, Corporation Files, Century Mining Corporation; Mineral Policy Sector, Ottawa, Corporation File (Century Mining Corporation, Elbow Lake Mining Syndicate Limited, Golden West Mines Limited, Ram Petroleums Limited), Galley *et al*. (1989); Mineral Inventory File (63K/15SW, Au4); Syme (1990).

Tartan Lake

Location: 13.5 km northeast of Flin Flon.

Map Reference: Map ER86-1-3, location FF8.

Description of Deposit:

The following description is summarized primarily from Fedorowich *et al*. (1991). The area of the Tartan Lake deposit is underlain by a layered gabbroic complex that intruded mafic to intermediate flow rocks and intermediate to felsic pyroclastic rocks of the Flin Flon arc assemblage (Fig. 35). The Tartan Lake deposit consists of four gold-bearing shear zones: the Main zone, South zone, East zone and Baseline zone. The main zone occurs along the contact of the gabbroic complex with the volcanic rocks and the other three within the gabbroic complex (Fig. 35, 36)

Fedorowich *et al.* (1991) identified five deformation phases (D_1 to D_5) in the Tartan Lake area. The Tartan Lake shear zone was initiated during D_3 during which N-S trending folds and dip slip faults were generated under peak metamorphic conditions (middle greenschist facies with biotite at Tartan Lake). During D_4 the Embury Lake fold formed and rotated strata on the north limb into E-W direction (Map ER86-1-3). The Tartan Lake shear zone was reactivated and late conjugate strike slip shear zone developed (during D_4). These zones range in width from 5-35 m and comprise the 0.3 km wide deposit-hosting structure at Tartan Lake. Within the shear zones sericite, chlorite, quartz, carbonate, albite, tourmaline, and pyrite are the dominant minerals. Biotite and actinolite were retrograded to chlorite, indicating that alteration and gold mineralization is younger than peak metamorphism. Gold mineralization is associated with two vein types;
1) laminated quartz-tourmaline-carbonate±pyrite, chalcopyrite, gold veins that occur in the central parts of shear zones. The veins range in widths

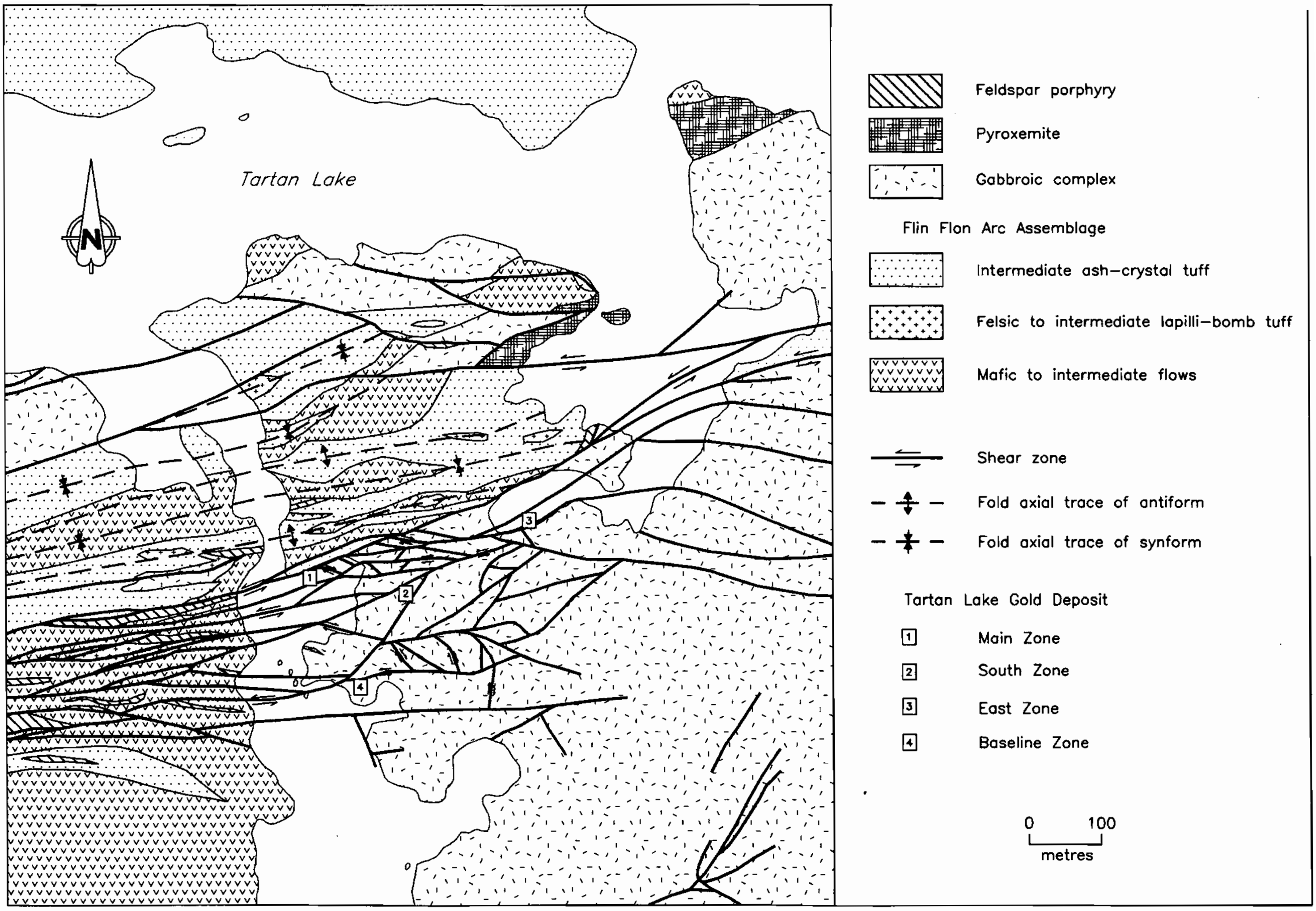


Figure 35: Geology in the area of the Tartan Lake deposit (from Fedorowich et al., 1991).

from 0.3-4.5 m, have strike lengths of up to 30 m and extend down dip for up to 100 m. 2) mineralogically similar to 1) form arrays of veins, crosscut 1) and are highly oblique to the shear zone. Individual veins within these arrays are 0.05-2 m long and less than 10 cm wide.

Gold mineralizing fluids were of H_2O-CO_2-NaCl composition. Stable oxygen isotope compositions of the vein minerals indicate an average temperature of 372°±41°C and pressures of 1.2 to 2.4 kbars which corresponds to 4.3 to 8.6 km crustal depth. The timing of the mineralizing event has been constrained by the $^{40}Ar/^{39}Ar$ method at 1791±4 Ma, *i.e.* post-peak metamorphism (1840-1805 Ma; Table 11).

Most of the property's reserves are confined to the Main zone shear and consist of two gold-bearing lenses that strike 090°, dip steeply to the north and plunge steeply west to northwest (Northern Miner, January 20, 1985; Kreczmer and Deveaux, 1986). Lens number 1 has a strike length of 60 m and extends vertically to the 90 m level. Lens number 2, located 5-10 m on the footwall side of lens 1, has a strike length near surface of 40 m, increasing to 200 m on the 200 m level.

History of Exploration and Development:

The property was first staked in 1931, as the Killarney and Monica claims. The following year Consolidated Mining and Smelting Company of Canada (Limited) did surface work on the west side of the property. Samples yielded assays that ranged from 3.09 g/tonne (0.09 oz/ton) gold over 4.58 m to 171.78 g/tonne (5.01 oz/ton) gold over 0.31 m.

Nesnah Mining and Exploration Company Limited took an option on the property in 1945. Drilling outlined possible reserves of 207 tonnes per vertical metre grading 19.20 g/tonne (0.56 oz/ton) gold (Manitoba Mines Branch, Corporation File, Nesnah Mining and Exploration Limited). The Killarney and Monica claims lapsed in 1960 and 1971, respectively.

The area was restaked by J. Murray and A.T. Jacobson in the 1960s and 1970s; however, little exploration was done and the claims lapsed.

Granges Exploration Aktiebolag staked the property in September 1981. Diamond drilling confirmed a zone of gold mineralization over a strike length of 183 m to a vertical depth of 122 m. The discovery hole intersected 16.84 m averaging 20.78 g/tonne (0.61 oz/ton) gold (Granges Exploration Aktiebolag, News Release, November 26, 1984). In 1985, in joint venture with Abermin Corporation, Granges carried out delineation drilling that indicated a deposit with reserves of 465 000 tonnes grading 11.97 g/tonne (0.349 oz/ton) gold (Granges Exploration Ltd., Annual Report, 1985).

In 1986 the joint venture partners carried out an underground development program consisting of driving an exploration decline, underground drilling for stope definition and surface drilling of the South zone (Fig. 36). Based on the results of underground drilling construction of a 450 tonne per day modular mill started in early 1987. Capital costs were estimated at $20 million (Northern Miner Jan 12 and March 16, 1987) and

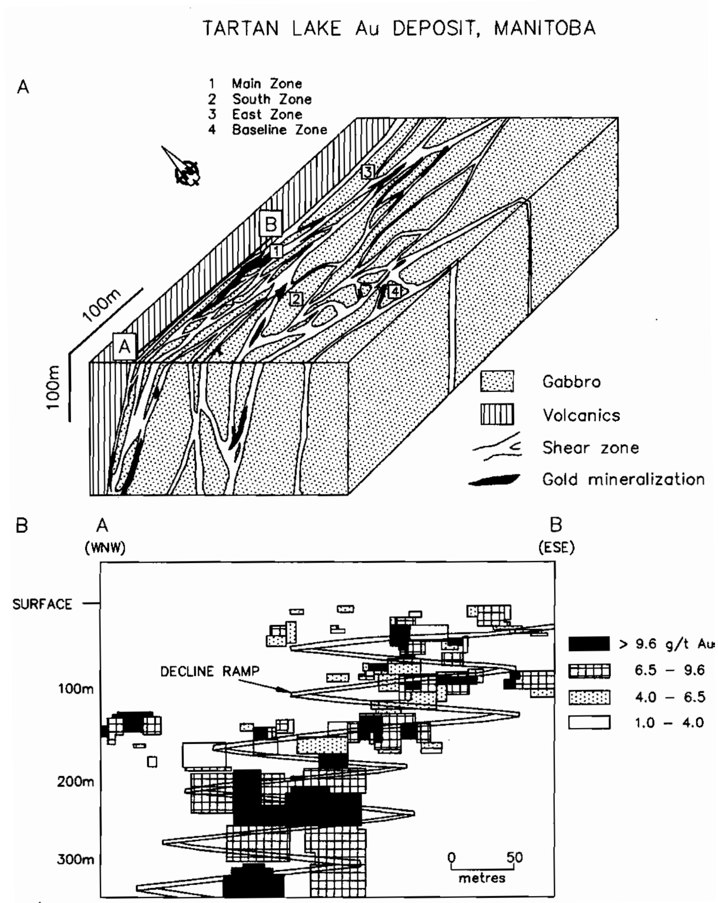


Figure 36: A. Block diagram of the Tartan Lake deposit showing the distribution of shear zones and gold mineralization B. Longitudinal projection A-B showing the distribution of gold within the Main zone of the Tartan Lake deposit (from Fedorowich et al., 1991).

on September 1, 1987 the mine opened. During 1987 the mine produced 160 kg (5010 ounces) of gold. Milling capacity was increased to 500 tonnes per day and Granges anticipated 1988 production to be in excess of 620 kg (20,000 oz) of gold. In December 31, 1987 proven and probable ore reserves were estimated at 503 000 tonnes grading 7.2 g/tonne (0.21 oz/ton) gold (Granges Exploration Ltd. 1987 Annual Report). In 1988 the mine experienced operating problems, reserves and grade were adjusted lower and production only reached 418 kg (13,500 oz) of gold. Granges was taken over by MIM Holdings Australian in 1989 and because of continuing operating and legal problems the Tartan mine was closed in October 1989 (Northern Miner Sept. 18, Oct. 23, 1989 and Feb. 26, Sept. 24, 1990). The property remained idle until Granges resumed some exploration drilling in 1995 and found a new “West Zone”, SW of the main mine zone. Mineable reserves at Tartan Lake stand at 375, 000 tonnes grading 6.27 g/tonne (0.18 oz/ton) gold (Northern Miner March 27,1995).

History of Production:

Year	Gold produced kg	(oz)
1987	160	(5010)
1988	432	(13,500)

Selected Bibliography: Fedorowich *et al.* (1991); Gale (1981); Kreczmer and Deveaux (1986); Manitoba Mines Branch (Corporation File, Nesnah Mining and Exploration Company Limited); Mineral Inventory File (63K/13 Au2); Peloquin and Gale (1985); Peloquin *et al.* (1986).

DEPOSITS

Apex

Location: 15.5 km southeast of Snow Lake, on a peninsula separating Herb Bay and Crowduck Bay of Wekusko Lake.

Map Reference: Map ER86-1-3, location FF9.

Description of Deposit:

The area is underlain by Post-Missi suite granodiorite. Gold, sulphide and tungsten-bearing quartz stockworks fill fractures and shears in the granodiorite. At surface the mineralized area is hook-shaped and is 260 m long and averages 10 m wide. Arsenopyrite is the predominant sulphide and may constitute up to 10% of the stockworks over narrow widths. Visible gold and lenses of scheelite occur locally.

History of Exploration and Development:

The property was first staked in 1918. Various prospectors held the property until The Mammoth Mining Corporation Limited acquired the property in 1920. J.A. Reid, a consulting geologist, visited the property in 1923 and took over 900 samples (Manitoba Mines Branch, Corporation File, Mammoth Mining Corporation Limited). The best zone of mineralization averaged 16.46 g/tonne (0.48 oz/ton) gold over an average width of 2.75 m and length of 36.6 m. A 4.6 m shaft was sank on Apex in 1927. In 1930 Consolidated Mining and Smelting Company of Canada Limited took approximately 540 channel samples across 1.5 m widths. Based on 816 kg of assayed samples they estimated that the deposit contained 758 000 tonnes grading 3.63 g/tonne (0.11 oz/ton) gold. The company planned to carry out diamond drilling; however, problems arose in negotiating an option agreement and drilling was not carried out.

Fifty-Three Syndicate Limited was formed in 1934 to examine the property and develop it. They carried out diamond drilling but did not intersect mineralization similar to that exposed in outcrop.

R. Kerr restaked the property in 1940. Tungold Mines Limited explored the claims for tungsten and in 1942 discovered scheelite in the former gold workings. A hand-cobbed 1115 kg sample assayed 7.54 g/tonne (0.22 oz/ton) gold and 46.64% WO_3. From 1943 to 1946 Tungold carried out a 77-hole 2711 m drill program. Of the first 52 holes drilled, 33 contained significant gold mineralization but scheelite grades were low. Tungold planned to carry out a deep drilling program to test the deposit at depth; however, financing of the project was never completed and the claims were canceled in 1955.

The property, although staked three times from 1956 to 1973, was not explored.

In 1973 W. Bartum Kobar staked the property. A&V Harris Exploration Services acquired the property in 1979 and optioned it to Placer Development Limited in 1980. Placer carried out 16 km of linecutting, detailed mapping, sampling and 517 m of drilling before dropping the option. Nord Resources reportedly optioned the property and in 1981 contracted San Francisco Mining Associates to carry out an 11-hole, 915 m, drill program. Results of the program are not known.

Selected Bibliography: Alcock (1919); Bailes (1971); Little (1959); Manitoba Mines Branch, Annual Reports on Mines and Minerals (1941, 1944), Corporation File (Consolidated Mining and Smelting Company of Canada Limited, Mammoth Mining Co. Ltd., Tungold Mines Ltd), Mineral Inventory File (63J/13SW, Au11); Reid (1923); Shepherd (1943).

Snow Lake Mines Ltd. Property

Location: 1.5 km northwest of Snow Lake.

Map Reference: Map ER86-1-3, location FF10.

Description of Deposit:

The following description is summarized primarily from Galley *et al.* (1986). The property is underlain by three northwest-striking units: 1) a northern unit comprising massive to pillowed flows that are crosscut by numerous diorite intrusions; 2) a central unit of mafic fragmental rocks and flows; and 3) a southern zone of felsic quartz-phyric tuff and lapilli tuff, intruded by hornblendite dykes and sills. These units represent a complexly faulted homoclinal sequence that strikes northwest and dips to the northeast.

There are several mineralized zones on the property; however, the No. 3 zone and Birch zone are the largest. The No.3 zone occurs in heterolithic fragmental rocks, is 2 to 11 m thick, has economic grades proven over a length of 200 m and extends down dip at 45° for 100 m. The zone is characterized by numerous faults, erratic thicknesses and a quartz vein stockwork. The faults and mineralized zone are curvilinear striking 285° at the northwest extremity and 080° at the eastern extremity. Mineralization consists of up to 10% arsenopyrite, 0-5% pyrite and up to 5% tourmaline. High-grade zones comprise felted masses of arsenopyrite along the margins of quartz veins and locally contain visible gold. Hudson Bay Mining and Smelting Co., Limited estimate drill indicated reserves of the No.3 zone at 200 000 tonnes grading 15.09 g/tonne gold (Northern Miner, April 28, 1986).

The Birch zone, which is located 1.2 km north-northwest of the No.3 zone, has a strike length in excess of 120 m and downdip extent in excess of 180 m (Northern Miner, March 9, 1987). Drill results indicate the presence of at least 127 000 tonnes averaging 18.1 g/tonne (0.528 oz/ton) gold over an average width of 1.98 m.

History of Exploration and Development:

The property was first staked in the early 1940s by various individuals including: C.R. Parres, G. Richard and H. Vickers. Nor-Acme Gold Mines Limited acquired the property in 1942 and then sub-leased it to the Howe Sound Exploration Company, Ltd. The lease was cancelled on November 17,1964.

From 1964 to 1971 the property was held by various individuals. During this period geophysical surveys were completed.

In 1971 W. Bruce Dunlop Limited (NPL) staked the property. Granges Exploration Aktiebolag optioned the property in 1980 and carried out linecutting and geophysical surveys over the property. Granges dropped the option and in subsequent agreements the property was transferred to Darius Gold Mine Inc. in 1982, and then to Gold Fields Canadian Mining Limited in late 1982. Gold Fields carried out further linecutting and geophysical surveys followed by 16 140 m of diamond drilling. In June 1985 HBM&S optioned the property and carried out a 47-hole 3406 m drill program. The option lapsed in early 1986.

In March 1986 Silver Hart Mines Ltd acquired 100% interest in the property, subject to a 3.5% net smelter return on the three principal claims and 1% net smelter return on the balance. Snow Lake Mines (a subsidiary of Silver Hart) acquired the property in late 1986 and commenced diamond drilling in early 1987. In March they announced the discovery of the Birch zone.

No further work was performed by Silver Hart and the property reverted back to W. Bruce Dunlop Ltd. In September 1993 High River Gold Mines entered into an option agreement with W. Bruce Dunlop Ltd. to acquire the property. The property now forms part of the New Britannia Mine (see above).

Selected Bibliography: Harrison (1949); Galley et al. (1986); Gonzales and Fedikow (1984).

TABLE 12: SUMMARY OF MAIN GOLD DEPOSITS/OCCURRENCES IN THE FLIN FLON-SNOW LAKE AREA

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
NEW BRITANNIA (formerly Nor Acme) FF1 Map ER86-1-3	Past (1949-58: 19 546 kg (628 400 oz) and present producer 1995: 1800 tonnes per day 3100 kg (100 000 oz) gold per year	1994 combined reserves: 4.2 mill tonnes at 6 g/t (0.18 oz/ton)	stockwork of quartz-carbonate -plag ioclase±tourmaline veins and stringers in brecciated volcanic rocks within splay fault(s) of major fault; gangue minerals arsenopyrite, pyrite, pyrrhotite, chalcopyrite, sphalerite, galena	TVX Gold Ltd. and High River Gold Mines Ltd. (1996)
NEW BRITANNIA -3 and Birch Zones (formerly Snow Lake Mines Ltd.) FF10 Map ER86-1-3	Present producer (first ore to be mined for mill feed at New Britannia)	1994 combined reserves: 743 000 tonnes at 8.3 g/t (0.24 oz/ton)	See FF1, above; gangue minerals: arsenopyrite, pyrite, pyrrhotite, chalcopyrite, sphalerite, galena.	TVX Gold Ltd. and High River Gold Mines Ltd. (1996)
LAGUNA FF2 Map ER86-1-3	Past producer 1936-40: 1834 kg (58 960 oz)	unknown	quartz vein in 'schistose' zone along margin of quartz-feldspar porphyry that intruded metasedimentary rocks; gangue minerals: arsenopyrite, pyrrhotite, chalcopyrite, galena	W. Bruce Dunlop Limited (1996)

TABLE 12: SUMMARY OF MAIN GOLD DEPOSITS/OCCURRENCES IN THE FLIN FLON-SNOW LAKE AREA (cont.)

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
TARTAN LAKE FF8 Map ER86-1-3	Past producer 1987-89: 1108 kg (35 620 oz)	1995 proven reserves: 375 000 tonnes at 6.27 g/t (0.18 oz/ton)	quartz-carbonate-tourmaline veins in shear zones along the margin and within gabbroic complex; gangue minerals: pyrite, chalcopyrite, albite, tourmaline	Granges Inc. (1996)
GURNEY FF3 Map ER86-1-3	Past producer 1937-39: 872 kg (28 045 oz)	unknown	quartz veins in shear zone within andesite to basalt, dacite to rhyolite and metasedimentary rocks; gangue minerals: pyrite, chalcopyrite, galena.	W. Bruce Dunlop Limited (1996)
FERRO-RAINBOW FF4 Map ER86-1-3	Small past producer 1932-33: 23 kg (740 oz) 1962-64: 3.7 kg (119 oz) 1973-74: 26.5 kg (852 oz)	1989 probable reserves: 66 000 tonnes 13.4 g/t; possible 10 000 tonnes 11.7 g/t (0.39 oz/ton)	quartz±carbonate veins in shear zones and fractures within andesite; gangue minerals: pyrite, pyrrhotite, chalcopyrite, arsenopyrite	Daniel V. Ziehlke (1996)
MOOSEHORN FF5 Map ER86-1-3	Small past producer 1917-18: 5 kg (161 oz) gold	unknown	quartz vein in sheared quartz-feldspar porphyry; gangue minerals: arsenopyrite, pyrite, galena, sphalerite, petzite	W. Bruce Dunlop Limited (1996)
BINGO FF11 Map ER86-1-3	Small past producer 1926: 4.4 kg gold	unknown	quartz-vein in quartz-feldspar porphyry; gangue minerals: pyrite, galena, arsenopyrite, tourmaline	W. Bartum Kobar (1996)
GOLD HILL FF6 Map ER86-1-3	Small past producer 1935: 103 tonnes milled that contained 20.3 g/t (0.59 oz/ton) gold	unknown	quartz veins/lenses in granite; gangue minerals: pyrite, galena, arsenopyrite, tourmaline	W. Bruce Dunlop Limited (1996)
CENTURY FF7 Map ER86-1-3	Small past producer 1942: 1.85 kg (60 oz) gold bar	1980 drill indicated reserves: 272 000 tonnes at 12.0 g/t (0.35 oz/ton)	quartz lenses/veinlets in sheared quartz -feldspar porphyry dyke; gangue minerals: pyrite, galena, arsenopyrite, tourmaline	Ram Petroleums Limited (1996)
APEX FF9 Map ER86-1-3	Prospect 1943-46, 1980, 1981: drilling	1946: 362 874 tonnes at 2.4 g/t (0.07 oz/ton)	quartz stockwork in fractures/shears in granodiorite; gangue minerals: arsenopyrite (up to 10%), scheelite	W. Bartum Kobar (1996)

LYNN LAKE GREENSTONE BELT

REGIONAL GEOLOGY

Introduction

The Paleoproterozoic Lynn Lake greenstone belt domain extends for 150 km in an east-west direction and lies on strike with the La Ronge domain in Saskatchewan (Fig. 29). The belt is divided into two major belts, the Northern belt and the Southern belt, which are separated by granitoid intrusions. The Miskwa belt is a third, but much smaller belt that branches off the Southern belt near Wasekwan Lake (Map ER86-1-4). Several smaller belts occur in the granitoid terrain to the south. (Map ER86-1-4). The greenstone belt domain is bounded to the north by the Southern Indian sedimentary gneiss belt, to the east by the Rusty Lake greenstone belt and to the south by the Kisseynew gneiss belt (Fig. 5, 29).

The greenstone belts in the Lynn Lake belt comprise volcanic and derived sedimentary rocks of the Wasekwan Group (Bateman, 1945), which have been intruded by subvolcanic plugs and were subsequently folded, faulted and later intruded by gabbro and intermediate to felsic plutons. These intrusions and the Wasekwan Group supracrustal rocks were unconformably overlain by conglomerates and sandstones of the Sickle Group (Norman, 1934). This division has still been used in the latest regional geological surveys (Gilbert *et al.,* 1980; Syme, 1985a; Zwanzig *et al.,* 1985; Baldwin *et al.,* 1987).

Wasekwan Group

Each greenstone belt is characterized by a unique stratigraphic succession, chemistry and structure; correlations of units between belts is uncertain. The Southern belt, extending for over 150 km from Laurie Lake in the west to Opachuanau Lake in the east consists of lens-shaped volcanic and sedimentary units which have been interpreted as overlapping volcanic edifices with flanking aprons of volcaniclastic rocks (Gilbert *et al.,* 1980). The volcanic units include tholeiitic basalt at Cockeram Lake and porphyritic calc-alkaline basalt at McVeigh Lake and Fox mine. The basalts are locally overlain by felsic volcanic units, such as the Fraser Lake rhyolite or Snake Lake dacite. The units in the Southern belt form a large anticline and probably contain the oldest supracrustal rocks in the Lynn Lake greenstone domain (Gilbert *et al.,* 1980). In contrast the over 100 km long Northern Belt is a north-facing homocline. Its stratigraphic succession starts with 1910+15/-10 Ma rhyolite (Baldwin *et al.,* 1987) at the base overlain by andesite and basalt, sedimentary rocks and an upper basaltic unit. The basalts are tholeiites and include high alumina varieties and subordinate high-magnesia basalt. (Syme, 1985a). Smaller belts of Wasekwan Group rocks occur in the Counsell Lake, Miskwa Lake and Durand Lake areas.

Pre-Sickle Intrusions

Large composite plutons of diorite, tonalite, granodiorite and granite, such as the 1876+6/-4 Ma Pool Lake intrusive suite (Baldwin *et al.,* 1987), underlie the area between the Northern and Southern Belts (Map ER86-1-4). In addition, the Wasekwan Group is intruded by isolated plutons of gabbro, norite and minor ultramafic rocks, such as the Lynn Lake gabbro, which contain Cu-Ni deposits. Composite plutons also separate the smaller volcanic belts.

Sickle Group

The Sickle Group overlies deformed Wasekwan Group and Pre-Sickle Intrusions with an angular unconformity. It comprises a basal conglomerate and thick, fining upward alluvial sandstone successions (Gilbert *et al.,* 1980; Zwanzig, 1981).

Post-Sickle Intrusions

Post-Sickle intrusions range in composition from gabbro to granite and occur at Laurie Lake, Burge Lake north of the Northern Belt and south of the Southern belt (*e.g.* Eden Lake intrusive suite, Black Trout Lake diorite; Map ER86-1-4).

METAMORPHISM

The grade of metamorphism of Wasekwan Group and Sickle Group rocks ranges from upper greenschist to upper amphibolite facies. Upper greenschist facies mineral assemblages are developed in the Cartwright Lake-Hughes Lake area and locally in the Northern Belt. The metamorphic grade increases west of Cartwright Lake to amphibolite facies. Amphibolite facies metamorphism prevailed throughout the Northern Belt, in the western part of the Southern Belt and in the Miskwa Lake Belt. Upper amphibolite facies mineral assemblages are developed in the Fox Mine area.

STRUCTURE

Gilbert *et al.* (1980) recognized five periods of deformation including three phases of folding. East- and northeast-trending upright folds (F_1) formed in Wasekwan Group rocks of the Southern Belt during D_1 deformation. In the eastern part of the Northern Belt the Wasekwan Group is folded by arcuate east- to southeast-trending folds (F_1?).

Uplift, northwest-trending folding and faulting occurred during D_2 deformation, during intrusion of Pre-Sickle plutons. Both D_1 and D_2 structures in Wasekwan Group rocks are truncated at the unconformity with overlying Sickle Group rocks.

Thrusting occurred along the belt margins during D_3 deformation. During D_4 deformation northeast-trending F_2 folds were produced in conglomerates to the north of the Northern Belt. North- and east-trending synclines (F_2) formed basins of Sickle Group rocks at Hughes Lake, Sickle Lake and Conglomerate Lake. Elsewhere F_1 folds in the Wasekwan Group became appressed during D_4.

An extensive zone of faulting, cataclasis and shearing developed along the south margin of the Southern Belt. This zone, the “Johnson Shear Zone” (Bateman, 1945) is about 44 km long and extends from Franklin Lake east to One Island Lake along the contact between Pre-Sickle intrusions and Wasekwan Group rocks. The Johnson shear zone is structurally quite variable. It locally is a discrete structure (up to 50 m wide) defined by intense cataclastic deformation and shearing, whereas elsewhere it is expressed as a series of widely spaced discrete shears and/or brittle faults, separated by broader zones of only moderately strong developed schistosity (Peck *et al.,* 1995).

During D_5 deformation open cross-folding (F_3) and north- to northeast-trending faults were produced.

MINERALIZATION

Introduction

Five gold deposits and nine significant occurrences have been found in the Lynn Lake greenstone belts (Map ER86-1-4). Three deposits, the Maclellan, Farley, and 'K Zones and Rushed' (also known as "Dot") deposits, occur in the Northern belt. One deposit, the 'Burnt Timber' and seven occurrences are located in the Johnson shear zone in Southern (Map ER86-1-4). The Lasthope deposit occurs in the Miskwa Lake belt.

Northern Belt

At present, the Northern Belt is known to contain three significant deposits, the Maclellan Mine, the Farley Lake deposit, and the 'K Zones and Rushed' deposit (Map ER86-1-4, locations 1, 2, 15). The deposits are all hosted by a distinct stratigraphic sequence of Wasekwan Group rocks that comprises basaltic-ultramafic komatiites, siliceous and biotite-rich, locally sulphidic siltstones, and oxide, sulphide, and silicate facies iron formation (Fedikow, 1983, 1986a). Because of its stratabound mineralization and its significant lateral extent it was termed the Agassiz Metallotect by Fedikow (1984; Fig. 37). The main characteristics of the Agassiz Metallotect were summarized by Fedikow *et al.* (1986a, 1990).

The stratigraphic sequence of the metallotect can be traced from Dot Lake eastward to Spider Lake, east of Barrington Lake, a distance of about 100 km (Fedikow, 1986b; Ferreira, 1986a; Fig. 37; Map ER86-1-4). The metallotect has a distinct aeromagnetic signature.

Host Rocks

Mineralization at the Maclellan Mine (Fig. 37) occurs in four main zones within thinly bedded and interlayered siltstone, iron formation and basaltic-ultramafic komatiites (Fedikow, 1986a) in the stratigraphically lower part of the Agassiz Metallotect (Fig. 38). Within these zones the favoured host rocks to mineralization are biotitic and siliceous siltstones; the highest ore grades are related to carbonate-quartz-sulphide veins and their silicification haloes. The 'K Zones and Rushed' occur in the same stratigraphic interval as the Maclellan deposit. The Farley Lake deposit (Fig. 37) is located in iron formation (Fig. 38). The mineralization consists of gold-bearing sulphides that have replaced magnetite laminae and grains in an oxide facies iron formation. The gold-bearing sulphidized laminae form zones that are oblique to layering.

Ore Mineralogy

Mineralization at the Maclellan Mine and 'K Zones and Rushed' deposit consists of iron sulphides with minor arsenopyrite, sphalerite, galena and rare chalcopyrite. Augsten (1985) found that the gold occurs as: 1) grains less than 30 microns in size associated with pyrrhotite, arsenopyrite, galena, pyrite, sphalerite, ilmenite and magnetite; 2) small irregular veinlets less than 10 microns in silicate host rocks; or 3) mantling rims or fracture fillings in galena, arsenopyrite and pyrrhotite.

At Farley Lake gold is associated with sulphides in partially sulphidized magnetite-chert iron formation. Gold occurs as isolated grains in cavities in the silicate matrix and within pyrrhotite and magnetite grains (Manitoba Mineral Resources Ltd., internal report, 1986).

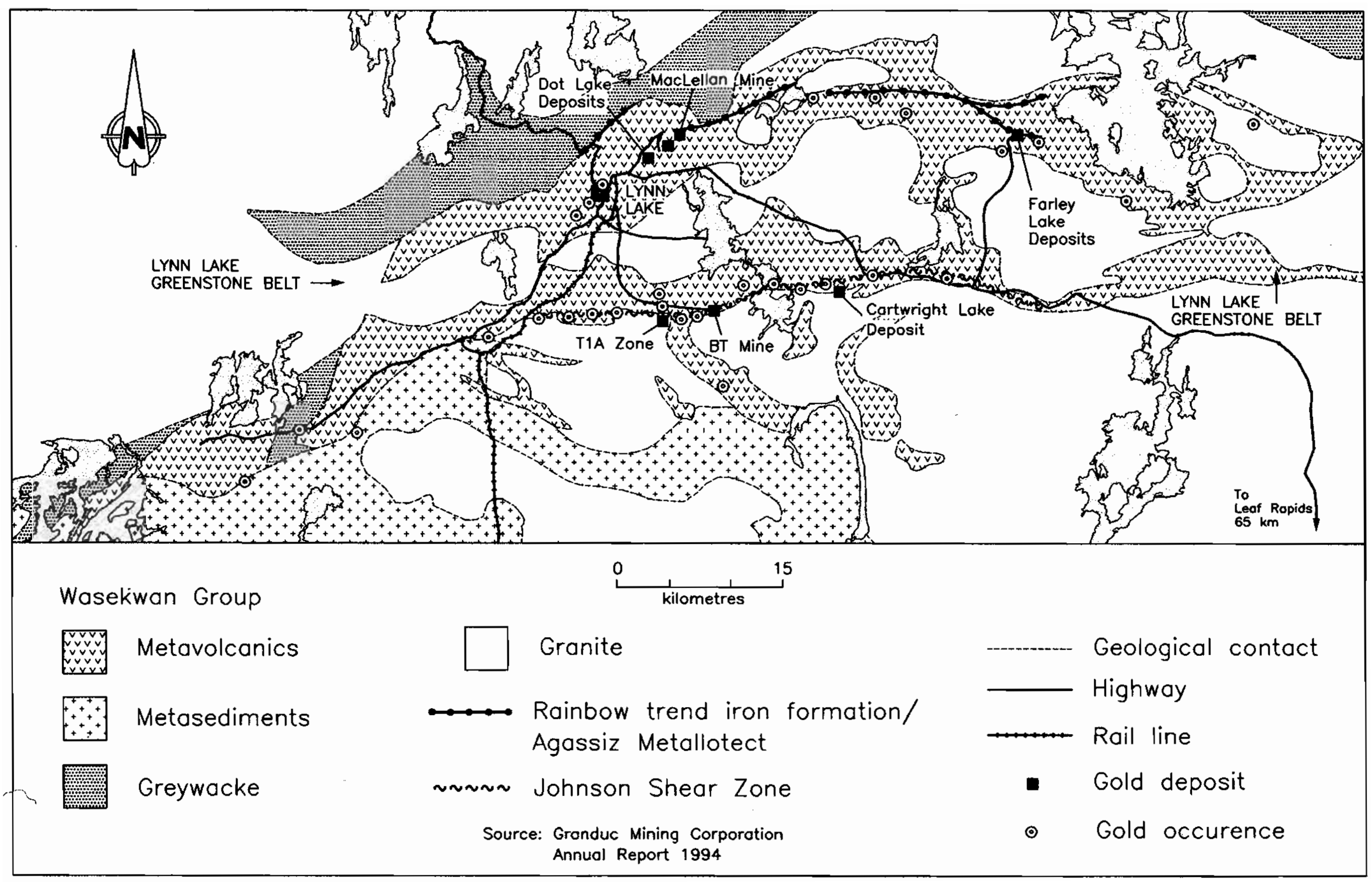


Figure 37: General Geology and gold deposits in the Lynn Lake belt (after Grandue Mining Corporation, 1994). Rainbow Trend Iron Formation is equivalent to the main portion of the Agassiz Metal/oteet (Fedikow, 1984).

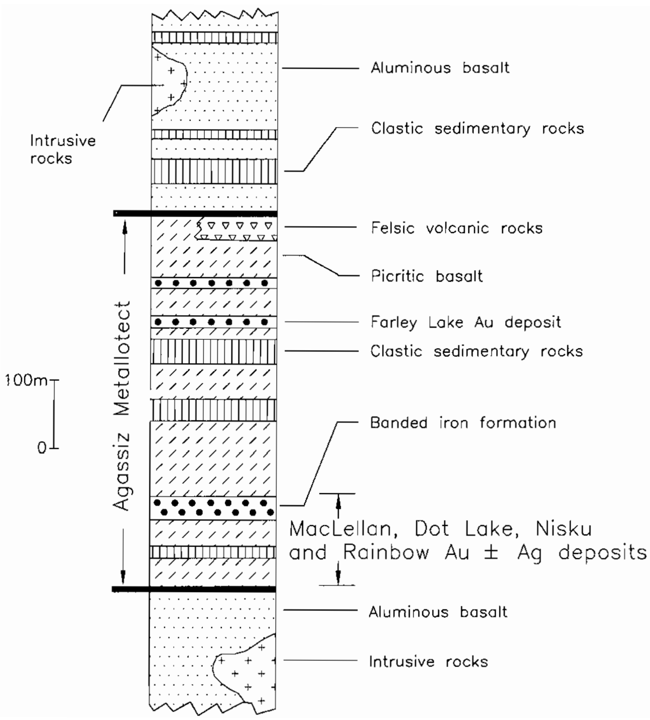


Figure 38: Schematic stratigraphic section of the Agassiz Metallotect of the northern belt of the Lynn Lake greenstone belt (after Fedikow et al., 1986).

Genesis

Fedikow (1986a) proposed that mineralization at the Maclellan Mine was syngenetic and subsequent deformation resulted in mobilization of the mineralization into fracture fillings and veins. In contrast Gagnon (1991) concluded that the mineralization is epigenetic, based on a detailed study of the alteration associated with the mineralized veins at the Maclellan Mine.

At the Farley Lake deposit geologists of Manitoba Mineral Resources Ltd. and Hudson Bay Exploration and Development Company Limited favored an epigenetic-replacement genesis for the gold mineralization, based on textures observed in drill core, and the oblique attitude of the deposits and the enclosing alteration zones to layering.

Southern Belt

Of the nine deposits and occurrences in the Southern Belt all except the Caimito Group showing in the Laurie Lake area (location 11; Map ER86-1-4) occur within or adjacent to the Johnson Shear Zone.

Host Rocks and Nature of Mineralization

The Burnt Timber deposit (BT deposit in Fig. 37) lies in silicified and carbonatized mafic volcanic and sedimentary Wasekwan Group rocks in the hanging wall of a major fault. Gold mineralization is associated with disseminated and fracture controlled pyrite, minor galena, chalcopyrite and locally, trace amounts of sphalerite. The Cartwright Lake deposit (Fig. 37) and CL Group occurrences consist of quartz and sulphide fracture fillings within a quartz-feldspar porphyry dyke and albitite felsic intrusion, respectively. The mineralization comprises pyrite, pyrrhotite, arsenopyrite, galena and sphalerite. The gold is associated with sulphides and occurs as microscopic grains and rarely as coarser visible grains.

The Johnson Shear occurrence (also known as Faust occurrence) and Ace Vein occurrences are characterized by quartz veins up to 35 cm wide that occur within volcaniclastic sedimentary rocks. Mineralization consists of massive clots as well as 2-5% disseminated pyrite, pyrrhotite, galena, sphalerite and chalcopyrite (Fedikow *et al.,* 1986a).

The Austin Vein is a gold-bearing quartz-filled shear within Pre-Sickle Group tonalite. Pyrite, galena and sphalerite occur as large, coarse grained, massive clots in shattered quartz veins.

The Gemmell Lake occurrence is hosted by quartzite and mafic tuffs which contain disseminated pyrite, arsenopyrite and rare visible gold.

The Caimito Group occurrence consists of a gold-bearing quartz-filled shear within amphibolite (Stewart and Brewer, 1984). Mineralization is localized along fractures in the quartz, either adjacent to contacts with the wall rocks or adjacent to inclusions of wall rocks within the quartz. It comprises pyrite, pyrrhotite, minor chalcopyrite and rare galena. Milligan (1960) reported that spectroscopic analysis of drill core indicated the presence of gallium.

Miskwa Lake Belt

The Lasthope deposit (Map ER86-1-4, location 3) consists of two parallel quartz veins that occur within a west-northwest-striking layered succession of quartz-feldspar porphyry, mafic tuff, mudstone, magnetite-bearing quartzite and feldspathic quartzite (Baldwin *et al.,* 1985). Mineralization consists of 5% (up to 15% locally) pyrite and trace chalcopyrite.

Summary

The Maclellan Mine, the Farley lake deposit, and the 'K Zones and Rushed' deposit occur within a narrow and laterally continuous stratigraphic sequence that has a strike length of approximately 100 km. Features favoring syngenetic concentration of gold in this sequence include (Fedikow, 1986a): 1) chemical sediments acted as chemical traps for gold-bearing fluids; 2) komatiite/seawater interaction provided a source for the generation of gold-enriched fluids (Keays and Scott, 1976); and 3) the mineralized, altered and thinly bedded nature of the sequence served to focus deformation; syngenetically deposited gold-bearing sulphides were mobilized into fractures, intergranular pore spaces and along foliation planes.

Features favouring epigenetic deposition of gold include: 1) mafic-ultramafic lithologies with abundant Ca-Mg minerals highly susceptible to alteration during CO_2 flooding; 2) oxide facies iron formation with an abundance of iron oxides to react with gold bearing sulphidic alteration fluids; 3) interlayering of different lithologies favorable for localization of shearing and introduction of alteration fluids; and 4) differences in competencies favorable for the development of fractures/vein systems during deformation.

The Maclellan Mine represents Manitoba's first primary gold producer since the San Antonio Mine in southeastern Manitoba closed in 1968. The fact that the Maclellan deposit and the Farley Lake deposit occur within a stratigraphic sequence potentially favourable to gold deposition over a strike length of 100 km suggests that the area has a high potential for the discovery of more gold deposits.

Most of the gold deposits and occurrences of the Southern Belt and Miskwa belt are structurally controlled and are of epigenetic quartz vein type. The depositional sites for gold-bearing quartz veins are preferentially developed in competent rocks of the Wasekwan Group or felsic intrusive rocks within or close to the Johnson Shear Zone.

PRESENT PRODUCER

Burnt Timber (BT mine)

Location: 13 km southeast of the town of Lynn Lake

Map reference: Map ER86-1-4, location 4

Description of Deposit

The following description is taken from a report provided by M. Eastwood with permission of Black Hawk Mining Inc. (Black Hawk) for this publication.

The Burnt Timber deposit lies in the hanging wall of a post mineralization fault (T1 Fault) that strikes east-northeast and dips steeply to the north, along the southern margin of the Johnson shear (Fig. 37). The deposit is located in a highly altered and deformed sequence of Wasekwan Group mafic volcanic and metasedimentary rocks, which locally is intruded by felsic porphyry. Massive basalts become increasingly silicified and carbonatized and mineralized (primarily pyrite) towards the T1 Fault. Shear laminated, mylonitic and silicified metasediments(?), and mafic volcanic rocks, occur adjacent to the T1 Fault and contain the bulk of the gold mineralization (Fig. 39). The footwall rocks on the south side of the T1 Fault are variably altered basalt, gabbro and metasediments or metavolcanic tuff.

The altered mafic metavolcanic and metasediments hosting the gold mineralization contain 1-5% (locally 5-10%) disseminated and fracture controlled pyrite, minor galena, chalcopyrite, and locally, trace amounts of sphalerite.

Three types of gold mineralization have been documented in the

Burnt Timber (BT) open pit mine, 1996, 13 km southeast of Lynn Lake, Manitoba

Burnt Timber deposit:

1) the main gold bearing zones are located in the hanging wall within 40 m of the T1 Fault, are well fractured or brecciated and form elongate north dipping lenses. These zones (consisting of highly altered metavolcanic and metasedimentary(?) rocks) contain abundant chlorite, carbonate and pyrite.
2) high grade, foliation-parallel pyrite±galena-bearing quartz veins occur

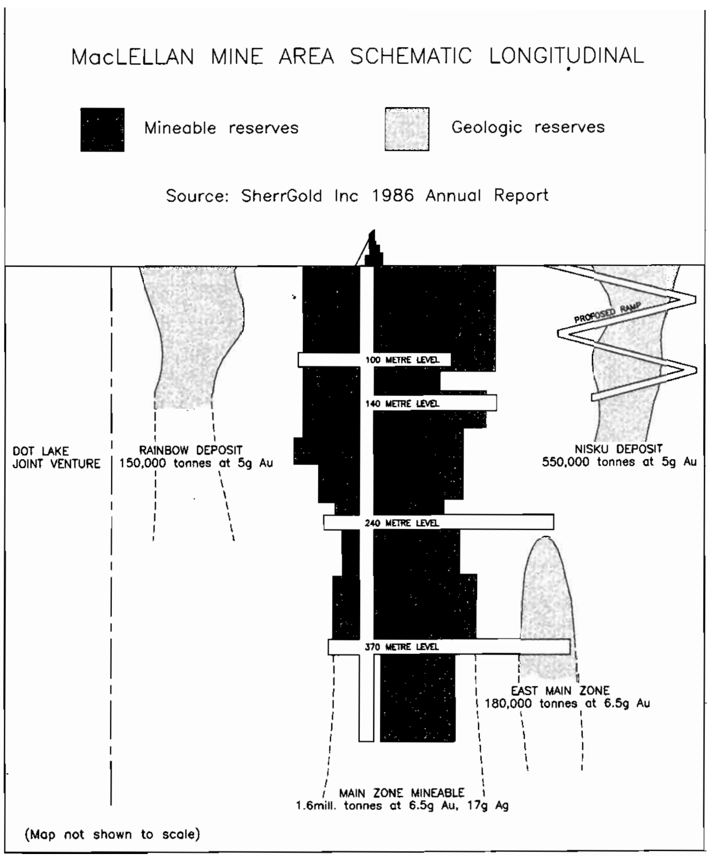


Figure 39: Schematic longitudinal section of the MacLellan Mine (after SherrGold Inc., 1986)

throughout the deposit but are more common in the eastern end.

3) narrow, foliation parallel, high grade, intensely silicified, laminated shear zones (up to 3 m wide) occur further into the hanging wall. These locally contain up to 200 g/tonne (5.8 oz/ton) gold.

History of Exploration and Development:

The Burnt Timber (B1) gold deposit was discovered in 1988 by Lynn Gold Resources Inc. Corp. and Trans America Industries Ltd. during systematic test drilling of induced polarization (IP) geophysical anomalies along the regional (>44 km long) Johnson Shear Zone. During 1988 and 1989, 135 holes were drilled (14 440 m) and 69 outlined a geological reserve to 122 metres depth of estimated 1.0 million tonnes grading 3.8 g/tonne (0.11 oz/ton) gold. Lynn Gold carried out metallurgical and feasibility studies for mining the deposit by conventional open pit mining methods. In 1989 the Maclellan mine and mill shut down and DCC Equities Ltd. acquired the assets of Lynn Gold. Cazador Explorations Limited entered into a joint venture agreement with DCC in 1992 and following 33 additional drillholes and a positive feasibility study the BT open pit mine began production in September 1993. In November 1993, Cazador and Granduc Mines Limited amalgamated to form Granduc Mining Corporation, operator of the BT mine.

The mining rate is 7000 tonnes per day and with a 4:1 pit stripping ratio; total production of gold-bearing ore is approximately 1400 tonnes per day. The ore is trucked 18 kilometres for processing at the refurbished mill in Lynn lake. Prior to production, open pit reserves were estimated at 1 232000 tonnes grading 2.85 g/tonne (0.08 oz/ton) gold with a cutoff of 1.7 g/tonne. Total contained gold was estimated to be 3500 kg (112 900 oz) of gold. By the end of 1995, 1905 kg (61 460 oz) of gold were produced. As of January 1st, 1996 mineable reserves were about 200 000 tonnes grading 2.7 g/tonne (0.08 oz/ton) gold containing 558 kg (18 000 ounces) gold. At the current production rate the remaining reserves will be depleted by April 1996. Resources outside the currently planned pit are placed at 1 014 000 tonnes grading 2.9 g/tonne (0.085 oz/ton) gold (Eastwood, 1996).

On July 1, 1996, Granduc Mines Ltd. and Black Hawk merged under the name Black Hawk Mining Inc. Presently (1996) the deposit and mill are owned 50% by Keystone Gold, Inc., the operator, and 50% by Black Hawk. Keystone Gold, Inc. is a wholly owned subsiduary of Black Hawk.

History of Production

Year	Tonnes milled	Grade g/tonne (oz/ton)	Gold produced kg (oz)
1993	73 174	3.24 (0.094)	190 (6107)
1994	351 506	2.17 (0.063)	826 (26 553)
1995	432 374	2.36 (0.068)	896 (28 812)

Selected Bibliography: Peck *et al.* (1994, 1995); M. Eastwood (written communication, 1996)

PAST PRODUCER

Maclellan Mine

Location: 6.5 km northeast of the town of Lynn lake.

Map Reference: Map ER86-1-4, location 1.

Description of Deposit:

The following description is summarized primarily from Fedikow (1986a, 1986c, 1991).

The Maclellan deposit consists of 4 mineralized zones: the Main and East Main zone, and the Nisku and Rainbow deposits (Fig. 40) which are all located within the stratigraphically lower part of the Agassiz Metallotect

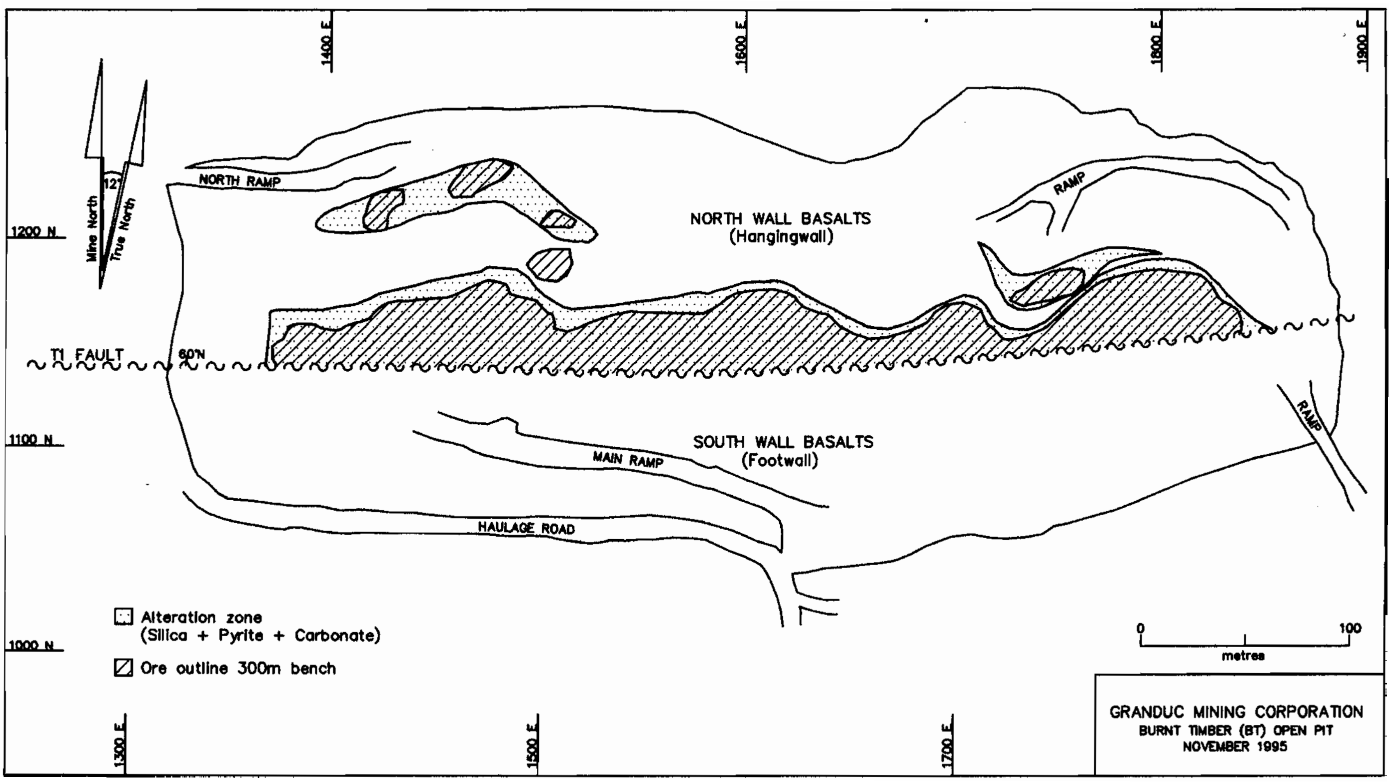


Figure 40: General geology and ore zones in the Burnt Timber open pit Mine (after Granduc Mining Corporation, 1995)

(Fig. 38). (The Dot lake deposit is, or has been, by some considered as part of the Maclellan deposit, but is described separately in this report; see below).

The mineralized zones of the Maclellan deposit are hosted by an interlayered sequence of: 1) biotite and siliceous siltstone; 2) oxide, silicate and sulphide facies iron formation; and 3) basaltic and ultramafic komatiite flows with minor tuffs (Fig. 38).

Main (or Central) Zone: This part of the deposit attains thicknesses of 10-20 m and is characterized by sections containing up to 1 m of 10-25% gold-bearing iron sulphides hosted in biotite-rich and siliceous siltstone. The highest gold values are associated with carbonate-quartz-sulphide veins and their silicification haloes. Persistent but lower grade values occur in silicified and sulphide-bearing komatiites. Silicification of the siltstones and patchy but locally intense carbonate alteration of komatiites represent the most common types of alteration.

Rainbow deposit (or West Zone): The geology of the Rainbow deposit is similar to that of the Main Zone; however, mineralized sections are narrower and the sulphide content is slightly lower. The deposit is located in tightly folded siltstone interlayered with basaltic and ultramafic komatiites and consists of two *en echelon* lenses containing quartz and quartz-carbonate veins. Each lens is about 150 m long and up to 15 m wide (Fedikow, 1985b). Visible gold occurs in association with arsenopyrite, pyrrhotite, pyrite and galena.

East Main Zone: In the East Main Zone 30-40% disseminated iron sulphides in addition to arsenopyrite, sphalerite and galena occur as tightly folded conformable lenses within siltstone and basaltic-ultramafic komatiites. The mineralization is accompanied by locally intense carbonatization. Deformed carbonate-quartz-sulphide veins are present throughout the East Zone and contain iron sulphides, arsenopyrite, sphalerite and galena. Gold is found in association with the highest concentrations of sphalerite and galena.

The Nisku deposit is a gold-lead-zinc deposit and has stratigraphic, mineralogical and alteration characteristics similar to the main zones of the Maclellan deposit. Mineralization is hosted by variably silicified, biotitized and carbonatized komatiitic basalt. The deposit contains disseminated to solid sulphide layers and lenses of pyrite, pyrrhotite, arsenopyrite, sphalerite and galena. Gold is associated with quartz veins that crosscut sulphide layers and lenses.

Augsten *et al.* (1986) carried out a detailed study of the ore mineralogy in the Main Zone of the Maclellan deposit and found that gold is present in the ore as native gold, electrum and aurian silver. The average size of gold grains is 20-30 microns although grains and veinlets greater than 150 microns were observed. The gold occurs as: 1) irregular shaped grains or veinlets of less than 10 microns in gangue, 2) rims on, or fracture fillings in galena, arsenopyrite and pyrrhotite; 3) inclusions in arsenopyrite, pyrrhotite and galena; and 4) sutured grains associated with galena.

Fedikow (1986a) acknowledged that the multiple deformational history of the host rocks makes determination of the genesis of mineralization very difficult; however, he considered that geochemical data, textures observed in diamond drill core, and thin sections studies supported an exhalative origin for the gold mineralization. He proposed the following depositional sequence:

1) Extrusion of basaltic to ultramafic komatiites followed by deposition of clastic and sulphidic chemical sediments. The sulphidic chemical sediments acted as traps for gold released during the interaction of komatiites and seawater, and by leaching of immiscible sulphide blebs;
2) Carbonatization of the volcanic units by the reaction of iron sulphides with organic carbon;
3) Extrusion of komatiite and aluminous basalts;
4) Intraformational folding accompanied by brittle deformation focused in the mineralized zone produced tight folding and dilatant zones that enabled lateral secretion of gold-enriched sulphides, carbonate and quartz;
5) Ductile deformation produced transposed stratigraphy and diffuse alteration zones; and
6) late brittle fractures resulted in discordant sulphide-filled fractures.

Gagnon (1991) studied the geochemistry and genesis of the Maclellan deposit in detail. He identified five hydrothermal events following peak metamorphism. The first 2 include CO_2 addition and the first 3 include HS addition. Gagnon (1991) suggests that gold mineralization occurred during the formation of the first 3 distinct sets of veins and their associated alteration. The highest concentrations of gold occur in the third set where gold is contained within arsenopyrite. He concludes that gold is epigenetic and precipitated from hydrothermal sulphidic fluids upon reaction with iron oxides contained in the wall rocks.

History of Exploration and Development:

The property was originally staked in 1946 by J.W. Boiley and J.G. Webb. In 1947 the claims were transferred to Roy Rundle who in turn optioned the property to Noranda Mines, Limited. Magnetometer and geological mapping surveys were conducted the same year. The option agreement was cancelled in 1948 and the claims lapsed in 1950.

In 1950, a portion of the J. J. Group was restaked as the J. R. Group of 12 claims by Roy and J. W. Rundle. Between 1950 and 1955 some trenching and test pitting was done. In April of 1955 Agassiz Mines Limited discovered gold mineralization when samples taken from two diamond-drill holes yielded low grade gold values. The claims were then optioned to Newkirk Mining Corporation Limited who assigned the claims to Aumaque Gold Mines Limited. Resistivity and EM surveys were carried out and followed up by a 21-hole drill program.

Central Manitoba Mines, Limited optioned the property in 1958. After a 2570 m drill program the option was dropped. Rayrock Mines Limited carried out a geophysical survey and prospecting in 1960.

The property remained idle until 1966. Between 1966 and 1968 Agassiz carried out 12 200 m of diamond drilling and sank a 3-compartment shaft to a depth of 137 m with levels established at 53, 98 and 137 m. In 1969 Agassiz Mines Limited became Royal Agassiz Mines Limited. By 1971, a total of 21 350 m of diamond drilling and 712 m of underground lateral work had been completed.

In 1979 the property was transferred to Comiesa Corporation who in turn optioned the property to Sherritt Gordon Mines Limited in late 1979. From 1979 to 1985 Sherritt spent in excess of $9 million on diamond drilling, shaft sinking and drifting to determine the size, grade and economics of the deposit. In July 1985 Sherritt announced the approval for the development of the deposit, to be called the Maclellan Mine. Kilborn Engineering (B.C.) estimated mineable ore reserves of the Main Zone to total 1.49 million tonnes grading 7.17 g/tonne (0.21 oz/ton) gold (SherrGold Inc., Preliminary Prospectus, September 17, 1985).

Sherritt arranged equity financing for development of the Maclellan Mine through subsidiary, SherrGold Inc. Development costs were also assisted by a $4 million grant from the Federal Government's Canadian Jobs Strategy program and a $2 million forgivable loan from the Manitoba government.

The Maclellan Mine started production in late 1986 and produced 264 kg of gold and 444 kg silver in that year. Capital costs were well above estimates at $45 million. In 1987 the mine produced 1228 kg gold from 264 236 tonnes with an average grade of 5.5 g/tonne (0.16 oz/ton) gold, all below expectations (SherrGold Inc. 1987 Annual Report). With new owners and a new name, Lynn Gold Resources Ltd., the mine made a small profit in 1988 producing 1710 kg gold, moving the operation up to near its rated capacity (Northern Miner May 20, June 5, 1989). Due to falling gold prices and continuing high operating costs the operation was closed in November 1989 and went into receivership in early 1990 (Northern Miner Nov. 6, 1989). The reserves at the mine in the proven, probable and possible categories were placed at 2.6 million tonnes grading 6.3 g/tonne (0.18 oz/ton) gold (Northern Miner Magazine, May, 1989). The Maclellan mill was reactivated in August 1993 to treat ore being produced from the Burnt Timber open pit, 16 km to the southeast (Granduc Mining Corp. 1994 Annual Report).

Selected Bibliography: Manitoba Mines Branch, Corporation File (Agassiz Mines Limited, Bulora Corporation Limited, Royal Agassiz Mines Limited, SherrGold Inc., Sherritt Gordon Mines Limited), Mineral Inventory (64C/15NW, Au1); Canadian Mines Handbook (1974-75); Milligan (1960); Gilbert *et al.* (1980); Fedikow (1983, 1986a, 1986b, 1986c); Fedikow and Gale (1982); Fedikow *et al.* (1984, 1990, 1991); Gagnon (1991); Nielsen (1983).

DEPOSITS

Farley Lake

Location: 40 km east of Lynn Lake.

Map Reference: Map ER86-1-4, location 2.

Description of Deposit:

The following description of the Farley Lake deposit is based mostly on personal communication with Neil Briggs of Manitoba Mineral Resources Ltd. (MMR) and Ted Baumgartner of Hudson Bay Exploration and Development (HBED).

The area is underlain by iron formation, argillite and andesite to basalt flows of the Wasekwan Group. These rocks are considered to be part of the Agassiz Metallotect. A small quartz diorite plug intruded these rocks to the west of Farley Lake.

Iron formation in the Farley Lake area is about 600 m wide and extends for about 6 km (Milligan, 1960; Map ER86-1-4). It is dominantly oxide facies iron formation that is intercalated with clastic sediments (Dahlstrom, 1949; Milligan, 1960). Oxide facies iron formation hosts several zones of gold mineralization (Fig. 38). They occur as lens-shaped deposits within and subparallel to alteration zones characterized by silicification, chloritization and sulphidization; both the deposits and the alteration zones are oblique to layering. The gold- and sulphide-bearing iron formation consists of interbedded pyrrhotite/magnetite and chert laminae. Minor amounts of pyrite and silicate minerals are also present. The proportion of pyrrhotite in individual pyrrhotite/magnetite laminae ranges from less than 5% up to 90% and contains small isolated grains of gold in cavities in the silicate matrix and within pyrrhotite and magnetite grains (Manitoba Mineral Resources, internal report). Traces of gold and sulphides also occur in quartz veins within iron formation, argillite, mafic volcanics and quartz diorite.

Exploration has outlined three zones of gold mineralization, the Wendy Zone and the South and East zones (Fig. 41). The Wendy Zone and East Zone have combined geological reserves of 635 000 tonnes averaging 6.86 g/tonne (0.20 oz/ton) gold (Northern Miner, January 19,1987, p. 13). The South Zone contains an estimated 363 000 tonnes grading 4.80 g/tonne (0.14 oz/ton) gold.

Geologists from MMR and HBED interpret the deposits to be epigenetic and similar in genesis to iron formation-hosted gold deposits at Water Tank Hill and Nevoria, Western Australia. Those deposits were interpreted to have been formed by selective replacement of oxide facies banded iron formation by gold- and sulphur-bearing fluids (Phillips *et al.,* 1984). Fyon *et al.* (1983) proposed a similar genesis for the Carshaw and Malga gold deposits at Timmins, Ontario and suggested that fluid ingress was along fractures and faults in the iron formation. Evidence supporting an epigenetic model for formation of the Farley Lake deposit are:

1) an abrupt change from barren oxide facies iron formation to gold- and sulphide-bearing iron formation;
2) the deposits and the surrounding alteration zone crosscut stratigraphy; the iron formation strikes east and is subvertical, whereas the alteration zone dips 35°-45° south; and
3) the concentration of gold relative to base metals in the deposit.

History of Exploration and Development:

Sherritt Gordon Mines Limited staked the area as the Lind claims in 1945. Mapping in the area discovered gold in frost heaved boulders at the west end of Farley Lake (Milligan, 1960). In 1947 drilling carried out by Sherritt on the Lind showing and in the Pot Hole Lake-Pump Lake area intersected two gold-bearing zones that assayed up to 14.0 g/tonne (0.41 oz/ton) gold (Manitoba Mines Branch, Non-confidential assessment files 91041, 91836). The claims lapsed in 1976.

HBED staked the property in 1977. From 1978 to 1983 HBED carried out linecutting, HLEM surveys and diamond drilling in the search for base metals. MMR, as operator in a joint venture agreement with HBED, has carried out extensive exploration programs from 1983 to present. In 1986 widespread gold mineralization was discovered in three zones, two of which may be amenable to open pit mining (Manitoba Mineral Resources, News release to the Northern Miner, January 1987). In total 15 250 m of drilling was carried out. Metallurgical testing and feasibility studies were conducted. By 1993, after more than 20 000 metres of drilling, the property, then owned by MMR and Mingold Resources Ltd. (Gold exploration subsidiary of Hudson Bay Mining), had an estimated open pit reserve of 1.6 million tonnes grading 3.62 g/tonne (0.105 oz/ton) gold (Northern Miner Aug. 16, 1993). The Keystone Joint Venture (Granduc Mining and Black Hawk Mining) later acquired the deposit as part of its development of The Burnt Timber deposit and reactivation of the MacLellan mill in Lynn Lake (Northern Miner Dec. 20, 1993). Stripping for the open pit at Farley began in October 1995. Granduc and Black Hawk expect to produce 1488 kg (48 000 oz) gold per year. Costs of development plus some changes to the mill were estimated at $4.7 million (Northern Miner Jan. 8, 1996). Drilling continued to firm up reserves in the Southeast Zone which are indicated at

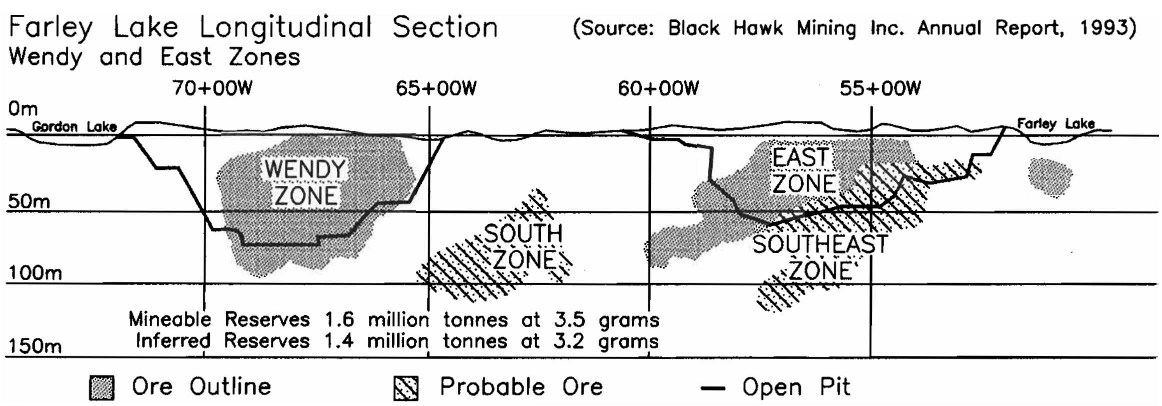


Figure 41: Longitudinal section of the Farley Lake gold deposit (after Black Hawk Mining Inc., 1993)

1.4 million tonnes grading 3.2 g/tonne (0.09 oz/ton) gold. These reserves are not included in the planned pit of the main ore body where reserves are stated at 1.45 million tonnes grading 3.9 g/tonne (0.11 oz/ton) gold (Northern Miner April 29, 1996).

Selected Bibliography: Manitoba Mines Branch, Non-confidential Assessment File (91041, 91836); Milligan (1960); Manitoba Mineral Resources Ltd., News release (February 24, 1986); Stanton (1948).

Lasthope

Location: 24 km southeast of Lynn Lake.

Map Reference: Map ER86-1-4, location 3.

Description of Deposit:

The following description is summarized primarily from Bateman (1945). The area is underlain by a west-northwest-striking layered succession that from south to north comprises quartz-feldspar porphyry, mafic tuff, quartzite, mudstone, magnetite-bearing quartzite and feldspathic quartzite (Fig. 42). Two parallel quartz veins cut the quartzite. The north vein is barren, whereas the south vein contains gold-bearing sulphide mineralization. The south vein is 0.3-1.2 m wide and can be divided into two units: 1) a southern white massive quartz unit; and 2) a northern grey aphanitic, siliceous unit with disseminated grains and stringers of pyrite and trace chalcopyrite. The average sulphide content of the vein is 5% (up to 15% locally). Visible gold was not reported by either Baldwin *et al.* (1985) or Stockwell (1945b); however, drilling carried out by Sherritt Gordon in 1939 intersected significant gold mineralization.

History of Exploration and Development:

The area was first staked in 1937 by R. Madole. Sherritt Gordon Mines, Limited carried out a 59-hole 3129 m drill program in 1939. Drilling indicated reserves of 127 000 tonnes averaging 7.9 g/tonne (0.23 oz/ton) gold (Bateman, 1945). Lasthope Gold Mines Limited, a subsidiary of Sherritt Gordon, was incorporated to develop the property. Further drilling was carried out; however, reserves were not increased. The claims lapsed in 1977.

W.B. Dunlop Limited NPL staked the area in 1978. After the property was prospected, it was transferred first to George Leary and then to Jalna Resources Ltd.. Jalna later sold the property to Balcor Resources Corporation and in 1986 the reserves were placed at 97 000 tonnes grading 10.9 g/tonne (0.32 oz/ton) gold. The deposit consists of two shallow plunging ore shoots within a steep, tabular quartz vein that averages 1.5 metres in width (Northern Miner Jan. 19, 1984 and Jan. 27, 1986). Balcor conducted drilling in early 1987, mainly on the 'Madole vein', which contained 5 to 20% sulphides and appeared to be localized on a major fault. The best gold values were found in the highly altered, quartz-pyrite- rich footwall. Geological reserves were 127 000 tonnes grading 7.2 g/tonne (0.21 oz/ton) gold (Northern Miner Jan. 19 and July 20, 1987). The property has been inactive since 1987.

Selected Bibliography: Baldwin *et al.* (1985); Bateman (1945); Gilbert *et al.* (1980); Manitoba Mines Branch, Mineral Inventory (64C/10NW Au1); Milligan (1960); Stockwell (1945b)

Johnson Shear Occurrence (Faust) and T1A Zone

Location: 12 km southeast of Lynn Lake, in the Foster Lake and Wasekwan Lake area.

Map Reference: Map ER86-1-4, location 5

Description of Deposit:

The Johnson Shear occurrence and T1A zone are located in the western part of the Johnson Shear Zone (Fig. 37), 0.4 km north of Foster Lake and at the northwest corner of Wasekwan Lake, respectively. Bateman (1945) described the occurrences in this area as consisting of one or more narrow zones of shearing in "Wasekwan Series" sediments.

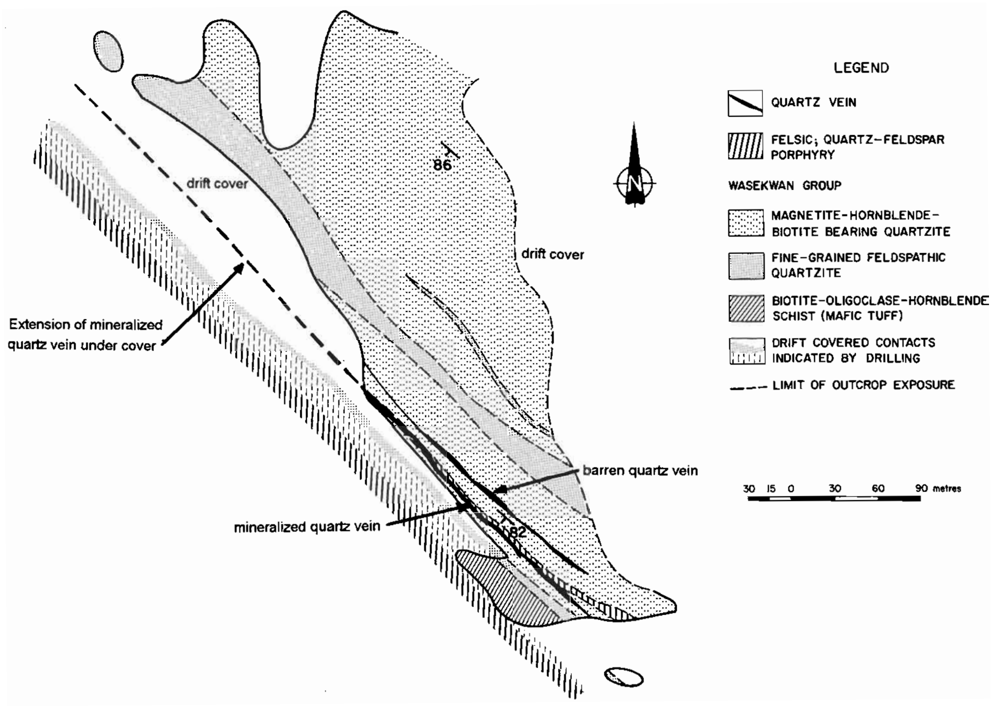


Figure 42: Geology in the area of the Lasthope deposit (after Bateman, 1945)

Milligan (1960) reported that trenches and diamond drilling in the Reservoir Lake-Foster Lake area outlined several gold-bearing zones in sheared basalt flows and tuffs. Narrow quartz veins within the shear reportedly carried galena, pyrite, chalcopyrite and gold. More recently Ferreira (1986b) observed that sulphide mineralization occurs preferentially in felsic sedimentary rocks, and to a lesser extent in intermediate sedimentary rocks where fracture cleavage is well developed. Pyrrhotite, which is generally present in amounts of 1-5%, is locally present in concentrations of up to 20% and is associated with trace amounts of pyrite, rare arsenopyrite and trace chalcopyrite. The sulphide minerals occur as fine grained aggregates forming streaks along foliation planes.

Deformed sulphide-bearing felsic rocks occur as siliceous lenses enveloped in intermediate rocks.

In 1985 and 1986 drilling along the T1 A zone by joint venture partners SherrGold Inc. and Trans America Industries Ltd. indicated a deposit with geological reserves of 907 000 tonnes averaging 3.1 g/tonne (0.09 oz/ton) gold (Kelley, 1986).

History of Exploration and Development:

The area was first staked in 1939 by A. McVeigh and F.E. Johnston. Diamond drilling totaling more than 2100 m was carried out from 1940 to 1943. The original claims lapsed in 1966. The area was restaked in 1973; however, work was not carried out and the claims lapsed in 1976. P. Dunlop staked the area in 1981 and optioned it in 1985 to Sherritt Gordon Mines Limited who transferred the property to SherrGold Inc.

Selected Bibliography: Bateman (1945); Ferreira (1986b); Kelley (1986); Milligan (1960); Gilbert *et al.* (1980); Syme (1985a).

Gemmell Lake (Finlay McKinlay gold occurrence)

Location: 16 km southwest of Lynn Lake

Map Reference: Map ER86-1-4, location 6

Description of the Deposit:

The area northeast of Gemmell Lake is underlain by Wasekwan Group mafic and felsic volcanics, Wasekwan and Sickle Group sedimentary rocks and Pre-Sickle granitic plutonic rocks (Gilbert *et al.,* 1980)

Veins comprising coarse grained and highly fractured quartz, carbonate, biotite, chlorite and tourmaline are hosted by a 30-40 m wide, >100 m long shear zone within by Pre-Sickle quartz diorite. The shear zone is interpreted to be part of the Johnson Shear. Mineralization consists of free gold, pyrite, chalcopyrite, arsenopyrite and minor sphalerite, and occurs in fractures within the quartz veins and in the wall rock. Alteration haloes (2-6 cm wide) with biotite, tourmaline, chlorite, carbonate and pyrite are associated with the veins (Fedikow *et al.,* 1991).

Sherman *et al.* (1989, 1990) describe three sets of veins that occupy brittle deformation zones: 1) southwest-trending, northwest-dipping quartz veins; 2) south-trending quartz-sulphide veins; and 3) quartz-sulphide veins that occupy the centre of the shear zone, strike northeast and dip southeast. Gold appears to be preferentially associated with the third set of veins.

History of Exploration and Development:

The property was first staked in 1947. It received little attention until 1976 when Sherritt Gordon carried out geophysical surveys and diamond drilling northeast of Gemmell Lake (Manitoba Mines Branch, Non-confidential Assessment File, 92193). In 1985 Granges carried out diamond drilling and reported that significant mineralization was intersected in three areas: 1) hole 1 intersected 63.43 g/tonne (1.85 oz/ton) gold over a 2.41 m section; hole 2, collared 650 m to the east, intersected 5.55 g/tonne (0.16 oz/ton) gold over 2.26 m and 4.22 g/tonne (0.12 oz/ton) gold over 1.86 m; and 3) drilling on a parallel chert horizon 183 m to the north cut a low grade zone averaging 1.44 g/tonne (0.04 oz/ton) gold over a width of 9.2 m and strike length of 1000 m. Drilling continued in 1986; however, results have not been published.

Selected Bibliography: Milligan (1960); Gilbert *et al.* (1980); Manitoba Mines Branch, Non-confidential Assessment File (92193), Sherman *et al.* (1989).

Cartwright Lake (Bonanza Claim Group)

Location: 23 km southeast of Lynn Lake, on the east side of a southern arm of Cartwright Lake.

Map Reference: Map ER86-1-4, location 7.

Description of Deposit:

The property is underlain by mafic volcanic flows, phyllitic siltstone and mudstone that are intruded by 16 m wide swarm of quartz-feldspar porphyry dykes, 0.5-5 m wide. Bateman (1945) reported that a network of gold-bearing quartz veins that occur in a fractured porphyry dyke. A channel sample yielded 17.49 g/tonne over a width of 6.1 m.

Two phases of quartz veins are present in the dykes (Fedikow *et al.,* 1991). The first phase consists of non-mineralized quartz pods (up to 1 m wide) that are unrelated to fractures. The second phase consists of 1 to 3 cm wide quartz veins in fractures. Coarse calcite, ankerite, biotite and muscovite and fine tourmaline occur in phase two veins and pyrite, and less commonly, arsenopyrite form near solid layers at the terminations of phase two veins. The latter are interpreted as to represent mobilization of silica from phase one quartz pods into fractures. Baldwin (1983) obtained values of 0.2-5.4 g/tonne gold from chip samples across phase two quartz veins.

Similar fracture (two phase) filling quartz veins occur in nearby porphyritic granite. Extensive zones of silicification and carbonatization in mafic rocks adjacent to the mineralized granite contain sulphide-rich veins and indicate extensive hydrothermal flooding. Since veins are deformed by S_2 structures, Peck (1985) interprets the mineralization to be D_1.

History of Exploration and Development:

The property was first staked in 1934. In 1952 nine holes were drilled by Mid-North Engineering. Based on the results of drilling carried out in 1986 SherrGold outlined a deposit with reserves that total 665 000 tonnes averaging 2.37 g/tonne (0.069 oz/ton) gold (Kelley, 1986).

Selected Bibliography: Bateman (1945); Davies *et al.* (1962); Gilbert *et al.* (1980); Manitoba Mines Branch, Corporation Files (Granville Lake Mines, Limited), Non-confidential assessment files (91290); Peck (1984, 1985, 1986).

K Zones and Rushed

Location: South of Dot Lake, 0.8- 2 km SW of MacLellan Mine

Map Reference: Map ER86-1-4, location 15

Description of Deposit:

These descriptions are summarized from Ferreira and Baldwin 1996. The ‘K Zones and Rushed’ deposits, also called the Dot Lake deposits, consist of several auriferous zones in a four kilometre long and 61 to 244 metre wide package of rocks that represents the westerly continuation of the host rocks to the MacLellan Au-Ag deposit (Fig. 37, 38). These

Wasekwan Group host rocks include picritic basalts, biotitic and siliceous siltstones, multiple-facies iron formation and minor felsic volcanic rocks (Fedikow *et al.,* 1986a, 1990). The K1 to K6 zones and the little tested K0 Zone (5.6 g/tonne (0.16 oz/ton) gold over 2 metres) have possible combined gold reserves of 1 051 843 tonnes grading 4.3 g/tonne (0.13 oz/ton) gold (Wright, 1989). The K1 and K2 zones have a combined strike length of 274 metres, a down-dip extension of 183 metres and, are hosted by picritic basalt. The gold mineralization is associated with 1-15% pyrrhotite, pyrite accessory galena, sphalerite and arsenopyrite within silicification alteration and quartz±carbonate veins. These veins are 5-10° discordant to host foliation. The K4 Zone occurs in strongly altered felsic volcanic and/or siltstone and K5 consists of six lenses in altered picrite over a strike of 213 metres and depth of 472 metres; both are slightly discordant to stratigraphy. The K6 zone is 244 metres long and extends for a minimum of 183 metres below surface. The mineralization consists of 1-7% sulfides at or near the contact of picritic basalt and an altered felsic unit. Silicification, carbonatization and quartz veins are present in the host rocks and shears are ubiquitous throughout the mineralized zone which crosscuts the stratigraphy (Wright, 1989). Drill indicated gold resources in the Dot lake deposits total 1 057 984 tonnes grading 4.36 g/tonne (0.13 oz/ton) gold (P. Pawliw, Granduc, pers. comm. 1996).

The Rushed gold occurrence 2 kilometre SW of Maclellan and just north of the K Zones, consists of several zones of near solid pyrite, pyrrhotite and arsenopyrite with minor magnetite, sphalerite and chalcopyrite extending along strike about 1200 metres and ranging from 0.2 to 1 metre thick. The sulfide zones occur in rusty weathered, fractured, sheared, interlayered siltstone and iron formation within predominantly basaltic rocks (Fedikow 1986a,b). The gold content is proportional to the amount of arsenopyrite (Audet, 1983). Drill core samples assayed from 0.68 to 3.4 g/tonne (0.02-0.1 oz/ton) gold (Fedikow 1986a). Tonnages have not been calculated.

History of Exploration and Development:

Noranda Exploration undertook magnetic and geological surveys over the area in 1948 and Sherritt Gordon Mines Ltd. drilled three holes (292 metres) in 1956. A number of regional airborne EM and Mag. surveys were conducted over the area; Canadian Nickel Co. Ltd. in 1954, Eldorado Mining and Refining Ltd. in 1954, Sherritt from 1957 to 1961, Hudson Bay Exploration and Development Co. Ltd. in 1970, Sherritt again in 1973 and the Province of Manitoba (Questor Input) in 1976. Geological mapping, geophysical, lithogeochemical surveys and drilling (number of holes and metreage not known) have been undertaken in the area by Sherritt and later its subsidiary SherrGold Inc. and Lynn Gold Resources Inc. (Ferreira and Baldwin 1996). Currently these deposits are part of the Keystone joint venture of Granduc Mining Corporation and Cazador Explorations Limited.

Selected Bibliography: Audet (1983); Fedikow (1986a,b); Fedikow *et al.* (1986a, 1990); Ferreira and Baldwin (1996); Wright (1989).

TABLE 13: SUMMARY OF MAIN GOLD DEPOSITS/OCCURRENCES IN THE LYNN LAKE BELT

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
MACLELLAN (and satellite deposits) Location 1 Map ER86-1-4	Past producer 1986-89: 4487 kg (144 257 oz) gold	1989 combined reserves: 2.6 million tonnes at 6.3 g/t (0.18 oz/ton)	quartz±carbonate±sulphide veins in siltstone, basaltic -ultramafic komatiite and iron formation; gangue minerals: pyrite, pyrrhotite, arsenopyrite, sphalerite, galena	Keystone Gold, Inc. and Black Hawk Mining Corporation (1996)
K ZONES & RUSHED (formerly the DOT LAKE deposits) (west extension MacLellan) Location 15 Map ER86-1-4	Prospect	1996 drill indicated reserves: 1.1 million tonnes at 4.36 g/t (0.13 oz/ton)	K Zones: discordant silicification alterations and quartz±carbonate veins within picritic basalt and/or felsic volcanic rocks and siltstone; gangue minerals: pyrrhotite (1-15%), pyrite, galena, sphalerite, arsenopyrite. 'Rushed': sulphide lenses within fractured, sheared basalt, interlayered siltstone and iron formation; gangue minerals: pyrite, pyrrhotite, arsenopyrite, magnetite, sphalerite, chalcopyrite	Granduc Mining Corporation and Black Hawk Mining Corporation (1996)
BURNT TIMBER Location 4 Map ER86-1-4	Producer 1993-96: 2000 kg (64 300 oz) gold	1994 open pit reserves: 1.2 mill tonnes at 2.85 g/t (0.8 oz/ton) discordant sulphide lenses within silicified, chloritized and sulphidized oxide facies iron formation; gangue minerals: pyrrhotite	fractured, brecciated lenses of altered basalt; quartz veins and silicified shear zones; within silicified and carbonatized, pyritiferous basalt and metasediments(?) adjacent to a fault; gangue minerals: pyrite, galena, chalcopyrite, sphalerite	Granduc Mining Corporation and Black Hawk Mining Corporation (1996)

TABLE 13: SUMMARY OF MAIN GOLD DEPOSITS/OCCURRENCES IN THE LYNN LAKE BELT (cont.)

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
FARLEY LAKE Location 2 Map ER86-1-4	Producer Production to begin in 1996	1996 open pit reserves: 1.45 million tonnes at 3.9 g/t (0.11 oz/ton)	discordant sulphide lenses within silicified, chloritized and sulphidized oxide facies iron formation	Granduc Mining Corporation and Black Hawk Mining Corporation (1996)
LASTHOPE Location 3 Map ER86-1-4	Prospect 1987 drilling	1987 geological reserves: 127 000 tonnes at 7.2 g/t (0.21 oz/ton)	quartz-sulphide veins and silicified zones in quartzite within a volcanic-sedimentary sequence; gangue minerals: 5-15% pyrite, chalcopyrite	W. Bruce Dunlop Limited (1996)
FAUST AND T1A Location 14 (formerly Johnson shear) Map ER86-1-4	Prospect 1940, 43 and 1985-86: drilling	1986 geological reserves: 907 000 tonnes at 3.1 g/t (0.09 oz/ton)	quartz-sulphide veins in fractures/sheared sedimentary rocks; gangue minerals: pyrrhotite (1-20%), pyrite, arsenopyrite, chalcopyrite	Granduc Mining Corporation and Black Hawk Mining Corporation (1996)
CARTWRIGHT LAKE Location 7 Map ER86-1-4	Prospect 1952 and 1986: drilling	1986 estimate: 655 000 tonnes at 2.37 g/t (0.07 oz/ton)	swarm; quartz-calcite -ankerite-biot ite-muscovite -tourmaline veins in fractures within quartz diorite; gangue minerals: pyrite, pyrrhotite	Granduc Mining Corporation and Black Hawk Mining Corporation (1996)
GEMMEL LAKE Location 6 Map ER86-1-4	Prospect 1985-86: drilling	unknown	quartz-carbonate-biotite -chlorite-to urmaline veins in shear zone within quartz diorite; gangue minerals: pyrite, chalcopyrite, arsenopyrite, sphalerite.	Granges Inc. (1996)

KISSEYNEW GNEISS BELT

REGIONAL GEOLOGY

Introduction

The Kisseynew gneiss belt is a 240 km by 140 km east-trending domain comprising highly deformed Paleoproterozoic, largely metasedimentary gneisses. The belt is near the southwest margin of the Churchill Province and is bounded by the Lynn Lake and Flin Flon greenstone belts to the north and south, respectively, by Archean rocks of the Superior Province to the east, and by the Tabbernor Fault and granitic rocks of the Glennie domain, Saskatchewan to the west (Fig. 29).

Ansdell *et al.* (1995) interpreted the Kisseynew belt to have originated as a back arc basin that formed between the Amisk collage of the Flin Flon belt and a northern accreted terrane comprising the Lynn Lake and Rusty Lake greenstone belts, the Chipewyan-Wathaman batholithic domain and the Archean Hearne craton (Fig. 29).

Traditionally the Kisseynew belt has been divided into three main lithologic groups: 1) pelitic and psammitic gneisses and migmatite derived from greywacke-mudstone turbidites; 2) quartzofeldspathic gneisses interpreted to have been derived from a variety of protoliths (see below); they occur mainly in the northern and southern flanks of the Kisseynew belt; and 3) intrusive rocks. A fourth less abundant group of lithologies include amphibolites that locally are spatially associated with gold mineralization.

The Kisseynew belt gneisses have been metamorphosed to middle and upper amphibolite facies with the highest grades of metamorphism and greatest migmatite development in the central portion of the belt (Bailes and McRitchie, 1978).

Pelitic and psammitic gneisses and migmatites

Pelitic and psammitic gneisses, derived migmatites and anatectic granitic bodies derived from greywacke, siltstone and mudstone comprise approximately 70% of the Kisseynew belt (Bailes and McRitchie, 1978). The most common rock type is a grey, massive to well layered quartz-feldspar-biotite-garnet±graphite±sillimanite gneiss with variable amounts of anatectic material. The metapelites are biotite-rich and may contain porphyroblasts of garnet, staurolite, sillimanite and/or cordierite. Psammitic/pelitic compositional layering on the order of mm to m and thin calc-silicate intercalations or concretions are locally prominent, particularly in the central and northern parts of the belt. The pelitic and psammitic gneisses have been interpreted as greywacke-mudstone turbidites and termed the Burntwood River metamorphic suite in the central and northern part of the Kisseynew belt (McRitchie, 1974). Gilbert *et al.* (1980) renamed these rocks the Burntwood metamorphic suite. On the southern flank of the Kisseynew belt pelitic gneisses of the Nokomis Group (Robertson, 1953) have recently been interpreted to be part of the Burntwood metamorphic suite (Zwanzig and Schledewitz, 1992). The term Burntwood suite is now being used (Zwanzig, 1994a) since it was recognized that the gneisses grade into lower grade sedimentary rocks in the Snow Lake area (Zwanzig *et al.,* 1996b).

U-Pb ages of 1842±2 Ma and 1845±2 Ma from detrital zircons of Burntwood suite gneisses (Machado *et al.,* 1996) and emplacement ages of 1841 to 1827 for plutons in the Kisseynew belt (Gordon *et al.,* 1990; Ansdell and Norman, 1995) restrict the period of sedimentation to a few million years, unless the basin collapsed (in deeper crustal levels) while sedimentation was continuing (in higher crustal levels).

Quartzofeldspathic gneisses

Quartzofeldspathic (termed arkosic gneisses by some geologists) occur on the north and south flanks of the Kisseynew belt. On the north flank arkosic gneisses have been interpreted to be metamorphic derivatives of the Sickle Group continental clastic deposits of the Lynn Lake greenstone belt and termed the Sickle Metamorphic Suite (Gilbert *et al.,* 1980).

On the Kisseynew belt south flank quartzofeldspathic gneisses include gneisses of the Sherridon Group (Bateman and Harrison, 1946) and ‘granitized’ Nokomis Group gneiss (Robertson, 1953). In both groups quartzofeldspathic gneisses are interlayered with amphibolitic rocks. The Sherridon Group, prominent in the Sherridon and Walton Lake areas comprise siliceous, pelitic and calc-silicate gneisses interlayered with amphibolite, garnet-rich gneisses and local cordierite-anthophyllite schist and were considered to represent metasedimentary rocks (Robertson, 1953; Froese and Goetz, 1981). Ashton and Froese (1988) suggested that the Sherridon Group may be metavolcanic rocks equivalent to the Amisk Group rocks. However, later Zwanzig and Schledewitz (1992) interpreted that the gneisses do not represent a stratigraphic sequence, but, rather a tectonic assemblage of both supracrustal and plutonic components and the term Sherridon suite was introduced. The Sherridon suite is now being interpreted to have been derived from mafic to felsic volcanic rocks and granitoid rocks that were in large part hydrothermally altered (Zwanzig, 1990; Zwanzig and Schledewitz, 1992) and to represent rocks of the Amisk collage. Sherridon suite rocks in the Sherridon and Walton Lake areas form the core of two south verging nappes, the Sherridon nappe and Walton Lake nappe, respectively (Zwanzig, 1994a; Zwanzig *et al.,* 1996a,b; Map ER86-1-3).

The ‘granitized’ Nokomis Group gneiss (Robertson, 1953) are a sequence of quartzofeldspathic gneiss and amphibolites, but Ostry (1986) observed that they are lithologically dissimilar to the quartzofeldspathic gneisses of the Sherridon Group (Sherridon suite) near Sherridon, Manitoba. Zwanzig and Schledewitz (1992) interpreted Robertson’s ‘granitized’ Nokomis gneisses as high grade metamorphic derivatives of the epiclastic Missi Group rocks in the Flin Flon belt and renamed them Missi metamorphic suite and later Missi suite (Zwanzig *et al.,* 1996b; Map ER86-1-3), because Missi suite rocks can be traced from the low grade Flin Flon belt to the high grade Kisseynew belt (Zwanzig *et al.,* 1996b). The Missi suite typically comprises magnetite-bearing quartz-feldspar-biotite±hornblende gneisses derived from sandstone and conglomerate, and mesocratic gneisses, amphibolite and felsic gneiss derived from sedimentary, mafic and felsic volcanic rocks (Zwanzig and Schledewitz, 1992).

Amphibolites

Discontinuous amphibolite layers and lenses commonly occur a) within what are considered to be the stratigraphically younger portions of the Burntwood suite gneisses, near or at the pelitic/quartzofeldspathic gneiss contact in the northern and southern margin of the Kisseynew belt, and b) within quartzofeldspathic gneisses in the southern flank.

Amphibolitic rocks that occur between underlying Burntwood suite and overlying Sickle metamorphic suite quartzofeldspathic rocks on the Kisseynew belt north flank are part of a “marker horizon” (Schledewitz, 1972; Baldwin *et al.,* 1979; Lenton, 1981; Zwanzig, 1981) or “middle division” (Map ER86-1-4). The middle division comprises coarse clastic rocks (conglomerates, sandstones) carbonates, cherts, metabasalt and ultramafic rocks, including ultramafic flows (Zwanzig,1981). Geochemically the basalts have ocean floor affinity (Map ER86-1-4; Zwanzig, 1996). This succession is up to 500 m thick and is exposed for a strike length of approximately 40 km. It may represent deposits of a marginal basin or arc-rift basin (Zwanzig, 1996).

Amphibolites in the Kisseynew south flank occur near or along the contact between Burntwood suite metaturbidites and Missi suite continental metasedimentary and metavolcanic rocks (Map ER86-1-3). This "contact" is marked by intermittent conformable amphibolite units. Likely precursors to the amphibolites include: 1) volcanic rocks (Harrison, 1951 b; Lenton, 1981; Zwanzig, 1981, 1994a,b); 2) mafic and lime-rich sedimentary rocks (Harrison, 1951; Robertson, 1953; McRitchie *et al.,* 1979; Froese and Goetz, 1981; Zwanzig, 1984); and/or sill-like mafic intrusions (Moore and Froese, 1972; Bailes, 1975; Lenton, 1981; Ostry, 1990; Zwanzig, 1994b).

In part these amphibolites represent metabasalt and gabbroic intrusions in the stratigraphically upper part of the Burntwood suite *e.g.* at Nokomis Lake, and in the stratigraphically lower part of the Burntwood suite, south of Walton Lake and at Evans Lake (Zwanzig, 1994a, b). The magmatic rocks are characterized by extreme iron enrichment (Zwanzig, 1994b) and are locally associated with gold occurrences. The mafic magmatic rocks in the Burntwood suite on the north and south flank of the Kisseynew basin are associated with the Kisseynew basin margin, a long lived zone of folding and faulting (Zwanzig, 1994b). The fact that geochemically similar magmatic rocks on the south flank include the younger Josland Lake intrusion in the File Lake area (Bailes 1980) that are axial planar to early recumbent folds, indicates that this magmatism was not short lived.

Amphibolites within the quartzofeldspathic gneisses in the Kisseynew south flank also occur within Amisk collage gneisses at Sherridon and Walton Lake and within the Missi suite. Amphibolites in the Sherridon area include mafic to intermediate gneisses, in part interpreted as fragmental volcanic rocks (Froese and Goetz, 1981), massive amphibolite interpreted as igneous rocks (Zwanzig and Schledewitz, 1992), and calc silicate rocks, calcareous gneiss and marble, which were originally interpreted to be derived from impure limestone (Robertson, 1953), but more recently have been considered to be carbonatized volcanic rocks (Ashton and Froese, 1988). Amphibolites, up to 300 m thick, within the Missi suite, have been identified from Lobstick Narrows, east to Dow Lake, and north to Walton Lake (Map ER86-1-3; Zwanzig and Schledewitz, 1992). They include fine grained magnetiferous amphibolites, plagiophyric amphibolites and amygdaloidal mafic rocks, and have been interpreted as a sequence of mafic flows, tuffs, dykes and mafic intrusions (Zwanzig and Schledewitz, 1992). These amphibolites are distinguished from the amphibolites within the Amisk collage at Sherridon by the common presence of magnetite, absence of garnet, local abundance of amygdales and the continuity of amphibolite layers over several kilometres.

Intrusive Rocks

The Kisseynew belt includes intrusive rocks of various ages and compositions (Zwanzig and Schledewitz, 1992; Zwanzig *et al.,* 1996b). Intrusive rocks comprise: 1) granite, granodiorite, tonalite plutons, batholiths (1.82-1.78 Ga); 2) enderbite sills (1.83 Ga); 3) gneissic domes in the Kisseynew belt south flank (1.84-1.83 Ga); and 4) younger crosscutting dykes. The granitoid plutons are syntectonic in respect to D_2 and D_3 (Zwanzig and Schledewitz, 1992) and synchronous or slightly younger than the peak metamorphism in the Kisseynew belt dated at *circa* 1816 to 1803 Ma (Machado *et al.,* 1996), which supports earlier interpretations that they are anatectic. The 1.84-1.83 Ga gneiss domes are deformed Flin Flon arc plutons forming basement to the Burntwood suite turbidites and Missi suite deposits. Enderbite sills represents the end of arc related magmatism in the Kisseynew belt (Machado *et al.,* 1996). Most units are transected by numerous late narrow granitic dykes that are themselves cut by northerly trending pegmatitic dykes (McRitchie *et al.,* 1979).

Zwanzig and Schledewitz (1992) describe several occurrences of intermediate and mafic intrusive rocks from the Kisseynew belt south flank that stratigraphically lie near the contact between the Burntwood suite and the Missi suite. At Squall Lake, Ostry (1990) describes an up to 80 m thick differentiated gabbro-diorite-quartz diorite unit that is associated with gold mineralization. At Nokomis Lake, Zwanzig (1994b) describes a layered differentiated melagabbro-ferrogabbro-tonalite that hosts the Nokomis gold deposit (see below).

METAMORPHISM

Grade of metamorphism increases from the margins toward the centre of the Kisseynew gneiss belt and ranges from middle to uppermost amphibolite facies. On the basis of observed changes in metamorphic mineral assemblages of pelitic and semi-pelitic rocks within the belt, Bailes and McRitchie (1978) have developed a four-fold regional metamorphic zonation: 1) low grade mineral assemblages characterized by chlorite and biotite that are confined to the margins with the adjacent greenstone belts; 2) medium grade, characterized by moderate recrystallization, minor anatexis and porphyroblastic growth of garnet and staurolite; 3) high grade A, characterized by more intense recrystallization, sillimanite-garnet mineral assemblages and migmatite development; and 4) high grade B, distinguished by coarse recrystallization, extensive migmatite development and the stable assemblage garnet-cordierite-K feldspar. The transition from relatively low grade to high grade metamorphism generally occurs within 10-30 km of the belt margins (Bailes and McRitchie, 1978; Jackson and Gordon, 1985). Reactions in pelitic rocks similar to those discussed by Bailes and McRitchie (1978) have been documented by various investigators in the south part of the Kisseynew belt (Harrison, 1949; Froese and Gasparrini, 1975; Froese and Moore, 1980; Bailes, 1975, 1980; Gordon, 1981; Gordon *et al.,* 1985) and on the north flank (Zwanzig *et al.,* 1980; Jackson and Gordon, 1985).

STRUCTURE

Up to four sets of folds and two episodes of brittle deformation have been recognized throughout the Kisseynew gneiss belt. These deformations are considered to postdate deposition of the Missi suite/Sickle Metamorphic Suite (Bailes, 1980; Lenton, 1981). Zwanzig and Schledewitz (1992) have identified a Pre-Missi deformation, based on structural relationships, between Missi suite rocks and Amisk collage metaplutonic rocks in the Spyder Lake area, 6 km east of the Puffy Lake mine (Map ER86-1-3).

The earliest deformation (D_1), common to all areas of the belt, produced large-scale recumbent isoclinal folds (F_1) or nappe-like structures that verge to the north and south on the north and south flanks of the Kisseynew belt respectively. Most investigators have inferred this style of folding from regional inversions and repetitions of stratigraphy that have been deformed by later recognizable folds (Pollock, 1965; Pearson, 1972; Elphick, 1972; Schledewitz, 1972; Bailes, 1975; Baldwin *et al.,* 1979; Tuckwell, 1979; Zwanzig, 1984; Zwanzig and Schledewitz, 1992). F_1 fold axes are thought to parallel the easterly regional trend of the belt.

Major north-northeast- and east-trending folds (F_2) in the central and southern portions of the belt (Pearson, 1972; Bailes, 1975; Baldwin *et al.,* 1979) and northwest-trending folds (Lenton, 1981) and east-trending folds (Elphick, 1972; Schledewitz, 1972) on the north flank were generated during the second major deformational event (D_2). Zwanzig (1984) has suggested that east-trending F_2 folds with axial planes overturned to the south may be associated with major shear zones that occur along the Flin Flon-Kisseynew belt contact. Refolding of the early recumbent folds has produced dome and basin interference patterns, prevalent throughout the Kisseynew gneiss belt. Local development of axial planar schistosities and cataclastic foliations accompanied D_2 deformation. Both F_1 and F_2 folds are believed to have resulted from north-south compressive stresses generated during periods of crustal shortening.

The youngest folds (F_3 and/or F_4) are of the open and flexural type with axial surfaces that strike northeasterly (Elphick, 1972; Schledewitz, 1972; Bailes, 1975; Baldwin *et al.,* 1979; Zwanzig, 1984) and are associated with development of strong linear fabrics. The final phases of deformation (D_4 and D_5) produced faults, cataclastic zones and fractures commonly in the NE, N and NW directions.

A large amount of stratigraphic and structural data and interpretation have been generated from the Kisseynew south flank in the last 10 years and present a picture of at least two phases of nappe emplacements. Nappe emplacement resulted in the interleaving of various lithological units in the Kisseynew south flank and formed the complex transition from Kisseynew belt to the Flin Flon belt, evident on Map ER86-1-3. However, It is not the purpose of this report to present all these results and the reader is referred to Zwanzig (1990), Zwanzig and Schledewitz (1992), Zwanzig (1994a), Zwanzig *et al.,* (1996a, b) for further information.

Most recently Zwanzig *et al.* (1996a) proposed a structural model based on interpretations of LITHOPROBE seismic profiles and mapped structures. They suggest that the Kisseynew belt dips under the northern accreted Lynn Lake arc-Hearne craton (Fig. 29). The northern craton overrode the Kisseynew domain to the south during D_2, inverting part of the (originally north-verging) D_1 fold-thrust belt during a thermal peak (generating migmatites at 1816-1803 Ma) and making much of the Kisseynew belt allochthonous. Oblique convergence of the Kisseynew belt with the Superior craton produced southwest-verging F_3 and northeast-trending F_4 structures and syntectonic S_3 and S_4 granitic dykes (1.80-1.79 Ga), and subsequently, resulted in the formation of steep extension faults that shallow out in mid-crustal detachments.

MINERALIZATION

Scattered gold occurrences have been known in the Kisseynew belt since the 1950's. Gold prospects were noted by Robertson (1953) and Pollock (1964, 1965) on the south flank, in the central region by Quinn (1955) and on the north flank of the belt by Hunter (1953), Milligan (1960) and Barry (1965).

However, the Kisseynew belt being a relatively highly metamorphic metasedimentary gneiss belt, and situated between the greenstone belts of the Lynn Lake and Flin Flon-Snow Lake mining camps, has traditionally received little attention from mineral explorationists. Recent developments such as the interest in the 1980's in stratabound gold mineralization, the large regional extent of some stratigraphic units with possible potential for gold mineralization, the presence of significant gold at Nokomis Lake and Evans Lake (Gale and Ostry, 1984; Peloquin *et al.,* 1985), and the fact that the Puffy Lake gold deposit was put into production in 1989, have renewed interest in the gold potential of the Kisseynew belt. In response to these factors and coupled with an insufficient understanding of the stratigraphy and structure of the belt and the geological setting of gold mineralization the Manitoba Government, after completion of geological mapping in the northern and central part of the belt, initiated regional mapping along the south flank of the belt (Zwanzig, 1983, 1984, 1985; McRitchie, 1985, 1986; Schledewitz, 1985; Schledewitz and Trembath, 1986). Mineral deposit studies were also undertaken (Gale and Ostry, 1984; Peloquin *et al.,* 1985; Ostry, 1986, 1987, 1988, 1989, 1990).

On the north flank Hunter (1953) reported minor gold in pyrite-quartz stringers associated with intrusive rocks. Milligan (1960) documented a quartz vein hosted Au-Cu prospect within amphibolitic rocks near the Lynn Lake-Kisseynew belt contact. Gold and disseminated arsenopyrite mineralization associated with amphibolites and metasedimentary rocks (Map ER86-1-4, location 13, the Molly occurrence) was reported by Barry (1965). The amphibolites at the latter occurrence include volcanic flow rocks and occupy a stratigraphic position near the top of the Burntwood suite (Zwanzig, 1981). A regional till sampling program by Kaszycki (1989) identified an approximately 25 km wide As±Cu and Au dispersal train that begins near the Molly occurrence and extends south, approximately 60 km, to the Kississing Lake area. Disseminated pyrrhotite with local concentrations of chalcopyrite, galena, silver and gold at several scattered localities in the central portion of the belt were reported by Quinn (1955).

At least six localities of gold-arsenopyrite mineralization occur on the south flank of the Kisseynew belt within Manitoba; these include the Puffy Lake and Nokomis Lake gold deposits, and the Squall Lake, Evans Lake, Lobstick Narrows and Martell Lake occurrences. Gale and Ostry (1984) proposed that known gold mineralization in the south flank of the Kisseynew belt is associated with a thin unit of volcanogenic and sedimentary rocks, predominantly amphibolite, that occurs between Burntwood suite gneiss and Missi suite (formerly 'granitized' Nokomis) quartzofeldspathic gneiss. Previous investigators have drawn attention to local Fe-sulphide mineraiization variably accompanied by minor chalcopyrite and arsenopyrite associated with amphibolitic rocks at this stratigraphic interval (Robertson, 1953; Pollock, 1965; Barry, 1965; McRitchie *et al.,* 1972; Elphick, 1972; Schledewitz, 1972; Lenton, 1981), *i.e.* Nokomis Lake, Evans Lake, Lobstick Narrows, Squall Lake and Martell Lake (formerly Wood Lake).

The Puffy Lake gold deposit (Map ER86-1-3, KS 1) is located within a heterolithic gneiss sequence comprised of interlayered intermediate to mafic biotite-bearing gneiss with intercalated amphibolite, ultramafic rock and felsic gneiss that occurs between Burntwood suite and Missi suite rocks (Ostry and Halden, 1995; Fig.43). Gold-arsenopyrite-pyrrhotite mineralization occurs within intermediate biotite ± hornblende bearing gneisses and form up to 2 m thick, laterally extensive, moderately-dipping, parallel mineralized sheets that are conformable to lithologic layering and regional schistosity (Ostry, 1986; Ostry and Halden, 1995; Fig.44). Zwanzig and Schledewitz (1992) interpret these rocks to be part of the hydrothermally altered metavolcanic rocks of the Amisk collage (Fig. 43).

At Nokomis Lake, Evans Lake, Squall Lake (Map ER86-1-3, locations KS3, KS6, KS2) and Lobstick Narrows stratabound gold-bearing arsenopyrite mineralization is located within a regionally extensive layered amphibolitic sequence that stratigraphically occurs between Burntwood suite and arkose-derived Missi suite gneisses (Gale and Ostry, 1984 and Peloquin *et al.,* 1985; Parbery, 1990). At Nokomis and Evans lakes gold and sulphide mineralization is restricted to a mottled 'quartz-rich gneissic rock' that forms a layer up to 20 m thick within the amphibolitic rocks. Zwanzig (1994b) interpreted the amphibolitic sequence at Nokomis Lake as a differentiated mafic intrusion ranging in composition from melagabbro to ferro-tonalite. The gold mineralization is reported to be associated with ferro-tonalite that was metamorphosed to felsic, mottled gneiss.

At Lobstick Narrows gold mineralization is associated with a layered amphibolite unit (Gale *et al.,* 1980) that contains up to 5% arsenopyrite and occurs between Burntwood suite metagreywacke, and Missi suite conglomerate and sandstone. The layered amphibolite was interpreted as a sequence of metasedimentary and mafic metavolcanic rocks (Parbery, 1990).

Near Martell Lake Ostry (1987) describes arsenopyrite, galena, sphalerite, pyrite, pyrrhotite and chalcopyrite in quartz veins and quartz-filled tension gashes that occur within a composite felsic augen gneiss.

At Squall Lake, gold mineralization is associated with a differentiated gabbro-quartz diorite near the contact between Missi suite and Burntwood suite gneisses (Gale and Ostry, 1984; Ostry, 1990), a setting similar to the Nokomis Lake deposit.

The Cyclone and Moss 1 gold deposits (Map ER86-1-3, KS4, KS5) are hosted by hornblende-plagioclase gneiss and amphibolite, interpreted as metavolcanic rocks of the Snow Lake arc assemblage, between tonalitic gneiss of the Herblet Lake gneiss dome and Missi suite meta-sandstones.

Gold mineralization associated with disseminated pyrite and/or fuchsite occurs near the top of a greywacke-derived gneissic unit at Kipahigan Lake (Pollock, 1964, 1965).

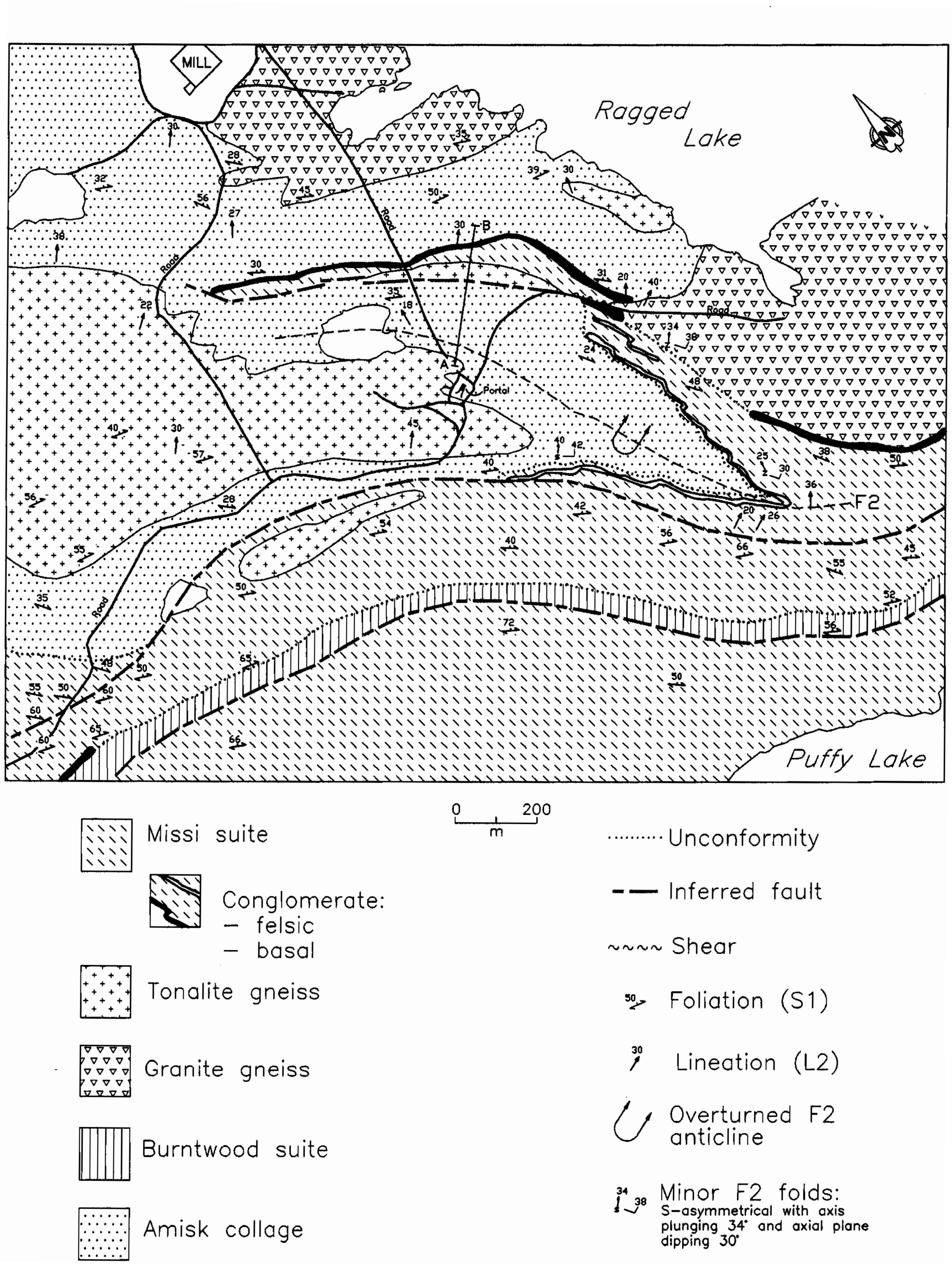


Figure 43: Geology in the area of the Puffy Lake deposit (after Ostry and Halden, 1995)

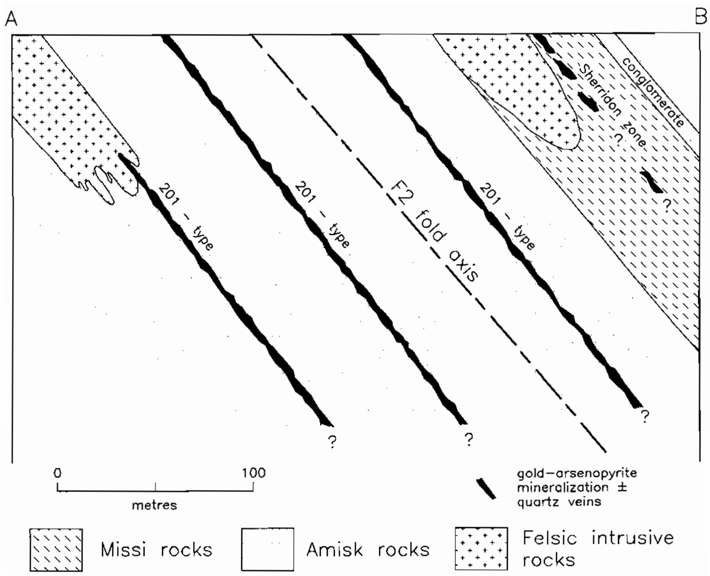


Figure 44: Cross *section of Puffy Lake gold deposit (after Ostry and Halden, 1995)*

PAST PRODUCER

Puffy Lake

Location: 61 km northeast of Flin Flon, 1 km north of Puffy Lake.

Map Reference: Map ER86-1-3, location KS1.

Description of Deposit:

Puffy Lake is located on the south flank of the Kisseynew gneiss belt. The Puffy Lake deposit area is underlain by Amisk collage intermediate to mafic supracrustal rocks and Burntwood suite rocks that are intruded by granitoid rocks (Fig. 43). Missi suite rocks disconformably overlying these rocks.

The Puffy Lake gold deposit is located in the core of an overturned anticlinal structure within a heterolithic gneiss sequence comprised of interlayered intermediate- to mafic biotite-bearing gneiss with intercalated amphibolite, ultramafic rock and felsic gneiss (Ostry, 1992). Gold - arsenopyrite mineralization is associated with biotite±hornblende bearing intermediate gneiss layers (Ostry and Halden, 1995) interpreted to be hydrothermally altered volcanogenic rocks of the Amisk collage (Zwanzig and Schledewitz, 1992). Two main styles of mineralization, the 201 and 214 type, have been recognized (Ostry and Halden, 1995). The 201 type consists of several 1-2 m thick sheets of arsenopyrite-gold mineralization that commonly contain quartz veins (Fig. 44). The ore sheets, and contained sulphide grains, are oriented parallel to the foliation and compositional layering and probably formed during the first deformation phase and thus are pre- or syn-D_1 deformation. The quartz veins that occur with the 201 type mineralization postdate introduction of the arsenopyrite, but predate D_3 deformation. The mineralized biotite gneiss contains up to 20% disseminated arsenopyrite and, locally, pyrrhotite. The 214 type mineralization is an anastomosing network of gold- and arsenopyrite-bearing diopside-biotite-feldspar±quartz veins in altered host rock. This mineralization is younger than 201 type mineralization and is interpreted as a syn-D_3 remobilization of arsenopyrite and gold into dilated structures which parallel F_3 fold axes.

A third type of gold mineralization is informally referred to as “Sherridon zone” (Fig. 44). It consists of erratic gold mineralization associated with arsenopyrite and commonly occurs in fractures within quartz veins, mobilized during or after the D_3 event. The 201 type mineralization contains the bulk of the mine’s reserves, but the younger 214 type mineralization is considered to have future potential (Ostry and Halden, 1995).

History of Exploration and Development:

Hudson Bay Exploration and Development Co. Ltd. discovered the Puffy Lake deposit in 1960 by drilling an Airborne Input anomaly that was also located on the ground using Apex Maxmin II. Granges Exploration Aktiebolag acquired the property in 1979 and optioned it to Maverick Mountain Resources Ltd. (later Pioneer Metals Corporation). After 59 additional diamond-drill holes and an underground development program that included a decline to the 100 m and 200 m levels, drifting, trial stoping and bulk sampling, Pioneer announced plans to put the Puffy Lake gold deposit into production at a rate of 500 tonnes per day. The reserves were reported as 1.2 million tonnes of 7.88 g/tonne (0.23 oz/ton) gold in four parallel mineralized zones (Northern Miner, January 26, 1987). Milling began December 4, 1987 and the first dore bar was poured December 15, 1987 (Northern Miner, March 7, 1988). Reserves of probable and possible ore were reported as 3.54 million tonnes of 7.88 g/tonne (0.23 oz/ton) gold (Northern Miner, May 9, 1988). In March 1989, Pioneer announced suspension of mining operations (Globe and Mail, March 21, 1989). About 930 kg (30 000 oz) of gold had been produced over a 15 month period (Northern Miner May 25, 1988). The property has been inactive since July 1989, but recently, based on a 1993 Kilborn Engineering Ltd. feasibility study and a study of possible mining methods by Tonto Mining Ltd., Pioneer Metals Corporation announced plans to reactivate the mine (Northern Miner March 18, 1996). Kilborn calculated the mineral inventory to be 1.3 million tonnes of proven and probable ore grading 8.57 g/tonne (0.25 oz/ton) gold and possible ore reserves of 883 700 tonnes grading 7.15 g/tonne (0.21 oz/ton) gold for total contained gold of 16 800 kg (543 400 ounces). Tonto calculated a mineable reserve figure of 855 000 tonnes grading 6.7 g/tonne (0.2 oz/ton) gold (all from Kilborn’s proven and probable ore reserve figure). Pioneer plans a $6.5 million bulk sampling, underground development and surface rehabilitation program.

Selected Bibliography: Manitoba Mines Branch, Corporation File (Granges Exploration Aktiebolag, Maverick Mountain Resources Limited); Ostry (1986); Ostry and Trembath (1992); Ostry and Halden (1995); Zwanzig (1984).

DEPOSITS

Squall Lake

Location: 6.5 km northwest of Snow Lake, between Squall Lake and McLeod Lake.

Map Reference: Map ER86-1-3, location KS2.

Description of Deposit:

The following description is summarized primarily from Harrison (1949) and Fedikow *et al.* (1989). The Squall Lake deposit and several gold occurrences are located on the northwest limb of a northeast-trending synform. The area is underlain by Burntwood suite garnet-staurolite schist and Missi suite arkosic gneisses (Map ER86-1-3) that are intruded by a biotitic diorite sill. Gold occurs in three zones that contain discontinuous subparallel mineralized lenses over a stratigraphic thickness of 60 m at or near the hanging wall contact of the diorite sill: 1) the uppermost zone is within Missi meta-arkose and consists of a quartz and quartz-carbonate stockwork; 2) the middle or main zone occurs at the upper contact of the diorite with meta-arkose and consists of a series of I mineralized lenses within silicified and slightly carbonatized diorite; and 3) a lower zone that is up to 2 m wide occurs within silicified and carbonatized diorite. Arsenopyrite is the most common sulphide, but the highest gold concentrations are found where quartz and chlorite are also present.

Gale and Ostry (1984) reinterpreted the diorite sill as a well layered sequence of mafic metasedimentary or metavolcanic rocks. However, north of Squall Lake, Ostry (1990) interpreted this unit as a differentiated gabbro-diorite-quartz diorite intrusion, consistent with Harrison's (1949) interpretation.

History of Exploration and Development:

The area was first staked in 1924. Numerous individuals held claims in the area between Squall and Moore Lake from 1924 to 1945, but limited exploration work was undertaken. During 1944-45 Wekusko Consolidated Limited staked and optioned approximately 103 claims in the area. They carried out an 8309 m drill program that intersected significant gold mineralization. Samples contained from 3.09 g/tonne (0.09 oz/ton) to 14.4 g/tonne (0.42 oz/ton) gold over widths of 0.76 m to 2.75 m. Squall Lake Gold Mines Limited acquired the property in 1945 and carried out 7642 m of drilling to test the mineralized zones at greater depth. A series of 17 holes intersected mineralization averaging 9.09 g/tonne (0.27 oz/ton) gold over 1.49 m. The property remained dormant until the claims were cancelled in 1977.

In 1977 and 1978 Stan Major and Hudson Bay Exploration and Development staked claims over the area. Hudson Bay carried out line cutting, geophysical surveys and diamond drilling before the claims lapsed in 1981. In 1980, within a period of 3 months, the Stan Major property was transferred to Corporate Oil and Gas Limited, W. Bruce Dunlop Limited (NPL) and finally to Camflo Mines Limited (in 1984 Camflo Mines amalgamated with Barrick Resources Corporation under the latter's name). Geophysical surveys were carried out in 1981 and were followed by mapping and diamond drilling that indicated reserves of 1 088 621 tonnes averaging 6.85 g/tonne (0.20 oz/ton) gold (Northern Miner, October 18, 1984). A further 5000 m of drilling was completed that outlined 680 000 tonnes grading 3.43 g/tonne (0.1 oz/ton) gold (Northern Miner, January 10, 1985). In 1987 Zenco Resources Inc. acquired 100% interest in the property.

The Zenco 16 claim property contains 7 of 11 stratiform gold mineralized zones that occur at or near the upper contact of a mafic sill with overlying Missi metasedimentary rocks and can be traced for over 8 kilometers. Only the "South", "Margaret" and "Margaret Extension" zones have been drilled extensively. In 1987 about 3400 metres of drilling was conducted on the Margaret Extension Zone. Zenco's name changed to Solidor Resources Inc. in 1987 and with Prime Exploration Ltd. another 3700 metres of drilling on three new target areas was planned. D.S. Robertson and Associates Ltd. recommended bulk sampling and a 50 tonne sample was taken in 1988. The property has had little activity since 1988 (Northern Miner June 8, 1987 and June 13, 1988; Zenco's Annual Report, 1986).

References: Fedikow *et al.* (1989); Gale and Ostry (1984); Harrison (1949); Manitoba Mines Branch, Corporation File (Squall Lake Gold Mines Limited), Mineral Inventory File (63 K/16 Au1 0); Ostry (1990).

Nokomis

Location: 55 km northeast of Snow Lake, on the east shore of Nokomis Lake.

Map Reference: Map ER86-1-3, location KS3.

Description of Deposit:

The Nokomis Lake deposit area is underlain by an up to 190 m thick layered amphibolite sequence that is structurally overlain by Burntwood suite pelitic gneiss and underlain by Missi suite gneiss (Zwanzig, 1984). Gold mineralization is hosted by a composite 20 m thick quartz-baring mottled gneiss layer within the amphibolite sequence (Gale and Ostry, 1984; Ostry and Trembath, 1992). Pyrite and pyrrhotite are the most common sulphide minerals and occur mainly as disseminations throughout the quartz-rich gneiss in a layer 1-2 m thick; arsenopyrite occurs locally. Gold appears to be associated with the arsenopyrite. Peloquin *et al.* (1985) stated that the gold-bearing mineralized zones are essentially stratabound within the quartz-rich gneiss with sulphide veinlets tending to occur toward the structural base of the quartz-rich gneiss.

Ostry and Trembath (1992) interpreted the deposit as a chemical sediment type deposit due to its stratabound nature and lack of obvious associated alteration. Based on detailed mapping and geochemistry, Zwanzig (1994b) interpreted the host amphibolites and felsic gneisses as basalt intruded by one or more differentiated gabbroic sills that range in composition from melagabbro to ferrogabbro to ferrotonalite. The gold mineralization is located within what Zwanzig (1994b) interprets as a gneissic tonalite, and considers hornblende-magnetite veins within this unit as carbonate alteration. The Nokomis Lake amphibolites can be traced for at least 8 km (Zwanzig, 1984) and are part of the Kisseynew basin margin sequence (Zwanzig, 1994b) that represent a potential stratabound host for gold mineralization (Gale and Ostry, 1984).

Rio Tinto Canadian Exploration Limited reported the "vein zone" outlined by their 1961 drilling program was 152 m long and 3.32 m wide (Mines Branch, Non-confidential Assessment File, 90657-59).

History of Exploration and Development:

The property was first staked in 1952 by S.C. Simpson. A.L. Parres optioned the property in 1958 and carried out a 5-hole drill program. The option was dropped in 1960. In 1961 Rio Tinto Canadian Exploration Limited optioned the property and carried out a 41-hole 2860 m drill program that outlined possible reserves of 90 700 tonnes grading 10.29 g/tonne (0.3 oz/ton) gold. The claims lapsed in 1971.

Dome Exploration (Canada) Limited staked the property in 1974 and carried out geophysical surveys and diamond drilling in 1975. In 1985 additional diamond drilling was carried out.

Selected Bibliography: Bailes (1971); Davies *et al.* (1962); Gale and Ostry (1984); Manitoba Mines Branch, Mineral Inventory File (63 N/2 Au1), Non-confidential Assessment File (90657-59); Ostry and Trembath (1992); Peloquin *et al.* (1985); Robertson (1953); Zwanzig (1994b).

Cyclone (Sask-Mani)

Location: 18.5 km northeast of Snow Lake, on the west shore of the northeast arm of Herblet Lake.

Map Reference: Map ER86-1-3, location KS4.

Description of Deposit:

The property is underlain quartz-biotite and quartz-hornblende gneisses interpreted to be metamorphosed Snow Lake arc assemblage (Map ER86-1-3) that are intruded by pegmatite and aplite dykes (Wright, 1931). Tonalitic gneisses of the Herblet Lake gneiss dome complex occur to the northwest.

Mineralization is associated with a shear 1 to 1.5 m wide and 244 m long. The shear contains quartz veins and lenses. Gold is reported to occur in quartz along the footwall of the shear in a zone of gouge (Fedikow *et al.,* 1993). Silver and copper minerals are also present. A section across one of the ribs of the shaft consisted of the following units, described from footwall to hanging wall:

- 0.23 m of footwall gouge
- 0.92 m of mica gneiss with a few quartz lenses and stringers less than 0.6 cm wide.
- 0.38 m of jointed mica gneiss with lenses of quartz up to 1.27 cm in width.

5.1 cm wide gold-bearing quartz vein (at the hanging wall contact with quartz-mica gneiss).

Drillholes intersected disseminated (3-5%) pyrrhotite over core intervals of generally <1 m in the host gneiss.

History of Exploration and Development:

The property was first prospected in 1916 when J. Kerr staked the property. In 1920 G.C. Taylor staked the property and optioned it to John Nutt and Russsel Hartney in 1925. Pits and trenches were dug in 1921, 1924, 1928 and 1931. Cyclone Development Company sank a shaft to a depth of 15 m in 1926. A small mill was installed and a test run of 27 tonnes of ore averaged 19.89 g/tonne (0.58 oz/ton) gold (Wright, 1931). In 1929 Taylor assigned his interest in Cyclone to Broad Bay Mining Company, Limited. The assets of Broad Bay were absorbed in 1929 by a new company, the Sask-Mani Precious Metals Mining Company Limited.

In 1970 a Turam survey was carried out by HBED on adjacent ground to the east. The claims were cancelled in 1976. In 1978 Granges Exploration Aktiebolag staked the property and carried out a 2-hole 143 m drill program in 1980. Hole AB-34 intersected minor sulphides that assayed trace amounts of gold (Manitoba Mines Branch, Non-confidential Assessment File 99849). In 1982 P. P. Dunlop staked the property and carried out sampling and stripping in 1984.

Selected Bibliography: Fedikow *et al.* (1993); Manitoba Mines Branch, Corporation File (Sask-Mani Precious Metals Mining Company), Mining Engineering Files (Sask-Mani Precious Metals Mining Company), Mineral Inventory File (63 J/13NW, Au24), Non-confidential Assessment File (91499, 99849); Wright (1931).

Moss 1

Location: 13.5 km northeast of Snow Lake, on the western shore of the northeast arm of Herblet Lake.

Map Reference: Map ER86-1-3, location KS5.

Description of Deposit:

The area of the deposit is along strike 3 km SW of the Cyclone deposit and is hosted by metavolcanic rocks of the Snow Lake arc assemblage (Froese and Moore, 1980; Map ER86-1-3). Mafic metavolcanic rocks host gold-bearing quartz stringers over widths of up to 6.1 m and along a strike length of 458 m. Mineralization consists of 1-5% disseminated and veinlet pyrite, chalcopyrite, sphalerite, magnetite and native gold (Fedikow *et al.,* 1993). Tungsten mineralization occurs locally (Cole, 1942). Assays from channel samples averaged 0.384 WO_3 across 7.5 m.

History of Exploration and Development:

The area was first staked in 1916 by R. Kerr. In late 1942 W Ringsleben of the Metals Controller's Office, Ottawa analyzed a series of channel samples that averaged 0.384% WO_3 across 7.6 m, ranging from 0.026-1.215% WO_3 (Manitoba Mines Branch, Unpublished Information File 63 J/13NW). Trenching, stripping, and blasting were done in the mid-1940's. A 5.5 m channel sample across one trench assayed 12.73 g/tonne (0.37 oz/ton) gold (Northern Miner, Jan. 1, 1946). In 1946 the property was assigned first to J.R. Starnes and then to WH. Stainton Limited.

Ferguson Mines Limited acquired the property in 1950. Of 22 channel samples taken in the main trench, 12 averaged 6.86 g/tonne (0.20 oz/ton) gold. By May 1950, approximately 8164 tonnes of ore averaging 25.71 g/tonne (0.75 oz/ton) had been broken. A 13.6 tonne Gibson mill was installed; however, there is no record of any gold being produced. In 1955, 196 tonnes of material was reported in a surface stockpile. Canadian Nickel Company Ltd. conducted an airborne EM survey in 1957. HBED completed a Turam survey on adjacent ground. The Moss 1 claim lapsed in 1973, the property has been staked by WB. Dunlop, B. Gulka and P. Dunlop.

Selected Bibliography: Bailes (1971); Cole (1942); Manitoba Mines Branch, Annual Report on Mines and Minerals (1928, 1951), Corporation File (Ferguson Mines Limited), Mineral Inventory File (63 J/13NW, Au20), Non-confidential Assessment Files (91624,91499) Unpublished Information File 63 J/13NW; Wright (1931)

Martell Lake (formerly Wood Lake)

Location: west shore of Martell Lake, 37 km northwest of Snow Lake

Map Reference: Ostry (1987)

Description of Deposit:

The following description is summarized from Ostry (1987). The mineralization at Martell Lake is believed to be the Wood Lake occurrence (*cf.* Gale and Ostry, 1984) reported by Robertson (1953).

The area of mineralization, near the west shore of Martell Lake, is underlain by layered amphibolite, interpreted to be part of the Fourmile Island arc assemblage (see chapter Flin Flon belt and Map ER86-1-3) and a composite unit of augen gneiss. The augen gneiss comprises fine- to medium grained felsic quartz-feldspar-biotite-muscovite gneiss that locally contains up to 40% coarse grained tectonized feldspar blasts, and a fine- to medium grained sericitic quartz-feldspar-biotite±garnet gneiss. The sericitic biotite±garnet gneiss is altered and locally contains 1-2% disseminated arsenopyrite. At the main occurrence arsenopyrite, galena, sphalerite, pyrite, pyrrhotite and chalcopyrite mineralization is associated with quartz veins and quartz filled tension gashes that have been exposed in seven trenches over a distance of 125 m. The quartz veins appear to form an irregular anastomosing network of individual and composite veins (individually <1 m in width) that crosscut the foliation. The composite veins contain abundant wall rock and form a stockwork. Arsenopyrite is the predominant sulphide. The quartz veins observed in trenches occupy relatively late structural sites, generally extension fractures, but have also been deformed by a post-mineralization deformation.

Grab samples of quartz-arsenopyrite mineralization collected from trenches yielded 1.14 to 32.3 g/tonne (0.04-1.04 oz/ton) gold and from outlying occurrences up to 3.5 g/tonne (0.11 oz/ton) gold (Ostry, 1987).

Selected Biography: Gale and Ostry (1984); Ostry (1987): Robertson (1953); Zwanzig and Schledewitz (1992)

Evans Lake

Location: Evans Lake, 55 km NW Snow Lake

Map Reference: Ostry and Trembath (1992)

Description of Deposit:

The following description is summarized from Ostry and Trembath (1992). The area is underlain by an up to 160 m thick amphibolite sequence (Peloquin *et al.,* 1985) that is structurally overlain by Burntwood suite metagreywacke and underlain by felsic gneiss of the (metamorphic) Missi suite. The amphibolite sequence includes: 1) layered amphibolite (<80 m) with calc-silicate interlayers; 2) a composite quartz-bearing mottled gneiss (<30 m) with locally abundant garnet, magnetite, albite, carbonate, calc-silicates and sulphide-rich lenses/zones; 3) garnet-rich hornblendite (<7 m); 4) massive, garnet-bearing amphibolite (<35 m); and 5) massive, locally layered, calcareous amphibolite (<90 m) containing <1 m very fine grained, locally mineralized siliceous layers. Zwanzig (1994a) recognized pillow breccia in portions of the amphibolites at Evans Lake.

Lenses of gold-arsenopyrite mineralization are stratabound within the composite quartz-bearing mottled gneiss and the siliceous layer within the calcareous amphibolite. Sulphide mineralization comprises up to 5% disseminated pyrite, pyrrhotite±arsenopyrite and rare chalcopyrite. < 1 cm wide veins of iron sulphides and/or arsenopyrite occur locally within mottled gneiss. Galena was observed in one mineralized quartz vein.

Exploration and Development

The northern part of the area of mineralization at Evans Lake was staked in 1946 by G. Simpson, C. Shapland and D.C. Beveridge and transferred to International Mining Corp. (Canada). International Mining drilled 14 holes (539 m) in 1948. Assays of drill core range from 14.1 g/tonne over 4.3 m to 2.2 g/tonne over 1.8 m. The southern portion of the occurrence area was staked by W. F. Uhrich in 1947 and geological mapping and trenching were conducted. Grab and channel samples from outcrop and trenches assayed up to 37 g/tonne (1.1 oz/ton) gold. In 1980 and 1981 the northern portion of the occurrence area was staked by J.J. Studer for Granges Exploration Aktiebolag.

Selected Bibliography: Manitoba Mines Branch Cancelled Assessment files (90653, 90660), Mineral Inventory Card 63N/2 SW Au2; Ostry and Trembath (1992); Peloquin *et al.* (1985); Robertson (1953); Zwanzig (1994a); Zwanzig and Schledewitz (1992).

TABLE 14: SUMMARY OF MAIN GOLD DEPOSITS/OCCURRENCES IN THE KISSEYNEW GNEISS BELT

NAME AND MAP REFERENCE	STATUS (PRODUCTION)	GOLD TONNAGE/ GRADES	GEOLOGICAL ENVIRONMENT	PRESENT OWNERSHIP
PUFFY LAKE KS1 Map ER86-1-3	Past producer 1988-89: 429 kg (13 790 oz)	1993 proven reserves: 855 000 tonnes at 6.7 g/t (0.19 oz/ton)1)	sub-parallel quartz veins and ore sheets in biotite±hornblende gneiss; 2) anastomosing network of diopside-biotite-feldspar±quartz veins; gangue minerals: 1) arsenopyrite, pyrrhotite, 2) arsenopyrite	Pioneer Metals Corporation (1996)
SQUALL LAKE KS2 Map ER86-1-3	Prospect 1945, 1981, 1984, 1986, 88: diamond drilling	1984: 1 088 621 tonnes at 6.85 g/t (0.20 oz/ton)	sub-parallel lenses of quartz and quartz-carbonate stockwork within silicified and carbonatized diorite, at its margin and in host meta-arkose; gangue minerals: arsenopyrite, chlorite	Solidor Resources Incorporated (1996)
NOKOMIS KS3 Map ER86-1-3	Prospect 1958-61-71-85: diamond drilling; more than 50 holes	1984: 136 000 tonnes at 7.8 g/t (0.23 oz/ton)	quartz-bearing mottled gneiss (metatonalite?); gangue minerals: pyrite, pyrrhotite, arsenopyrite	Placer Dome Canada Limited (1996)
CYCLONE KS4 Map ER86-1-3	Small past producer 1926: 15 m deep shaft 27 tonnes milled that contained 19.9 g/t (0.58 oz/ton)	unknown	quartz lenses/stringers within biotite and hornblende gneiss; gangue minerals: pyrrhotite (3-5%), chalcopyrite	W. Bruce Dunlop Limited (1996)
MOSS 1 KS5 Map ER86-1-3	Small past producer 1950: 8164 tonnes milled that contained 25.7 g/t (0.75 oz/ton)	1951: 5400 tonnes at 51.4 g/t (1.5 oz/ton) in dump	quartz stringers in sheared mafic metavolcanic rocks: gangue minerals: pyrite (1-5%), chalcopyrite, sphalerite, magnetite	W. Bruce Dunlop Limited (1996)
Martell Lake (Wood Lake) 37 km NW Snow Lake Ostry (1987)	Prospect surface grab samples: 1.14-32.3 g/t (0.04-1.04 oz/ton) gold	unknown	anastomosing network of quartz veins and quartz filled tension gashes within sericitic biotite±garnet augen gneiss that contains 1-2% arsenopyrite; gangue minerals: arsenopyrite, galena, sphalerite, pyrite, pyrrhotite, chalcopyrite	New Island Minerals Ltd. 1996
Evans Lake 55 km NW Snow Lake Ostry and Trembath (1992)	Prospect surface grab samples: up to 37 g/t (1.1 oz/ton) gold	unknown	lenses of arsenopyrite±quartz in quartz-bearing mottled gneiss (metonalite?) and in siliceous layeres within calcareous amphibolite; (*cf.* Nokomis KL3, above); gangue minerals: pyrite, pyrrhotite, arsenopyrite, chalcopyrite, rare galena	W. Bruce Dunlop Limited (1996)

SEAL RIVER AREA

REGIONAL GEOLOGY

The Seal River area discussed in this report includes an area extending from Tadoule Lake eastwards, straddling Seal River and the northeast portion of North Knife River, to the west shore of Hudson Bay (Fig. 45). The area is part of the Churchill Province (Trans-Hudson orogen; Fig. 4) and includes the southeastern portion of the Seal River domain and the Great Island domain in Figure 5. The area is characterized by a paucity of outcrop, hampering interpretations and regional correlations.

Schledewitz (1986) classified the rocks into five broad groups:

1) Archean and probable Archean plutonic rocks.
2) Metasedimentary and locally metavolcanic rocks of Proterozoic and possibly, in part, Archean age (Sequence I);
3) Proterozoic and possibly Archean intrusive rocks;
4) Metasedimentary rocks of Proterozoic age (Sequence II; the Great Island Group); and
5) Hudsonian igneous and metamorphic rocks

Sequence I and II supracrustal rocks are underlain by Archean (or probable Archean) granitic rocks. The sedimentary and volcanic rocks of Sequence I are intruded by granitic rocks ranging in composition from porphyritic quartz diorite to granite. The basal rocks of the Great Island Group are intruded by younger granites. A series of widely spaced occurrences of foliated granodiorite to tonalite, migmatite and amphibolite that occurs northeast of Tadoule Lake and 30 km east of Great Island has an unknown relationship to the above groups. Schledewitz (1986) was uncertain whether the granodiorite and tonalite are related to similar rocks with unknown affinities that occur outside the Seal River area or whether they are part of the Archean granitic rocks that underlie Sequence I.

Sequence I

These rocks outcrop over limited areas at Great Island and along the lower Seal River. The metavolcanic rocks at Great Island form the lower part of a structural basin 30 km wide by 50 km long. The volcanic rocks comprise massive and pillowed andesite; interlayered tuff and basalt or andesite; tuff and interlayered siliceous metasedimentary rocks; rhyolite to rhyodacite; and conglomerates (Schledewitz, 1986). The volcanic rocks along the lower Seal River comprise pillowed andesite flows, a rhyodacite lens and interlayered massive andesite, and intermediate to basic tuffs.

Great Island Group

Rocks of the Great Island Group occur as erosional remnants in the Great Island and Meade Lake area, along the Seal River east of Great Island, along the North Knife River and in the Churchill area. The basal units are composed of oligomictic or polymictic conglomerate, protoquartzite and interlayered phyllite to biotite schist, grey green phyllite, and biotite schist. Basal units are overlain by conglomerate, siltstone, dolomitic marble, argillite, garnet-amphibole schist (iron formation), pyritic argillite, greywacke and interlayered greywacke and green phyllite, and Churchill quartzite.

METAMORPHISM

The area is characterized by regional upper greenschist to middle amphibolite facies metamorphism. Contact metamorphism is in evidence along the north and south margins of the domain.

STRUCTURE

Schledewitz (1986) grouped the structure of the Great Island Domain into three areas: 1) Tadoule-Wither Lake folds; 2) Great Island basin structure; and 3) fold structures south and east of the Great Island Basin.

In the Tadoule-Wither Lake area Great Island Group rocks are deformed by east- to northeast-trending folds (F_1). Primary layering is highly attenuated and boudinaged. A zone of cataclastic aplite and remobilized basement rock truncates the north flank of an F_1 synform along Seal River to the west of Great Island. This zone delineates the boundary between the Great Island Domain and the Seal River Domain. The F_1 folds are terminated to the east and separated from the Great Island basin by quartz monzonite and a northwest-trending shear zone. The Great Island basin is interpreted as a complex system of basins and domes that formed as a result of F_2 folds that deformed earlier F_1 folds about north- to northwest-trending fold axes. South and east of the Great Island basin deformation produced east-trending F_1 folds that predate the intrusion of a younger phase of shearing, faulting and associated F_2 folds.

MINERALIZATION

Gold mineralization was first reported in the area by Johnson (1936) on the north channel of the Seal River, 4.8 km downstream from the west end of Great Island (Fig. 45, location SR1). A 9.2 m wide shear zone contains numerous quartz stringers and pyrite that returned traces of gold when assayed.

Milligan (1955) reported a second occurrence 19 km to the east (Fig. 45, location SR2). A grab sample of a quartz vein in garnet amphibolite schist contained trace amounts of gold. Diamond drilling carried out in the area in the 1950's did not intersect any significant mineralization; however, holes drilled just southwest of Great Island intersected sulphides, including arsenopyrite (Manitoba Mines Branch, Non-confidential Assessment Files 90180-90185).

Manitoba Mineral Resources Ltd. carried out a base metal exploration program in the lower Seal River area from 1975 to 1979. A sample from diamond-drill hole 133-24 assayed 4.11 g/tonne (0.12 oz/ton) gold from 41.79 to 43.19 m and 3.77 g/tonne (0.11 oz/ton) gold from 43.62 to 45.14 m (Fig. 45, location SR3). The mineralized section is composed of dacite tuff with numerous siliceous laminae and massive bands of pyrrhotite (Manitoba Mines Branch, Non-confidential Assessment File 92117).

Dredge and Nielsen (1986) reanalyzed 26 till samples that were collected during the course of geological mapping of Quaternary deposits and these were found to have anomalous arsenic values. They reported that gold values well above 5 ppb were detected in six of these samples (Fig. 45). In 1986 additional till sampling was undertaken in the area of the highest anomaly, 5 km east of Great Island, to determine its source. A well defined dispersion train was defined using arsenic and gold analyses of the less than 2 micron fraction and less than 63 micron fraction (Nielsen, 1987). The source of the anomaly appears to be a mineralized outcrop located at the up-ice end of the dispersion train.

In 1986 two permits to explore for minerals were granted in the Great Island area. The first, which covers an area of 48 851 hectares north of Great Island, was held by R.A. Dickinson and was being explored by joint venture partners High D'Or Developments Ltd. and North American Metals Corp. Reconnaissance geological and geochemical surveys undertaken during the summer of 1986 located stratabound arsenopyrite-rich gold mineralization associated with chemically precipitated sediments and intermediate volcanic tuffs (Northwest Prospector Miners and Developers

Bulletin, February/March, 1987). Samples of mineralization from very sparse outcrop returned assays of up to 19.89 g/tonne (0.58 oz/ton) gold. Diamond drilling commenced on the property in February 1987. The second permit covering an area of 40 488 hectares northeast of Great Island, was held by Kidd Creek Mines Limited.

In 1987 Falconbridge Ltd. flew an airborne survey over their Kid Creek Permit in the area and followed up with a ground reconnaissance survey. Continental Gold Corporation (formerly High D'Or Developments Ltd.) completed ground geophysical programs, eleven drillholes (1685 m) and lake sediment geochemistry on their permit (Manitoba Energy and Mines 1987 Exploration Summary). In 1988 Falconbridge conducted a basal till sampling program and Pacific Sentinel Gold Corp, with Homestake Mineral Development Company, carried out a geophysical survey with follow-up drilling on Continental's permit. Homestake had earlier made an agreement with Pacific Sentinel to earn 60% in the property by spending $2.1 million by January 1993. Homestake's drilling tested a 4.5 km long gold-bearing iron formation horizon which had returned drill intersections of up to 9.5 g/tonne (0.28 oz/ton) gold over 1.8 metres. Geophysical surveys conducted during January 1988 indicated that the iron formation is highly folded and faulted. In the first half of 1988 Homestake drilled 11 holes (2004 m) in their 28 claims (5248 hectares) "Polar Gold" property on the Seal River. The best intersection was 1.03 g/tonne (0.03 oz/ton) gold over 1 metre. The iron formation commonly contained slightly elevated gold values.

Little or no exploration activity has occurred in this area since 1988. In 1991 the 260 km length of the Seal River plus 1 kilometer on either side of the river was designated a Heritage River by the Manitoba and Federal Governments. However, this designation does not necessarily restrict mining or mineral exploration in this area; these activities are only subject to land uses established under a provincially designated management plan. The development of mining land use conditions appropriate for the Seal River Heritage area would be developed through dialogue between the Federal Government, Manitoba Energy and Mines and the mining sector.

Selected Bibliography: Dredge and Nielsen (1986); Johnson (1936); Milligan (1955); Nielsen (1987) Northern Miner March 7, 1988; Pacific Sentinel Gold Corp,. Release March 10, 1988; Manitoba Energy and Mines Assessment Report 93536; Manitoba Energy and Mines 1988 Exploration Summary; Schledewitz (1986).

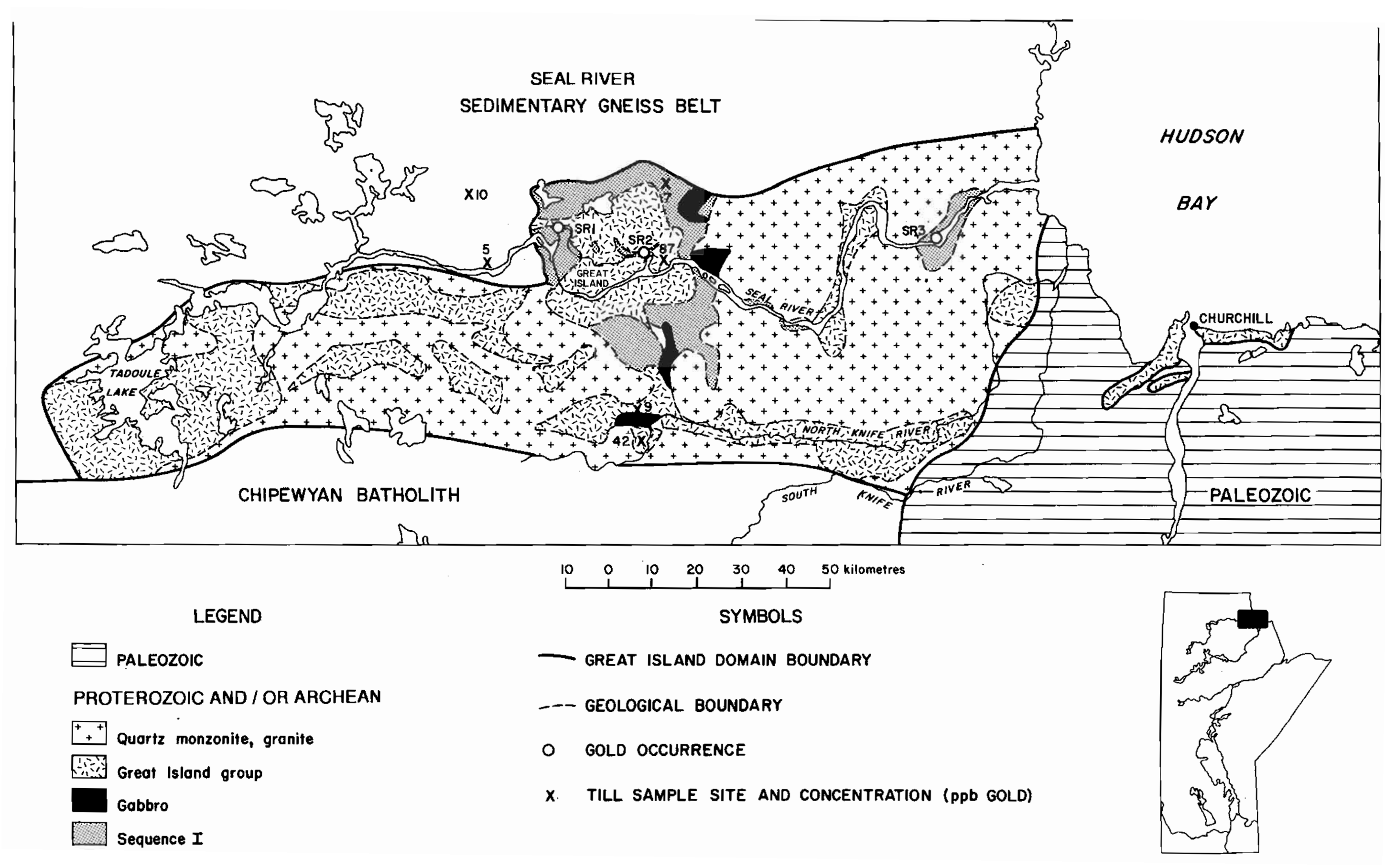


Figure 45: Geology of the Seal River area (after Schledewitz, 1986)

REFERENCES

Alcock, E.J.
- 1920a: Cross-Pipestone map-area, Manitoba; in Geological Survey of Canada, Summary Report 1919, Part D.
- 1920b: The Reed-Wekusko Map-area Northern Manitoba; Geological Survey of Canada, Memoir 119, 47p.
- 1919: Wekusko Lake area, Manitoba; in Geological Survey of Canada, Summary Report, 1918, Part D, p. 9-10.

Ames, D.E.
- 1988: Stratigraphy and alteration of gabbroic rocks near the San Antonio gold mine, in the Rice Lake area, southeastern Manitoba; unpiblished M.Sc. thesis, Department of Earth Sciences, Carleton University, Ottawa.

Ames, D.E., Franklin, J.M. and Froese, E.
- 1991 : Zonation of hydrothermal alteration at the San Antonio gold mine, Bissett, Manitoba; Economic Geology, v. 86, p. 600-619.

Amukun, S.E.
- 1969: Petrology of the gold-bearing vein rocks from Manitoba; University of Manitoba, unpublished M.Sc. thesis, 136 p.

Ansdell, K.M.
- 1993: U-Pb zircon constraints on the timing and provenance of fluvial sedimentary rocks in the Flin Flon and Athapapuskow basins, Flin Flon Domain, Trans-Hudson Orogen,Manitoba and Saskatchewan; in Radiogenic Age and Isotopic Studies: Report 7, Geological Survey of Canada, Paper 93-2, p. 49-57.

Ansdell, K.M. and Norman, A.R.
- 1995: U-Pb geochronlogy and tectonic development of the southern flank of the Kisseynew domain, Trans-Hudson Orogen, Canada; Precambrian Research, vol. 72, p. 147-167.

Ansdell, K.M., Kyser, T.K., Stauffer, M. and Edwards, G.
- 1992: Age and source of detrital zircons from the Missi Group: a Proterozoic molasse deposit, Trans-Hudson Orogen, Canada; Canadian Journal of Earth Sciences, v. 29, p. 2583-2594.

Ansdell, K.M., Lucas, S.B., Connors, K. and Stern, R.A.
- 1995: Kisseynew metasedimentary gneiss belt, Trans-Hudson orogen (Canada): Back-arc origin and collisional inversion; Geology, v. 23, p. 1039-1043.

Armstrong, P.
- 1922: Geology and ore deposits of Elbow Lake area, northern Manitoba; in Geological Survey of Canada, Summary Report 1922, Part C., p. 37-44.

Ashton, K.E. and Froese, E.
- 1988: Could the Sherridon Group at Sherridon be a high-grade equivalent of the Amisk Group? in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1988, p. 183-184

Ashton, K.E. and Lewry, J.F.
- 1994: Vergence of the “Pelican Slide” and Sturgeon-weir Shear Zone; in Trans-Hudson Orogen Transect, LITHOPROBE Report 38, p. 12-17.

Audet, M.
- 1983: Geology and mineralization of the Dot Lake property, Lynn Lake area, Manitoba; unpublished B.Sc. thesis, Queen’s University, 62 p.

Augsten, B.E.K.
- 1985: Ore mineralogy of the Agassiz stratiform gold deposit, Lynn Lake region, Manitoba; Carleton University, unpublished B.Sc. thesis, 36 p.

Augsten, B.E.K., Thorpe, R.I., Harris, D.C. and Fedikow. M.A.F.
- 1986: Ore mineralogy of the Agassiz (MacLellan) gold deposit in the Lynn Lake region, Manitoba; Canadian Mineralogist, v. 24, p. 369-377.

Bailes, A.H.
- 1980: Geology of the File Lake area; Manitoba Mineral Resources Division, Geological Report 78-1, 134 p.
- 1975: Geology of the Guay-Wimapedi Lakes area; Manitoba Mineral Resources Division, Publication 75-2.
- 1971 : Preliminary compilation of the geology of the Snow Lake-Flin Flon Sherridon area; Manitoba Mines Branch, Geological Paper 1/71,27 p.
- 1969: Geology and geochemistry of the Pilot-Smuggler shear zone, Rice Lake area, Manitoba; University of Manitoba, unpublished M.Sc. thesis.

Bailes, AH. and Galley, A.G.
- 1996: Setting of Paleoproterozoic volcanic-hosted massive sulphide deposits, Snow Lake; in EXTECH I, A multidisciplinary approach to massive sulphide research: Rusty Lake-Snow Lake greenstone belt, Manitoba, (ed.) G.E Bonham-Carter, A.G. Galley and G.E.M. Hall,: Geological Survey of Canada Bulletin, p.105-138.

Bailes, A.H. and McRitchie, W.D.
- 1978: The transition from low to high grade metamorphism in the Kisseynew sedimentary gneiss belt, Manitoba; in Metamorphism in the Canadian Shield (A Fraser and W.W. Heywood, eds.); Geological Survey of Canada, Paper 78-10, p. 155-177.

Bailes, A.H. and Syme, E.C.
- 1989: Geology of the Flin Flon - White Lake area; Manitoba Energy and Mines, Geological Report GR87-1, 313 p.
- 1984: Geological investigations in the Flin Flon area; in Manitoba Energy and Mines, Mineral Resources Division, Report of Field Activities 1984, Report GS-11, p. 37.
- 1983: Flin Flon-Schist Lake project (parts of 63/K/12, 13); in Manitoba Department of Energy and Mines, Mineral Resources Division, Report of Field Activities 1983, Report GS-5, p.15-22.

1980: White Lake-Mikanagan Lake project (parts of 63K/12 and 13); in Manitoba Mineral Resources Division, Report of Field Activities 1980, Report GS-9, p. 43-50.

Bailes, A.H., Syme, E.C., Galley, A.G. and Skirrow, R.G.
1987: Early Proterozoic volcanism, hydrothermal activity and associated ore deposits at Flin Flon and Snow Lake, Manitoba; Field trip guidebook, Geological Association of Canada/Mineralogical Association of Canada, Joint Annual Meeting, Saskatoon, Saskatchewan.

Baker, W.F.
1935: Geology of God's Lake Gold Mines Limited; Transactions of the Canadian Institute of Mining and Metallurgy, v. 38, p. 155-162.

Baldwin, D.A.
1989: Mineral deposits and occurrences in the Lynn Lake area, NTS 64C/14; Manitoba Energy and Mines, Mineral Deposit Series Report 6.
1983: Stratigraphic studies of felsic volcanic rocks associated with mineral occurrences in the Lynn Lake area, Manitoba; in Manitoba Department of Energy and Mines, Mineral Resources Division, Report of Field Activities, 1983, p. 88-93.
1980: Porphyritic intrusions and related mineralization in the Flin Flon volcanic belt; Manitoba Mineral Resources Division, Economic Geology Report ER79-4, 23 p.

Baldwin, D.A., Frohlinger, T.G., Kendrick, G., McRitchie, W.D. and Zwanzig, H.V.
1979: Geology of the Nelson House-Pukatawagan region (Burntwood Project); Manitoba Mineral Resources Division, Geological Maps 78-3-1 to 78-3-22.

Baldwin, D.A., Parbery, D., Boden, S. and Michielsen, A.
1985: Mineral deposit studies in the Lynn Lake and Barrington Lake areas; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities 1985, Report GS-24, p. 20-28.

Baragar, W.R.A. and Scoates, R.F.J.
1981: The circum-Superior belt: A Proterozoic plate margin?; in Precambrian Plate Tectonics, (A. Kroner, ed.); Elsevier Science Publishing Co. Inc., 782 p.

Barry, G.S.
1965: Geology of the Trophy Lake Area (east halt); Manitoba Mines Branch, Publication 63-3, 47 1961: Geology of the Gods Narrows area; Manitoba Mines Branch, Publication 60-1,33 p.
1959: Geology of the Oxford House-Knee Lake area, Oxford Lake and Gods Lake Mining Divisions; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 58-3,39 p.

Bateman, J.D.
1945: McVeigh Lake area, Manitoba; Geological Survey of Canada, Paper 45-14, 34 p.

Bateman, J.D. and Harrison, J.M.
1946: Sherridon, Manitoba; Geological Survey of Canada, Map 862A with descriptive notes.
1945: Mikanagan Lake, Manitoba; Geological Survey of Canada, Map 832A with descriptive notes. Bell, C.K.
1971: History of the Superior-Churchill boundary in Manitoba; Geological Association of Canada, Special Paper, No. 9, p. 11-39.
1962: Cross Lake map-area, Manitoba; Geological Survey of Canada, Paper 61-22. 22 p.

Bernier L.R. and Maclean, W.H.
1989: Auriferous chert, banded iron formation, and related volcanogenic hydrothermal alteration, Atik Lake, Manitoba; Canadian Journal of Earth Sciences, vol. 26, p. 2676-2690

Blackburn, C.E. and Janes, D.A
1983: Gold deposits in Northwestern Ontario, AC. Colvine, ed., O.G.S. Misc. Paper 110, 278 p.

Blackburn, C.E., Johns, G.W, Ayer, J. and Davis. D.W
1991: Wabigoon Subprovince; in Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 1, p. 303-382.

Bleeker, W.
1991: Structural-metamorphic history of the Thompson Nickel Belt; Ph.D. thesis, University of New Brunswick
1990a: New structural-metamorphic constraints on Early Proterozoic oblique collision along the Thompson Nickel belt, Manitoba, Canada; in The Early Proterozoic Trans-Hudson Orogen of North America (J.F. Lewry and M.R. Stauffer, eds.); Geological Association of Canada, Special Paper 37, p. 57-73.
1990b: Thompson area-general geology and ore deposits; in Galley, AG., Bailes, AH., Syme, E.C., Bleeker, W, Macek, J.J. and Gordon, T.M.: Geology and Mineral deposits of the Flin Flon and Thompson belts, Manitoba, 8th IAGOD Symposium field trip guidebook, Geological Survey of Canada, Open File 2165, p. 93-136.

Brommecker, R.
1991: The structural setting of gold occurrences in the S.E. Rice Lake greenstone belt, S.E. Manitoba; unpublished M.Sc. thesis, Queen's University, 267p.

Brommecker, R., Scoates, R.F.J. and Poulsen, K.H.
1993: Komatiites in the Garner Lake-Beresford Lake area: implications for tectonics and gold metallogeny of the Rice Lake greenstone belt, S.E. Manitoba; in Current Research, Part C; Geological Survey of Canada, Paper 93-1, p.259-264.

Brooks, C., Ludden, J., Pigeon, Y. and Hubregtse, J.J.M.W
1982: Volcanism of shoshonitic to high-K andesite affinity in an Archean arc environment, Oxford Lake, Manitoba; Canadian Journal of Earth Sciences, vol.19, p. 55-67.

Brownell, S.M.
1941: Geology of the Falcon Lake Stock, southeastern Manitoba; Canadian Institute of Mining and Metallurgy Transactions, 44, p. 230-250
1931: Report on the Gem Lake Mines Limited; Manitoba Energy and Mines, Mines Branch, Corporation File, Gem Lake Mines Limited.

Bruce, E.L.
1919: Gold-quartz veins and scheelite deposits in southeastern Manitoba; in Geological Survey of Canada, Summary Report, 1918, Part D, p. 2-5.

1918: Amisk-Athapapuskow Lake district; Geological Survey of Canada, Memoir 105, 91 p.

1916: Amisk-Athapapuskow Lake area, northern Saskatchewan and northern Manitoba; Geological Survey of Canada, Department of Mines, Summary Report, 1915, p. 130.

Campbell, F.H.A.

1971: Stratigraphy and sedimentation of part of the Rice Lake group, Manitoba; in Geology and Geophysics of the Rice Lake region, Southeastern Manitoba (W.D. McRitchie and W. Weber, eds.); Manitoba Department of Mines and Natural Resources, Mines Branch, Geological Paper GP71-1, p. 135-183.

Chastko, L.C.

1986: Summary of 1985-86 exploration and development and a proposal for continued exploration of the Whiteshell mineral claim, Star Lake, Manitoba. Internal report, Whiteshell Ventures Limited.

Clark, G.S. and Cheung, S.P.

1977: Rubidium-strontium whole-rock ages from the Oxford Lake-Knee Lake greenstone belt, northeastern Manitoba; University of Manitoba, Centre for Precambrian Studies, Annual Report, 1977, p. 106-121.

Cole, G.E.

1927: The development in gold mining in Canada; Second (Triennial) Empire Mining and Metallurgical Congress, Winnipeg, p. 63-64.

1942: Manitoba Energy and Mines, Mines Branch, Unpublished Information File (63J/13).

Connors, K.A.

1996: Unraveling the boundary between turbidites of the Kisseynew Domain and volcano-plutonic rocks of the Flin Flon domain in the eastern Trans-Hudson Orogen, Canada; Canadian Journal of Earth Sciences (in press).

Connors, K. A and Ansdell, K. M.

1994: Timing and significance of thrust faulting along the boundary between the Flin Flon and Kisseynew Domains, eastern Trans-Hudson Orogen; in Z. Hajnal and J. Lewry (Editors), Report of 1994 THOT Transect Meeting. LITHOPROBE Report 38, p. 112-122.

Cooke, H.C.

1921 : Geology and mineral resources of Rice Lake and Oiseau River areas, Manitoba; in Geological Survey of Canada, Summary Report, 1921, Part C, p. 33.

Corfu, F. and Andrews, AJ.

1987: Geological constraints on the timing of magmatism, deformation, and gold mineralization in the Red Lake greenstone belt, northwestern Ontario. Can. Jour. Earth Science, v. 24, p.1302-1320.

Corfu, F. and Davis, D.W.

1992: A U-Pb geochronological framework for the western Superior Province, Ontario; in Geology of Ontario; Ontario Geological Survey, Special Volume 4, Part 2, p.1335-1346.

Corkery, M.T.

1986: Butterfly area; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1986, p. 143-146.

1985a: Cross Lake supracrustal investigation in the eastern Pipestone Lake area; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities 1985, Report GS-32, p. 165-172.

1985b: Geology of the lower Nelson River project area; Manitoba Energy and Mines, Geological Services, Geological Report GR82-1, 66 p.

1983: Cross Lake supracrustal investigation; in Manitoba Mineral Resources Division, Report on Field Activities, 1983, Report GS-7, p. 32-45.

1981: Little Stull Lake area; in Manitoba Department of Energy and Mines, Mineral resources Division, Report of Field Activities, 1981, p. 43-44.

Corkery, M.T., Davis, D.M. and Lenton, P.G.

1992: Geochronological constraints on the development of the Cross Lake greenstone belt, northwest Superior Province, Manitoba; Canadian Journal of Earth Sciences, vol. 29, number 10, p. 2171-2185.

Corkery, M.T. and Lenton, P.G.

1989: Cross Lake supracrustal geological investigations; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1989, p. 88-90.

1984: Cross Lake supracrustal investigations; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities 1984, Report GS-28, p. 107-109.

Corkery, M.T., Lenton, P.G., Breedveld, M. and Davis, D.M.

1988: Cross Lake geological investigations; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1988, p. 106-110.

Cumming, G.L., Eckstrand, O.A. and Peredery, W.V.

1982: Geochronologic interpretations of Pb isotope ratios in nickel sulfides of the Thompson belt, Manitoba; Canadian Journal of Earth Sciences, v. 19, p. 2306-2324.

Dahlstrom, C.D.A

1949: Report on the Farley Lake group; Manitoba Energy and Mines, Mines Branch, Non-confidential Assessment File (91041).

David, J., Bailes, A.H. and Machado, N.

1996: Evolution of the Snow Lake portion of the Paleoproterozoic Flin Flon and Kisseynew belts, Trans-Hudson Orogen, Manitoba, Canada; Precambrian Research, in press.

David, J., Machado, N. and Zwanzig, H.V.

1993: U-Pb geochronology of the south flank of the Kisseynew Gneiss Belt, Kississing-Batty Lakes area; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1993, p. 38-41.

Davies, J.C. and Smith, P.M.

1988: The geological setting of gold occurrences in the Lake of the Woods area, Kenora District; Ontario Geological Survey, Open File report 5695, 381 p.

Davies, J.F.

1963: Geology and gold deposits of the Rice Lake-Wanipigow River area, Manitoba; University of Toronto, unpublished Ph. D. thesis, 142 p.

1954: Geology of the West Hawk Lake-Falcon Lake area; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 53-4, 28 p.
1953: Geology and gold deposits of southern Rice Lake area; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 52-1, 41 p.
1950: Geology of the Wanipigow area; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 49-3, 21 p.
1949: Geology of the Wanipigow Lake area; Manitoba Department of Mines and Natural Resources, Mines Branch, Preliminary Report 48-2, 14 p.

Davies, J.F., Bannatyne, B.B., Barry, G.S. and McCabe, H.R.
1962: Geology and mineral resources of Manitoba; Manitoba Department of Mines and Natural Resources, Mines Branch, MRD 2, 190 p.

Davis, W.D. and Smith, P.M.
1991: Archean gold mineralization in the Wabigoon Subprovince, a product of crustal accretion: evidence from U-Pb geochronology in the Lake of the Woods area, Superior Province, Canada; Journal of Geology, vol. 99, p.337-353.

Dawson, C.B.
1937: Gurney Gold Mines Limited; Manitoba Energy and Mines, Mines Branch, Corporation File, Gurney Gold Mines Limited.
1950: Report on the property of Falnora Gold Mines Limited; Manitoba Department of Energy and Mines, Mines Branch, Non-confidential Assessment File (91070).

Delaney, G.D.
1976: A reconnaissance study of the metamorphic petrology and volcanic geochemistry of a portion of the Island Lake greenstone belt, Manitoba; unpublished. M.Sc. thesis, Carleton University, Ottawa, Ontario, 171 p.

DeLury, J.S.
1927: The mineral resources of southeastern Manitoba, Rice Lake district, Oiseau River district and Boundary district; Industrial Development Board of Manitoba, 55 p.
1921: Mineral prospects in southeastern Manitoba; Manitoba Bulletin, p. 22-23.
1920: Mineral prospects in southeast Manitoba, Rice Lake, Maskwa River, and Boundary districts; Manitoba Government Bulletin, p. 33.

De Wet, J.P.
1936: Mining in Manitoba during 1935; in Canadian Mining Journal, February 1936, p. 77-78.

Diamond, L.W
1989: Fluid inclusion composition in Archean shear-hosted gold-quartz veins of the Rice Lake-Bissett district, Uchi Subprovince, S.E. Manitoba: consequences for ore genesis and exploration; in Geological Association of Canada/ Mineralogical Association of Canada Annual Meeting 1989, Program with Abstract, v. 14, p. A119

Diamond, L.W, Marshall, D.O., Jackman, J.A. and Skippen, G.
1989: Elemental analysis of individual fluid inclusions by Secondary Mass Spectrometry (SIMS): application to cation ratios in an Archean mesothermal gold-quartz vein; Geochemica Cosmochemica Acta, v. 23, p. 26-76.

Dix, W.F.
1951: Geology of the Gods Lake area; Manitoba Mines Branch, Publication 47-4, 7 p.

Downie, D.L.
1936: Stull Lake, east half sheet, Map 451A, Geological Survey of Canada, scale 1 inch to 4 miles.

Dredge, L.A. and Nielsen, E.
1986: Gold concentrations in till, Great Island, northern Manitoba; in Current Research, Part A, Geological Survey of Canada, Paper 86-1 A, p. 779-782.

Dresser, J. A.
1917: Gold bearing districts of southeastern Manitoba; in Geological Survey of Canada, Summary Report 1916, p. 169-174.

Eakins, P.R.
1949: Geology of the Jeep Mine, Rice Lake area, southeastern Manitoba; McGill University, unpublished M.Sc. thesis, 28 p.

Eastwood, M.
1996: Summary of the geology, mineralization and reserves of the Burnt Timber gold deposit, Lynn Lake area, Manitoba; Granduc Mining Corporation unpublished report, 4 p.

Ebbutt, F.
1944: The Nor-Acme property of the Howe Sound Exploration Company; The Precambrian, v. 17, no. 7, p. 6-11.

Eccles, D.R. and Fedikow, M.A.F.
1985: Mineral occurrence documentation and alteration zone mapping, Snow Lake area; in Manitoba Department of Energy and Mines, Mineral Resources Division, Report of Field Activities 1985, Report GS-20, p. 82-99.

Elphick, S.C.
1972: Geology of the Mynarski-Notigi Lakes Area; Manitoba Department of Mines, Resources and Environmental Management, Mines Branch, Publication 71-2C, 48 p.

Ermanovics, I.F.
1981: Geology of the Manigotagan area, Manitoba; Geological Survey of Canada, Paper 80-26, 14p.
1970: Precambrian geology of Hecla-Carroll Lake map area, Manitoba-Ontario; Geological Survey of Canada, Paper 69-42,33 p.

Ermanovics, I.F. and Wanless, R.K.
1983: Isotopic age studies and tectonic interpretation of Superior Province in Manitoba; Geological Survey of Canada, Paper 82-12, 22 p.

Fedikow, M.A.F.
1986a: Geology of the Agassiz stratabound Au-Ag deposit, Lynn Lake, Manitoba; Manitoba Energy and Mines, Geological Services, Open File Report OF85-5, 79 p.
1986b: The Agassiz metallotect-Spider Lake area; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report GS-5, p. 23-25.
1986c: Manitoba Energy and Mines, Minerals Division, Open House, November 19-20, Winnipeg, Manitoba, Poster Display.

1984: Preliminary results of biogeochemical studies in the Lynn Lake area; Manitoba Department of Energy and Mines, Mineral Resources Division, Open File Report OF84-1, 104 p.

1983: Geological and geochemical investigations at the Agassiz Au-Ag deposit, Lynn Lake, Manitoba; in Manitoba Department of Energy and Mines, Geological Services Branch, Report of Field Activities 1983, Report GS-15, p. 94-97.

1981: Mineral deposit studies-Superior Province-Southeastern Manitoba; in Manitoba Department of Energy and Mines, Mineral Resources Division, Report of Field Activities 1981, Report GS-15, p. 64-73.

Fedikow, M.A.F., Athayde, P., and Galley, A.G.

1993: Mineral deposits and occurrences in the Wekusko Lake area, NTS 63J/13; Manitoba Energy and Mines, Geological Services, Mineral Deposit Series, Report No. 14, 460 p.

Fedikow, M.A.F., Baldwin, D.A. and Taylor, C.

1986a: Gold mineralization associated with the Agassiz metallotect and the Johnson Shear Zone, Lynn Lake greenstone belt, Manitoba; in Gold in the Western Shield Symposium (L.A. Clark, ed.); Canadian Institute of Mining and Metallurgy, Special Volume 38, 1986, p. 361-377.

Fedikow, M.A.F., Ferreira, K.J. and Baldwin, D.A.

1991: The Johnson shear zone-A regional metallogenic feature in the Lynn Lake area; Manitoba Energy and Mines, Mineral Deposit Thematic Map Series, Map 91-1, 1:50 000

Fedikow, M.A.F. and Gale, G.H.

1982: Mineral deposit studies in the Lynn Lake area; in Manitoba Department of Energy and Mines, Geological Services Branch, Report of Field Activities 1982, Report GS-8, p. 58-59.

Fedikow, M.A.F., Kramarchuk, B. and Charlesworth, R.B.

1984: Geochemical studies along the Agassiz metallotect; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities 1984, Report GS-9, p. 29-31.

Fedikow, M.A.F., Ostry, G., Ferreira, K.J. and Galley, A.G.

1989: Mineral deposits and occurrences in the File Lake area, NTS 63K116; Manitoba Energy and Mines, Geological Services, Mineral Deposit Series, Report No.5, 277 p.

Fedikow, M.A.F., Parbery, D. and Ferreira, K.J.

1990: Agassiz metallotect-A regional metallogenic concept, Lynn Lake area; Manitoba Energy and Mines, Mineral Deposit Thematic Map series, Map 89-1, 1:50 000.

1991: Geochemical target selection along the Agassiz Metallotect utilizing stepwise discriminant function analysis; Economic Geology, vol. 86, p. 585-599.

Fedikow, M.A.F., Roney, C.T., Schmidt, G.J. and Robbie, T.J.

1986b: Mineral deposit studies in the Snow Lake area; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report GS-16, p. 77-85.

Fedorowich, J., Stauffer, M. and Kerrich R.

1991: Structural setting and fluid characteristics of the Proterozoic Tartan Lake gold deposit, Trans-Hudson orogen, northern Manitoba: Economic Geology, vol. 86, p. 1434-1467.

Fedorowich, J.S., Kerrich, R. and Stauffer, M.R.

1995: Geodynamic evolution and thermal history of the central Flin Flon Domain, Trans-Hudson Orogen: constraints from structural development, $^{40}Ar/^{39}Ar$, and stable isotope geothermometry; Tectonics, v. 14, p. 472-503.

1993: $^{40}Ar/^{39}Ar$ constraints on the timing of metamorphism, sequential shear zone development, and gold mineralization in the Flin Flon domain during the Trans Hudson orogeny; in Geological Association of Canada/ Mineralogical Association of Canada Annual Meeting 1993, Program and Abstract, v. 18, p. A-29.

Ferreira, K.

1986a: Geological investigations in the Sheila Lake-Margaret Lake area; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report GS-2, p. 13-17.

1986b: Geological investigations in the Foster Lake-Wasekwan Lake area; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report, GS-3, p. 13-17.

Ferreira, K.J. and Baldwin, D.A.

1996: Mineral deposits and occurrences in the Cockeram Lake area, NTS 64C/15; Manitoba Energy and Mines, Mineral Deposit Series Report 8.

Fingler, J.L.

1991 : Precious metal mineralization related to the Falcon Lake Intrusive Complex, southeastern Manitoba; unpublished M. Sc. thesis, University of Manitoba, 145 p.

Fountain, D.M. and Salisbury, M.H.

1981: Exposed cross-sections through the continental crust: implications for crustal structure, petrology, and evolution; in Earth and Planetary Science Letters, no. 56, p. 263-277.

Fox, J.S.

1976: Some comments on the volcanic stratigraphy and economic potential of the West Amisk Lake area, Saskatchewan; Geological Association of Canada/ Mineralogical Association of Canada, Annual Meeting, Edmonton, Program with Abstracts.

Franklin, J.M. and Thorpe, R.I.

1982: Comparative metallogeny of the Superior, Slave and Churchill Provinces; in Precambrian Sulphide Deposits, H.S. Robinson Memorial Volume (R.W. Hutchinson, C.D. Spence and J.M. Franklin, eds.); Geological Association of Canada, Special Paper 25, p. 3-90.

French, A.G.

1915: Penniac Reef Gold Mines Ltd.; Manitoba Energy and Mines, Corporation File, Penniac Reef Gold Mines, Ltd.

Froese, E. and Gasparrini, E.

1975: Metamorphic zones in the Snow Lake area, Manitoba; Canadian Mineralogist, v. 13, p. 162-167.

Froese, E. and Goetz, P.A.

1981: Geology of the Sherridon Group in the vicinity of Sherridon, Manitoba; Geological Survey of Canada, Paper 80-21.

Froese, E. and Moore, J.M.

1980: Metamorphism in the Snow Lake area, Manitoba; Geological Survey of Canada, Paper 78-27, 16 p.

Fyon, J.A., Crocket, J.H. and Schwartz, H.P.
1983: The Carshaw and Malga iron-formation-hosted gold deposits of the Timmins area; in The Geology of Gold in Ontario; Ontario Geological Survey, Miscellaneous Paper 110, p. 98-110.

Gaba, R.G.
1985: Mineral deposit investigations in the Wallace Lake-Siderock Lake area; in Manitoba Energy and Mines, Report of Field Activities, 1985, Report GS-29, p. 148-151.
1984: Geology of the Gatlan area, Wallace Lake; Manitoba Energy and Mines, Geological Services Branch, Preliminary Map 1984R-2.

Gaba R.G. and Theyer, P.
1984: The Gatlan gold occurrence, Wallace Lake; in Manitoba Energy and Mines, Mineral Resources Division, Report of Field Activities 1984, pp. 100-101.

Gagnon J.E.
1991: Geology, geochemistry, and genesis of the Proterozoic MacLellan Au-Ag deposit, Lynn Lake greenstone belt, Manitoba; unpublished M.Sc. thesis, University of Windsor, 275 p.

Gale, G.H.
1981: Mineral deposit studies in the Flin Flon area; in Manitoba Department of Energy and Mines, Mineral Resources Division; Report of Field Activities 1981, Report GS-12, p. 45-51.

Gale, G.H., Baldwin, D.A. and Koo, J.
1980: A geological evaluation of Precambrian massive sulphide deposit potential in Manitoba; Manitoba Department of Energy and Mines, Mineral Resources Division, Economic Geology Report ER79-1, 137 p.

Gale, G.H. and Ostry, G.
1984: Stratabound gold mineralization in the Kisseynew gneiss terrain; in Manitoba Energy and Mines, Mineral Resources, Report of Field Activities 1984, Report GS-18, p. 73-80.

Galley, A.G., Ames, D.E. and Franklin, J.M.
1989: Results of studies on gold metallogeny of the Flin Flon belt; in Geological Survey of Canada, Open File 2133, p. 25-32.
1985: Preliminary investigations of gold mineralization in the Flin Flon-Snow Lake belt, Manitoba and Saskatchewan; in Current Research, Part A, Geological Survey of Canada, Paper 85-1A, p. 761-771.

Galley, A.G., Ziehlke, D.V., Franklin, J.M., Ames, D.E. and Gordon, T.M.
1986: Gold mineralization in the Snow Lake-Wekusko Lake region, Manitoba; in Gold in the Western Shield (L.A Clark, ed.); Canadian Institute of Mining and Metallurgy, Special Volume 38, p. 379-398.

Gibb, R.A.
1983: A model for suturing of Superior and Churchill plates: an example of double indentation tectonics; Geology, v. 11, p. 413-417.

Gibb, R.A. and Walcott, R.I.
1971: A Precambrian suture in the Canadian Shield; in Earth and Planetary Science Letters, No. 262, p. 417-422.
1971: Geology of the Falcon Lake stock, southeastern Manitoba; in Geological Association of Canada, Special Paper Number 9, p. 129-135.

Gibson, J.C. and Stockwell, C.H.
1948: San Antonio Mine; in Structural Geology of Canadian Ore Deposits, Canadian Institute of Mining and Metallurgy Symposium, p. 315-321.

Gilbert. H.P.
1985a: Geological investigation in the Island Lake-Stevenson Lake area; in Manitoba Energy and Mines, Geological Services, Report of Field Activities 1985, Report GS-38, p. 187-199.
1985b: Geology of the Knee Lake-Gods Lake area; Manitoba Energy and Mines, Geological Services, Geological Report GR83-1 B, 76 p.
1984: Island Lake project; in Manitoba Energy and Mines, Mineral Resources, Report of Field Activities, 1984, p. 120-125.

Gilbert, H.P. and Weber W.
1983: Island Lake project; in Manitoba Department of Energy and Mines, Mineral Resources Division, Report of Field activities, 1983, p. 63-69.

Gilbert, H.P., Syme, E.C. and Zwanzig, H.V.
1980: Geology of the metavolcanic and volcaniclastic metasedimentary rocks in the Lynn Lake area; Manitoba Energy and Mines, Mineral Resources Division, Geological Paper GP80-1, 118 p.

Godard, J.D.
1963: Geology of the Island Lake-York Lake area; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 59-3, 45 p.

Gonzales, A. and Fedikow, M.
1984: Mineral deposit studies, Snow Lake area; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities 1984, Report GS-13, p. 46-52.

Gordon, T.M.
1981: Metamorphism in the Crowduck Bay area, Manitoba; in Current Research, Part A, Geological Survey of Canada, Paper 81-1A, p. 315-316.

Gordon, T.M. and Gall, Q.
1982: Metamorphism in the Crowduck Bay area, Manitoba; in Current Research, Part A, Geological Survey of Canada, Paper 82-1A, p. 197-201.

Gordon, T.M., Hunt, P.A., Bailes, A.H. and Syme, E.C.
1990: U-Pb zircon ages from the Flin Flon and Kisseynew belts, Manitoba: Chronology of crust formation at an Early Proterozoic accretionary margin; in Lewry, J.E and Stauffer, M.R., eds., The Early Proterozoic Trans-Hudson Orogen of North America; Geological Association of Canada, Special Paper 37, p. 177-199.

Gordon, T.M., Jackson, S.L. and Zaleski, E.
1985: Metamorphic processes in the Kisseynew metasedimentary gneiss belt; in Current Research, Part A, Geological Survey of Canada, Paper 85-1A, Report 62, p. 511-516.

Grant, B.
1987: Report on the fall 1987 exploration at the Long Lake property, southeastern Manitoba; Esso Minerals Canada, Internal Report, Man. 13.C903, p. 147.

Green, A.G., Najnal, Z. and Weber, W
1985: An evolutionary model of the western Churchill Province and western margin of the Superior Province in Canada and the north-central United States; in Tectonophysics, Volume 116, p. 281-322.

Hage, C.O.
1944: Geology of Gurney Gold Mine area, Manitoba; Precambrian, v. 17, no. 4, p. 5-7.

Halwas, D.
1984: The structure of the Sunbeam-Kirkland breccia pipe, southeastern Manitoba; unpublished B.Sc. thesis, University of Manitoba, 56 p.

Hannington, M.D., Peter, J.M., and Scott, S.D.
1986: Gold in sea-floor polymetallic sulfide deposits; Economic Geology, vol. 81, p. 1867-1883.

Harrison, J.M.
1951 a: Possible major structural control of ore deposits, Flin Flon-Snow Lake mineral belt, Manitoba; Canadian Mining and Metallurgy Institute, Transactions, v. 54, p. 4-8.
1951 b: Precambrian correlation and nomenclature, and problems of the Kisseynew gneisses in Manitoba; Geological Survey of Canada, Bulletin 20, 53 p.
1949: Geology and mineral deposits of File-Tramping Lakes area, Manitoba; Geological Survey of Canada, Memoir 250, 92 p.

Haugh, I.
1962: A petrofabric study of the Falcon Lake stock, southern Manitoba; University of Manitoba, unpublished M.Sc. thesis, 85 p.
1969: Geology of the Split Lake area; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 65-2,87 p.

Heaman, L.M., Ashton, K.E., Reilly, B.A., Sibbald, T.I.I., Slimmon, WL., and Thomas, D.J.
1993: 1992-93 U-Pb geochronological investigations in the Trans-Hudson Orogen, Saskatchewan; in Summary of Investigations 1993, Saskatchewan Geological Survey, Saskatchewan Energy and Mines, Miscellaneous Report 93-4, p. 109-111.

Heaman, L.M. and Corkery, M.T.
1996: Proterozoic tectonic evolution of the eastern Trans Hudson margin: Preliminary U-Pb results from the Split Lake block, Manitoba; abstract, geological Association of Canada/Mineralogical Association of Canada, Annual Meeting 1996, Program and Abstracts, vol. 21, p. A43

Heaman, L.M., Machado, N., Krogh, T.E. and Weber, W.
1986: Precise U-Pb zircon ages for the Molson dyke swarm and the Fox River Sill: Constraints for early Proterozoic crustal evolution in northeastern Manitoba, Canada; Contributions to Mineralogy and Petrology, v. 94, p. 82-89.

Herd, R.K. and Ermanovics, I.F.
1976: Geology of Island Lake map area (63E), Manitoba and Ontario; Geological Survey of Canada, Paper 76-1 A, p. 393-398.

Hoffman, P.F.
1989: Precambrian geology and tectonic history of North America; in A.W. Bally and A.R. Palmer (Editors), The geology of North America - an overview, Geological Society of America, Boulder, Co., p. 447-512.
1988: United plates of America, the birth of a craton: Early Proterozoic assembly and growth of Laurentia: Annual Review of Earth and Planetary Sciences, vol. 16, p. 543-603.

Hogg, N.
1957: The Nor-Acme Mine, in Structural Geology of Canadian Ore Deposits; Canadian Institute of Mining and Metallurgy, v. 2, p.262.

Holland, H.D., Feakes, C.R. and Zbinden, E.A.
1989: The Flin Flon paleosol and the composition of the atmosphere 1.8 BYBP; American Journal of Science, v. 289, p. 362-389.

Horwood, H.C.
1934: The Cross Lake map-area, Manitoba; Massachusetts Institute of Technology, unpublished Ph.D. thesis.

Hubregtse, J.J.M.W
1985: Geology of the Oxford Lake-Carrot River area; Manitoba Energy and Mines, Geological Services, Geological Report, GR83-1 A, 73 p.
1978: Chemistry of cyclic subalkaline and younger shoshonitic volcanism in the Knee Lake-Oxford Lake greenstone belt, northeastern Manitoba; Manitoba Department of Mines, Resources and Environmental Management, Mineral resources Division, Geological Paper 78/2, 18 p.

Hunter, H.E.
1953: Geology of the McKnight Lake Area; Manitoba Mines Branch, Publication 52-3, 7 p.

Innes, M.J.S.
1960: Gravity and isostasy in northern Ontario and Manitoba, Geological Survey of Canada, Publications of the Dominion Observatory, Ottawa, XXI(6).

Jackson, S.L. and Gordon, TM.
1985: Metamorphism and structure of the Laurie Lake region, Manitoba; in Current Research, Part A, Geological Survey of Canada, Paper 85-1A, p. 753-759.

Janes, D.A.
1976: Caddy Lake; Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, Preliminary Map 1976F-3, scale 1:50 000.

Jeffrey, W.H.
1912: Report of the Penniac Reef Gold Mines Limited; Manitoba Energy and Mines, Mines Branch, Corporation File, Star Lake Gold Mines, Limited.

Johnston, A.W.
1936: Seal River area, northern Manitoba; Geological Survey of Canada, Paper 35-2, 3 p.

Kaszycki, C.A.
1989: Surficial geology and till composition northwestern Manitoba; Geological Survey of Canada Open File 2118

Keays A.A. and Scott, A.B.
1976: Precious metals in ocean-ridge basalts: implications for basalts as source rocks for gold mineralization; Economic Geology, v. 71, p. 705-720.

Keith, T.L.
1988: The geology of the Long Lake gold prospect, Bissett area, southeastern Manitoba; unpiblished B.Sc. thesis, Queen's University. 64p. including map at 1:1000

Kelley, L.I.
1986: Overview of SherrGold exploration projects Lynn Lake belt; Sherritt Gordon Mines, communication.

Kraus, J. and Menard, T.
1995: Metamorphism of the File Lake formation, Snow Lake: Preliminary Results; in Manitoba Energy and Mines, Minerals Division, Report of Activities, p. 160-163.

Kraus, J. and Williams, P.F.
1995: The tectonometamorphic history of the Snow Lake area, Manitoba, Revisited; in Z. Hajnal and J. Lewry (eds.), Report of 1995 THOT Transect Meeting, LITHOPROBE Report 48, p. 206-212.
1994a: Structure of the Squall Lake area, Snow Lake (NTS 63K/16); in Manitoba Energy and Mines, Mineral Division, Report of Activities, p. 189-193.

Kreczmer, M.J. and Deveaux, P.J.
1986: Exploration and geology of Tartan Lake and Puffy Lake deposits, Flin Flon area, Manitoba; in Gold in the Western Shield (L.A. Clark, ed.); The Canadian Institute of Mining and Metallurgy, Special Volume 38, p. 359-360.

Krogh, T.E., Ermanovics, I.F. and Davis, G.L.
1974: Two episodes of metamorphism and deformation in the Archean rocks of the Canadian Shield; Carnage Institution of Washington, Year Book 73, p. 573-575.

Lamb, C.F.
1975a: Southeastern Manitoba; in Manitoba Mineral Resources Division, Summary of Geological Fieldwork, Geological Paper 2/75, p. 38-39.
1975b: Southeast Manitoba-Revised compilation; Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, Preliminary Map 1975F-8, scale half inch to a mile.

Lau, M.H.S.
1988: Structural Geology of the vein system in the San Antonio Gold Mine, Bissett, Manitoba, Canada; unpiblished M.Sc. thesis, Department of Geological Sciences, University of Manitoba, Winnipeg.

Lenton, P.G.
1981: Geology of the McKnight-McCallum Lakes area, Manitoba Mineral Resources Division, Geological Report GR79-1, 39 p.

Lewry, J.F., Hajnal, Z., Green, A, Lucas, S.B., White, D., Stauffer, M.A., Ashton, K.E, Weber, W and Clowes, A.M.
1994: Structure of a Paleoproterozoic continent-continent collision zone: a LITHOPROBE seismic reflection profile across the Trans-Hudson Orogen, Canada; in Seismic Reflection Probing of Continents and their Margins, edited by A.M. Clowes and AG. Green, Tectonophysics.

Little, H.W.
1959: Tungsten deposits of Canada (with reference to Manitoba); Geological Survey of Canada, Economic Geology Report 17, p. 147-157.

Lucas, S.B., Green, A, Hajnal, Z., White, D., Lewry, J., Zwanzig, H., Ashton, K., Weber, K. and Clowes, A.
1993: Deep seismic profile of a Proterozoic collision zone: Surprises at depth; Nature, v. 363, p. 339-342.

Lucas, S.B., Stern, R.A. and Syme, E.C.
1996: Flin Flon greenstone belt: intraoceanic tectonics and the development of continental crust (1.92-1.84 Ga); Geological Society of America Bulletin, vol. 108, no 5, p. 602-629.

Machado, N., Krogh, T.E. and Weber, W.
1990: U-Pb geochronology of basement gneisses in the Thompson Belt (Manitoba): evidence for pre-Kenoran and Pikwitonei-type crust and early Proterozoic basement reactivation in the western margin of the Archean Superior Province; Canadian Journal of Earth Sciences, vol. 27, p. 794-802.

Machado, N. and Zwanzig, H.
1995: U-Pb geochronology of the Kisseynew Domain in Manitoba: Provenance ages for the metasediments and timing of magmatism; in Z. Hajnal and J. Lewry (eds.), Report of 1994 THOT Transect Meeting. LITHOPROBE Report 38, p.133-142.

Machado, N., Zwanzig, H.V. and Parent, M.
1996: U-Pb geochronology of the Kisseynew domain, Manitoba: provenance ages for metasediments and timing of magmatism, metamorphism and deformation; Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting 1996, Program and Abstract, vol. 20, in press.

Mandziuk, W.S.
1988: Primary structures of the Falcon Lake intrusive complex, southeastern Manitoba; unpublished M.Sc. thesis, University of Manitoba, 103 p.

Mandziuk, W.S. and Brisbin, W.C.
1989: Igneous structures in the Falcon Lake intrusive complex, southeastern Manitoba; Canadian Mineralogist, vol. 27, pp. 81-92

Manitoba Energy and Mines
1995: Bedrock geology Compilation Map Series, Sipiwesk, NTS 63P, 1:250 000
1992a: Bedrock Geology Compilation Map Series, Preliminary Edition, Cormorant, NTS 63K, Sheet 3, 1:250 000.
1992b: Bedrock geology compilation map Series, Knee Lake, NTS 53M, 1:250 000
1991: Bedrock Geology Compilation Map Series, Split Lake, NTS 64A, 1:250 000.
1990: Bedrock Geology Compilation Map Series, Winnipeg, NTS 62H, 1: 250 000.
1987a: Bedrock Geology Compilation Map Series, Preliminary Edition, Keener, NTS 52E, 1:250 000.
1987b: Bedrock Geology Compilation Map Series, Oxford House, NTS 53L, 1:250 000

Marr, J.
1971 : Petrology of the Wanipigow River suite, Manitoba; in Geology and Geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber eds., Manitoba Dept. of Mines and Natural Resources, Mines Branch Publication 71-1, pp. 203-214.
1970: Petrology of the northern granitic rocks Wanipigow River; University of Manitoba, unpublished M.Sc. thesis, 92 p.

Martin, B.
1992: Geology of the Gods Lake, Munroe Lake, Webber Lake area, Manitoba; Manitoba Energy and Mines, Geological Services, Geological Report GR83-1 0, 24 p.

Marten, B. and Gilbert, H.P.
1973: Gods Lake (marginal notes); Manitoba Department of Mines, Resources and Environmental Management, Preliminary Map 1973-H9.

McGregor, C.R.
1992: Sub-Quaternary Precambrian basement in SE Manitoba (NTS 52E and NTS 62H eastern portion); in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1992, p.115-117.

McGlynn, J.C.
1959: Elbow-Hemming Lakes area, Manitoba; Geological Survey of Canada, Memoir 305, 72 p.

McMurchy, R.C.
1944: Geology of the Island Lake area of Manitoba; in The Precambrian, September 1944, p. 4-9.

McRitchie, W.D.
1986: Kisseynew Project: Geological reconnaissance of Kisseynew Lake west; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, p. 96-99.
1985: Kisseynew Project: Geological reconnaissance of Kisseynew lake West (63K/13 NW); in Manitoba Energy and Mines, Report of Field Activities 1985, p. 57-63.
1977: Reindeer Lake-Southern Indian Lake; in Manitoba Mineral Resources Division, Report of Field Activities 1977, p. 13-18.
1974: The Sickle-Wasekwan Debate: A Review; Manitoba Mines Branch, Geological Paper 74-1, 23p.
1971a: Geology of the Wallace Lake-Siderock Lake area: a reappraisal; in Geology and Geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber, eds., Manitoba Mines and Natural Resources, Mines Branch, Publication 71-1, p.1 07-126 and Map 71-1/6, scale 1:31,680.
1971 b: Petrology and Environment of the acidic plutonic rocks of the Wanipigow-Winnipeg Rivers region, southeastern Manitoba; in Geology and Geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie, and W. Weber, eds., Manitoba Department of Mines and Natural Resources, Mines Branch Publication 71-1, pp. 7-62 and Map 71-1/10,1:506,000.
1971 c: Geology of the Wanipigow-Winnipeg Rivers region; in Geology and Geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber, eds., Manitoba Mines and Natural Resources, Mines Branch, Publication 71-1, Map 71-1/1.
1969: Project pioneer; in Manitoba Mines Branch, Summary of Geological Fieldwork, 1969, p. 107-114.

McRitchie, W.D., Peters, J. and Frohlinger, T.G.,
1979: History of exploration and geological work in the Nelson House-Pukatawagan region (Burntwood Project); Manitoba Mineral Resources Division, Geological Report 78-3 (Part 11), 40 p.

McRitchie, W.D. and Weber, W.
1971: Metamorphism and deformation of the Manigotagan Gneissic Belt, southeastern Manitoba; in Geology and Geophysics of the Rice Lake Region, Southeastern Manitoba (W.D. McRitchie and W. Weber, eds.); Manitoba Mines Branch, Publication 71-1, p. 235-284.

McRitchie, W.D., Weber, W. and Scoates, R.F.J.
1971; Summary of geological events; in Geology and Geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber, eds., Manitoba Mines and Natural Resources, Mines Branch, Publication 71-1, p.1.

Mezger, K., Bohlen, S.R. and Hanson, G.N.
1990: Metamorphic history of the Archean Pikwitonei granulite domain and the Cross Lake Subprovince, Superior province, Manitoba, Canada; Journal of Petrology, vol. 31, p.483-517

Milligan, G.C.
1955: Reconnaissance of the lower Seal River; Manitoba Mines Branch, Summary Report 55-4, 5 p.
1960: Geology of the Lynn Lake district; Manitoba Mines Branch, Publication 57-1, 317 p.

Moore, J.M. and Froese, E.
1972: Geological setting of the Snow Lake area; in Report of Activities, Part B, Geological Survey of Canada, Paper 72-1B, p. 78-81.

Morton, R.L. and Franklin, J.M.
1987: Two-fold classification of Archean volcanic-associated sulfide deposits; Economic Geology, vol. 82, p. 1057-1063.

Mukherjee, A.C.
1971: The Precambrian geology of the Flin Flon area, northern Saskatchewan and Manitoba, Canada; University of Saskatchewan, unpublished. Ph.D. thesis.

Nielsen, E.
1987: Till geochemistry of the Seal River area, east of Great Island, Manitoba; Manitoba Energy and Mines, Geological Services, Open File Report OF87-1, 28 p.
1983: Overburden sampling in the Lynn Lake area; in Manitoba Mineral Resources Division, Report of Field Activities 1983, Report GS-16, p. 98-100.

Neale, K.L.
1985: Geological investigations in the Knight Lake-Bigstone Lake area; in Manitoba Energy and Mines, Geological Services, Mines Branch, Report of Field Activities, 1985, p. 200-202
1984: Stratigraphy and basin evolution of the Upper Hayes River and Cochrane Bay groups, Island Lake greenstone belt, northeastern Manitoba; M.Sc. thesis, Carleton University, Ottawa, 177 p.

Neale, K.L. and Weber, W.
1981 a: Island Lake (parts of 53E115 and 16); in Manitoba Energy and Mines, Mineral Resources Division, Report of Field Activities, 1981, p. 39-42.
1981 b: Island Lake-Cochrane Bay; Manitoba Energy and Mines, Mineral Resources Division, Preliminary Map 1981 1-1, scale 1:

Norman, A.A., Williams, P.F. and Ansdell, K.M.
1995: Early Proterozoic deformation along the southern margin of the Kisseynew gneiss belt, Trans-Hudson Orogen: a 30 million year progressive deformation; Canadian Journal of Earth Sciences, vol. 32, p. 875-894.

Norman, G.W.H.
1934: Granville Lake district, northern Manitoba; Geological Survey of Canada, Summary Report, 1933, Part C, p. 23-41.

Ontario geological Survey
1991: Bedrock geology of Ontario, west-central sheet; Ontario Geological Survey, Map 2542, scale 1:1 000 000.

Ostry, G.
1992: Folded, mobilized and metamorphosed gold mineralization at Puffy Lake, Manitoba. Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Wolfville, Program with Abstracts.
1990: Mineral investigations in the Squall lake area (NTS 63K/16);in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1990, p. 91-94.
1989: Mineral investigations in the Kisseynew gneiss terrain; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1989, p. 59-63.
1988: Mineral investigations in the Kisseynew gneiss terrain; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1988, p. 80-83.
1987: Mineral investigations in the Kisseynew gneiss terrain; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1987, p. 87-90.
1986: Mineral investigations in the Kisseynew gneiss terrain; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report GS-20, p. 100-106.
1984: Mineral occurrence studies in the File Lake area; in Manitoba Mineral Resources Division, Report of Field Activities 1984, Report GS-14, p. 53-59.

Ostry, G. and Halden, N.H.
1995: Geology of the Puffy Lake gold deposit, Sherridon district, Manitoba; CIMM Exploration Mining Geology, vol. 4, no.1, p. 51-63.

Ostry, G. and Trembath, G.D.
1992: Mineral deposits and occurrences in the Batty Lake area, NTS 63N/2; Manitoba Energy and Mines, Mineral Deposit Series Report 19, 264 p.

Parbery, D.
1990: Mineral occurrence investigations in the Lobstick Narrows and Elbow Lake areas (NTS 63K/14, 63K/15);in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1990, p. 87-90.
1986: Mineral occurrence studies-Flin Flon area; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report GS-10, p. 49-55.

Parbery, D. and Gale, G.H.
1984: Mineral deposit investigations in the Flin Flon area; in Manitoba Energy and Mines, Geological Services, Report of Field Activities 1984, Report GS-15, p. 60-66.

Parsons, C.S.
1937: Gold ore from Laguna gold mine; in Investigations in Ore Dressing and Metallurgy; Mines and Geology Branch of Canada, Publication 771, Report 660, p. 184-187.
1930: The treatment of gold ores from the English Brook area, Rice Lake district, Manitoba; in Canada Department of Mines, Investigations in Ore Dressing and Metallurgy, 1930, p.164-169.

Pearson, D.E.
1972: The location and structure of the Precambrian Kisseynew Gneiss domain of northern Saskatchewan; Can. J. Earth Science, v.9, p.1235-1249.

Peck, D.C.
1986: The geology and geochemistry of the Cartwright Lake area: Lynn Lake greenstone belt, northwestern Manitoba; University of Windsor, unpublished M.Sc. thesis, 270 p.
1985: Geological investigations at Cartwright Lake, Manitoba; in Manitoba Energy and Mines, Geological Services, Report of Field Activities 1985, Report GS-8, p. 37-40.
1984: An investigation of gold mineralization at Cartwright Lake, Manitoba; in Manitoba Energy and Mines, Mineral Resources Division, Report of Field Activities 1984, Report GS-8, p. 24-28.

Peck, D.C., Cameron, H.D.M. and Layton-Matthews, D.
1995: Geological and geochemical studies in the southern part of the Lynn Lake greenstone belt, northwestern Manitoba; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1995, p. 4-10.

Peck, D.C., Theyer, P. and Kowalyk, E.W
1994: Geological investigations in the Lynn Lake greenstone belt and Kisseynew gneiss belt; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1994, p. 16-24.

Peloquin, S. and Gale, G.H.
1985: Geological setting of the Tartan Lake gold deposit; in Manitoba Energy and Mines, Geological Services, Report of Field Activities 1985, Report GS-16, p. 71-73.

Peloquin, S., Ostry, G. and Gale, G.H.
1985: Investigations of mineral occurrences in the Kisseynew metasedimentary terrain; in Manitoba Energy and Mines, Geological Services, Report of Field Activities Report GS-15, p. 64-70.

Peloquin, S., Tannahill, B. and Gale, G.H.
1986: Geology of the Tartan Lake gold deposit; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report GS-11 , p. 56-64.

Phillips, G.N., Groves, D.I. and Martin, J.E.
1984: An epigenetic origin for Archean banded iron-formation-hosted gold deposits; in Economic Geology, v. 79, p. 162-171.

Phinney, W.C., Morrison, D.A. and Maczuga, D.E.
1988: Anorthosites and related megacrystic units in the evolution of Archean crust; Journal of Petrology, vol. 29, part 6, p. 1283-1323.

Podolsky, T.
1951 : Cranberry Portage (east half), Manitoba; Geological Survey of Canada, Preliminary Map 51-17 with marginal notes.

Pollock, G.D.
1964: Geology of the Duval Lake area; Manitoba Mines Branch, Publication 61-6, 59 p.
1965: Geology of the Russick Lake area; Manitoba Mines Branch, Publication 63-2, 37 p.

Poulsen, K.H.
1989: Structure and hydrothermal alteration, Rice Lake gold district, southeastern Manitoba; in Investigations by the Geological Survey of Canada in Manitoba and Saskatchewan during the 1984-1989 Mineral Development Agreements; Geological Survey of Canada, Open File 2133, p.42-49

Poulsen, K.H., Ames, K.E., Lau, S. and Brisbin, W.C.
1986: Preliminary report on the structural setting of gold in the Rice Lake area, Uchi Subprovince, southeastern Manitoba; in Current Research, Part A, Geological Survey of Canada, Paper 86-1A, p. 213-220.

Poulsen, K.H., Weber, W., Brommecker, R. and Seneshen, D.N.
1996: Lithostratigraphic assembly and structural setting of gold mineralization in the eastern Rice Lake greenstone belt, Manitoba-Fieldtrip Guidebook A4; Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Winnipeg, Manitoba, May 27-29, 1996. 106 p.

Poulsen, K.H., Weber, W., Garson, D.F. and Scoates, R.F.J.
1994: Digital database for Rice Lake Belt geology and mineral deposits: a progress Report; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1994, p. 163-166.

Price, D.
1977: Flin Flon, Snow Lake geology; Canadian Institute of Mining and Metallurgy field trip guidebook, Hudson Bay Mining and Smelting Co. Ltd., Flin Flon, Manitoba, 55 p.

Quinn, H.A.
1960: Geology of Island Lake, Manitoba-Ontario; Geological Survey of Canada, Map 26-1960 with marginal notes, scale 1 inch to 4 miles.
1955: Nelson House, Manitoba; Geological Survey of Canada, Preliminary Map 54-13 with marginal notes.

Quinn, H.A. and Currie, K.L.
1961: Oxford House sheet; Geological Survey of Canada, Preliminary Map 21-1961.

Reid, J.A.
1938: Report on the property of Laguna Gold Mines Limited; Manitoba Energy and Mines, Mines Branch, Corporation File, Laguna Gold Mines Limited.
1923: The Apex group of claims Herb Lake, Manitoba; Manitoba Energy and Mines, Mines Branch, Unpublished Information File (63J/13SW).

Reid, J.A. and Dresser, J.A.
1925: Sampling of the Bingo Mine; in Canadian Mining Journal, v. 46, p. 472-473.

Reilly, B., Slimmon, W.L., Harper, C.T., Ashton, K.E. and Watters, B.R.
1994: Contrasting lithotectonic assemblages from the western Flin Flon Domain; in Trans-Hudson Orogen Transect, LITHOPROBE Report 38, p. 105-111.

Roberts, R.G.
1987: Ore deposit models #11. Archean lode gold deposits; in Geoscience Canada, vol. 14, No.1, p. 37-52.

Robertson, D.S.
1953: Batty Lake map-area, Manitoba; Geological Survey of Canada, Memoir 271, 55 p.
1951: The Kisseynew Lineament, northern Manitoba; The Precambrian, v. 24, p. 8-11, 13, 23.

Robinson, A.H.A.
1935: Gold in Canada; Mines Branch, Ottawa, Publication 769, 127 p.

Rousell, D.H.
1966: Geology of the Cross Lake area; Manitoba Mines Branch, Publication 62-4, 69 p.

Russell, G.A.
1957: Structural studies of the Snow Lake-Herb Lake area; Manitoba Mines Branch, Publication 55-3, 33 p.
1952a: Structural studies of the Long Lake-Halfway Lake area; Manitoba Mines Branch, Publication 49-6, 10 p.
1952b: Geology of the Lily Lake-Kickley Lake Area; Manitoba Department of Mines and Natural Resources, Mines Branch, Publication 50-3, 16 p.
1949: Geology of the English Brook area; Manitoba Mines Branch, Preliminary Report 48-3, 22 p.
1948: Geology of the Wallace Lake area; Manitoba Mines Branch, Preliminary Report 47-1,15 p.

Scoates, R.F.J.
1990: The Fox River sill, northeastern Manitoba: a major stratiform intrusion; Manitoba Energy and Mines, Geological Report GR82-3, 192 p.
1981: Volcanic rocks of the Fox River belt, northeastern Manitoba; Manitoba Energy and Mines, Geological Report GR81-1, 109 p.
1971: Ultramafic rocks of the Rice Lake greenstone belt; in Geology and geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber, eds., Manitoba Department of Mines and Natural Resources, Mines Branch Publication 71-1, p. 189-202.

Schledewitz, D.C.P.
1986: Geology of the Cochrane and Seal Rivers area; Manitoba Energy and Mines, Minerals Division, Geological Report, GR80-9, 139 p.
1985: Kisseynew Project; Kississing Lake, Big Island-Yakushavich Island Region; in Manitoba Energy and Mines, Report of Field Activities 1985, Report GS-13, p. 54-56.
1972: Geology of the Rat Lake Area; Manitoba Mines Branch, Publication 71-2B, 57 p.

Schledewitz, D.C.P. and Trembath, G.
1986: Kisseynew Project: Kississing Lake; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report GS-18, p. 92-95.

Seneshen, D.M.
1990: The genesis of Archean rocks of the Manigotagan River Formation, southeastern Manitoba; unpublished M.Sc. thesis, University of Manitoba, 173p.

Seneshen, D.M. and Owens, D.J.
1985: Geological investigations in the Stormy Lake area; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities, 1985, p. 112-120.

Shanks, R.J. and Bailes, A.H.
1977: "Missi Group" rocks, Wekusko Lake area; in Manitoba Mineral Resources Division, 1977 Report of Field Activities Report GS-16, p. 83-87.

Shepherd, F.D.
1943: Recent developments in the Snow-Herb Lake area; The Precambrian, November, 1943, p. 27.
1939: The Gunnar Mine, Manitoba; in Canadian Institute of Mining and Metallurgy, v. 42, p. 406-415.
1935: Report on trip into Rice Lake and central Manitoba areas; Manitoba Energy and Mines, Mines Branch, Corporation File, Wingold Mines Ltd.

Sherman, G.R., Samson, I.M. and Holm, P.E.
1990: Hydrothermal activity and Au-quartz veining within a brittle-ductile shear zone in the Proterozoic Lynn Lake greenstone belt, Manitoba; abstract, Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, 1990, Program with Abstracts, vol.15, p. A121.
1989: Deformation, veining and gold mineralization along part of the Johnson shear zone, Lynn Lake greenstone belt, Manitoba; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1989, p. 16-18.

Shklanka, R.
1967: Geology of the Bee Lake area, district of Kenora, Ontario; Ontario Department of Mines, Geological Report 47, 42 p.

Sibson, R.H.
1989: Earthquake faulting as a structural process; Journal of Structural Geology, v. 12, p. 1-14.

Southard, G.G.
1977: Exploration history, compilation and review, including exploration data from cancelled assessment files, for the Gods, Knee and Oxford Lakes areas, Manitoba; Manitoba Mineral Resources Division, OF 77-5, 93 p.

Springer, G.D.
1952: Geology of the Rennie-West Hawk Lake area; Manitoba Mines Branch, Publication 50-6, 54 p.

Stanton, M.S.
1948: Geology of the Farley Lake area; Manitoba Mines Branch, Preliminary Report 47-5,22 p.

Stauffer, M.R
1990: The Missi formation: an Aphebian molasse deposit in the Reindeer Zone of the Trans-Hudson orogen, Canada; in Lewry, J.F. and Stauffer, M.R., eds.: The Early Proterozoic Trans-Hudson Orogen of North America: Geological Association of Canada, Special Paper 37, p. 121-141.
1974: Geology of the Flin Flon area: A new look at the Sunless City; Geoscience Canada, v. 1, p. 30-35.

Stauffer, M.R. and Mukherjee, AC.
1971: Superimposed deformations in the Missi meta-sedimentary rocks near Flin Flon, Manitoba; Canadian Journal of Earth Sciences, v. 8, p. 217-242.

Stauffer, M.R., Mukherjee, A.C. and Koo, J.
1975: The Amisk Group: an Aphebian island arc deposit; Canadian Journal of Earth Sciences, v. 12, p. 2021-2035.

Stephenson, J.F.
1971: Gold deposits of the Rice Lake-Beresford Lake greenstone belt, southeastern Manitoba; in Geology and Geophysics of the Rice Lake Region, Southeastern Manitoba (W.D. McRitchie and W. Weber, eds.); Manitoba Mines Branch, Publication 71-1, p. 337-374.
1972: Gold deposits of the Rice Lake-Beresford Lake area, southeastern Manitoba; University of Manitoba, unpublished Ph.D. thesis, 294 p.

Stephenson, J.F. and Ehmann, W.D.
1971: Neutron Activation analysis of gold in Archean igneous and metamorphic rocks of the Rice lake-Beresford Lake area, southeastern Manitoba; in Geology and Geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber eds., Manitoba Department of Mines and Natural Resources, Mines Branch Publication 71-1, p. 375-385.

Stern, R.A. and Lucas, S.B.
1994: U-Pb zircon constraints on the early tectonic history of the Flin Flon accretionary collage, Saskatchewan; in Radiogenic Age and Isotopic Studies: Report 8, Geological Survey of Canada, Current Research 1994-F, p. 75-86.

Stern, R.A., Syme, E.C., Bailes, A.H., Galley, A.G., Thomas, D.J. and Lucas, S.B.
1992: Nd-isotopic stratigraphy of Early Proterozoic Amisk Group metavolcanic rocks from the Flin Flon belt; in Radiogenic Age and Isotopic Studies, Report 6, Geological Survey of Canada, Paper 92-2, p. 73-84.

Stern, R.A., Syme, E.C., Bailes, A.H. and Lucas, S.B.
1995a: Paleoproterozoic (1.86-1.90 Ga) arc volcanism in the Flin Flon belt, Trans-Hudson Orogen, Canada; Contributions to Mineralogy and Petrology, v. 119, p. 117-141.

Stern, R.A., Syme, E.C. and Lucas, S.B.
1995b: Geochemistry of 1.9 Ga MORB- and OIB-like basalts from the Amisk collage, Flin Flon belt, Canada: Evidence for an intra-oceanic origin; Geochimica et Cosmochimica Acta, v. 59, p. 3131-3154.

Stevenson, R.K. and Turek, A.
1992: An isotopic age of the Island Lake greenstone belt, Manitoba: crustal evolution and progressive cratonization in the late Archean; Canadian Journal of Earth Sciences, v. 29, p. 2200-2210.

Stewart, J.W.
1977: Gold evaluation program; in Manitoba Mineral Resources Division, Report of Field Activities 1977, Report MEA-1, p. 105-108.
1980: Gold mines of Manitoba; Manitoba Mineral Resources Division, Educational Series ES80-1, 16 p.

Stewart, P.W. and Brewer, K.
1984: Mineral deposit studies in the western Lynn Lake greenstone belt; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities 1984, Report GS-5, p. 17-19.

Stockwell, C.H.
1964: Fourth report on structural provinces, orogenies, and time-classification of rocks of the Canadian Precambrian Shield; Geological Survey of Canada, Paper 64-17, part II, p. 1-21
1945a: Beresford Lake (Marginal Notes); Geological Survey of Canada, Maps 809A, 810A and 811A.
1945b: McVeigh Lake area, Manitoba; Geological Survey of Canada, Paper 45-14, 34 p.
1938: Rice Lake-Gold Lake area, southeastern Manitoba; Geological Survey of Canada, Memoir 210, 79 p.
1937: Gold deposits of Herb Lake area, northern Manitoba; Geological Survey of Canada, Memoir 208, 46 p.
1935: Gold deposits of the Elbow-Morton area, Manitoba; Geological Survey of Canada, Memoir 186, 74 p.

Stockwell, C.H. and Lord, C.S.
1939: Halfway Lake-Beresford Lake area, Manitoba; Geological Survey of Canada, Memoir 219, 66 p.

Stott, G.M. and Corfu, F.
1991: Uchi Subprovince; in Geology of Ontario, Ontario Geological Survey, Special Volume 4, Part 1, p.145-236

Syme, E.C.
1990: Elbow Lake project (parts of NTS 63K/15W); in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1990, p. 49-57.
1988: Athapapuskow Lake Project; in Manitoba Energy and Mines, Minerals Division; Report of Field Activities, 1988, p. 20-34.
1985a: Geochemistry of metavolcanic rocks in the Lynn Lake belt; Manitoba Energy and Mines, Geological Services, Geological Report GR 84-1, 84 p.
1985b: Athapapuskow Lake Project; in Manitoba Energy and Mines, Report of Field Activities 1985, Report GS-10, p. 44-47.

Syme, E.C. and Bailes, A.H.
1993: Stratigraphic and tectonic setting of volcanogenic massive sulfide deposits, Flin Flon, Manitoba; Economic Geology, v. 88, p. 566-589.

Syme, E.C., Bailes, A.H. and Lucas, S.B.
1996: Tectonic assembly of the Paleoproterozoic Flin Flon belt and setting of VMS deposits-Field Trip Guidebook B1; Geological Association of Canada/Mineralogical Association of Canada Annual Meeting, Winnipeg, Manitoba, May 27-29, 1996, 130 p.
1995: Geology of the Reed Lake area; in Manitoba Energy and Mines, Geological Services, Report of Activities, 1995, p. 42-60.

Syme, E.C., Bailes, A.H., Price, D.P. and Ziehlke, D.V.
1982: Flin Flon volcanic belt: Geology and ore deposits at Flin Flon and Snow Lake, Manitoba; Geological Association of Canada and Mineralogical Association of Canada Joint Annual Meeting, University of Manitoba, Winnipeg, Manitoba, 1982, Field Trip Guidebook No.6, 91 p.

Syme, E.C., Bailes, A.H., Stern, R.A., Lucas, S.B. and Galley, A.G.
1995: Tectonostratigraphic setting of volcanogenic massive sulphide deposits in the Paleoproterozoic Flin Flon metavolcanic belt, Trans-Hudson Orogen, Canada; in International Conference on Tectonics and Metallogeny of Early/Mid Precambrian Orogenic Belts, Program and Abstracts, p. 264.

Syme, E.C., Weber, W. and Lenton, P.G.
1993: Manitoba geochronology database; Manitoba Energy and Mines, Geological Services, Open File OF93-4, 157 p.

Tanton, T.L.
1941: Flin Flon; Geological Survey of Canada, Map 632A with descriptive notes.
1937: Echimamish area, northern Manitoba; Geological Survey of Canada, Preliminary Report, Paper 37-18, 38 p.

Theyer, P.
1994a: Mineral deposits and occurrences in the Bissett area, NTS 52M/3; Manitoba Energy and Mines, Geological Services, Mineral Deposit Series, Report No 18, 101 p.
1994b: Mineral deposits and occurrences in the Flintstone Lake area, NTS *52L/11;* Manitoba Energy and Mines, Geological Services, Mineral Deposit Series, Report No 22, 60 p.
1992: Mineral deposit investigations on Elk Island and Joswey Island in the Gods Lake area; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1992, p. 107-109.
1991a: Mineral deposits and occurrences in the Aikens Lake area, NTS 52M/3; Manitoba Energy and Mines, Geological Services, Mineral Deposit Series, Report No 15, 108 p.
1991b: Mineral deposit investigations in the Gods Lake area; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1991, p. 58-60.
1985: Ultramafic rocks of the Island Lake area; Manitoba Energy and Mines, Geological Services, Geological Paper GP84-1, 29 p.
1984a: Mineral deposit investigations in the Rice Lake greenstone belt; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities 1984, Report GS-23, p. 87-91.
1984b: Mineral deposit investigations: 1) gold occurrences in the Gods Lake area; and 2) platinum group metals in the Bird River Sill; in Manitoba Energy and Mines, Geological Services Branch, Report of Field Activities 1984, Report GS-34, p. 129-132.
1983: Geology of gold environments in the Bissett/Waliace Lake portion of the Rice Lake greenstone belt; in Manitoba Mineral Resources Division, Report on Field Activities, 1983, Report GS-17, p.101-107.
1982: Mineral deposit investigations-Superior Province, I) Island Lake area, II) Bird River Sill (southeastern Manitoba); in Manitoba Mineral Resources Division, Report of Field Activities 1982, Report GS-9, p. 55-57.
1981: Mineral deposit studies-Superior province: a) Island Lake, and b) Bird River sill; in Manitoba Mineral Resources Division, Report of Field Activities 1981, Report GS-16, p. 74-77.
1980: Stratigraphic investigations of the Island, Stevenson-Ponask, Bigstone and Knight Lakes areas and of the Island Lake Gold Mine; in Manitoba Mineral Resources Division, Report of Field Activities 1980, Report GS-8, p. 38-42.
1978: Stratigraphic position of ultramafic lenses in the Island lake area; in Manitoba Mineral Resources Division, Report of Field Activities 1978, Report MEA-2, p. 106-108.

1977: Evaluation of nickel environments; in Department of Mines, Resources and Environmental Management, Mineral Resources Division, Report of Field Activities, 1977, p. 116-121.

Theyer, P. and Ferreira, K.J.
1990: Mineral deposits and occurrences in the Garner Lake area, NTS 52L/13; Manitoba Energy and Mines, Geological Services, Mineral Deposit Series, Report No 10, 173 p.

Theyer, P. and Gaba, R.G.
1986: Mineral deposit investigations in the Rice Lake greenstone belt; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1986, Report GS-24, p. 120-124.

Theyer, P. and Yamada, P.H.
1989: Mineral deposits and occurrences in the Manigotagan Lake area, NTS 52L/13; Manitoba Energy and Mines, Geological Services, Mineral Deposit Series, Report No 4, 108 p.

Thurber, G.R.
1911: Report of Moore claim; in Manitoba Energy and Mines, Mines Branch, Corporation File, Star Lake Gold Mines, Limited.

Thurston, P.C. and Davis, D.
1991: Tectonic subdivisions of the northern Superior Province; Geological Association of Canada/Mineralogical Association of Canada Annual Meeting 1991, Program with Abstracts, vol. 17, p. A124.

Thurston, P.C., Osmani, I.A. and Stone, D.
1991: Northwestern Superior Province: review and terrane analysis; in Geology of Ontario, Ontario Geological Survey, Special Volume 4, part 1, p. 81-144.

Tirschmann, P.A.
1986: Physical volcanology and sedimentology of part of the Archean Rice Lake Group, Rice Lake greenstone belt, Southeastern Manitoba; unpiblished B.Sc. thesis, Department of Geological Sciences, University of Manitoba, Winnipeg.

Troop, A.J.
1949: The geology and genesis of the Ogama-Rockland Mine; unpublished M.Sc. thesis, University of Manitoba, 60p. includes map at 1:24,000.

Tuba, T. and Ostry, G.
1994: Gold Deposits of Manitoba; Manitoba Energy and Mines, Miscellaneous Publication 94-6, 23 p,

Tuckwell, K.
1979: Stratigraphy and mineral deposits of the Sherridon area; in Manitoba Mineral Resources Division, Report of Field Activities 1979, Report GS-11, p. 42-45.

Turek, A. and Weber, W.
1994: The 3 Ga granitoid basement to the Rice Lake supracrustal rocks, southeast Man; in Manitoba Energy and Mines, Minerals Division, Report of Activities 1994, p. 167-169.
1991: New U-Pb ages for the Rice Lake area: evidence for 3 Ga crust; in Manitoba Energy and Mines, Minerals Divisions, Report of Activities 1991, p. 53-55.

Turek, A., Carson, T.M., Smith, P.A., Van Schmus, W.R. and Weber, W.
1986: U-Pb zircon ages for rocks from the Island Lake greenstone belt, Manitoba; in Canadian Journal of Earth Sciences, v. 23, p. 92-101.

Turek, A., Keller, R., Van Schmus, W.R. and Weber, W.
1989: U-Pb Zircon ages for the Rice Lake area, southeastern Manitoba; Canadian Journal of Earth Sciences, vol. 26, p.23-30.

Turek, A. and Weber, W.
1987: U-Pb geochronology of the Bigstone Lake-Knight Lake area; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities, 1987, p. 148-150.

Walford, P.C. and Franklin, J.M.
1982: The Anderson Lake Mine, Snow Lake, Manitoba; in Precambrian Sulphide Deposits (R.W Hutchinson, C.D. Spence and J.M. Franklin, eds.); Geological Association of Canada, Special Paper 25, p. 481-523.

Wanless, R.K., Stevens, R.D., Lachance, G.R. and Rimsaite, J.Y.H.
1966: Age determinations and geological studies: K-Ar isotopic ages, Report 6; Geological Survey of Canada, Paper 65-17, 101 p.

Watters, B.R., Dostal, J., Slimmon, W.L. and Thomas, D.J.
1994: Geochemistry, petrogenesis and tectonic setting of Early Proterozoic volcanic rocks of the Flin Flon Domain, Saskatchewan (Canada): Oceanic back-arc volcanism: Neues Jahrbuch fur Mineralogie Monatshefte, v. 9, p. 416-432.

Weber, W.
1991: Geology of the English Brook area, southeastern Manitoba; in Manitoba Energy and Mines, Minerals Division, Report of Activities 1991, p. 49-52.
1990: The Churchill - Superior Boundary zone, southeast margin of the Trans-Hudson Orogen: a review; in The Early Proterozoic Trans-Hudson Orogen of North America; (J.F. Lewry and M.R. Stauffer, eds.); Geological Association of Canada, Special Paper 37, p. 42-55.
1988: Geological investigations in the Rice Lake area; in Manitoba Energy and Mines, Minerals Division, Report of Field Activities 1988, p. 103-104
1975: High Hill-Utik Lake area; in Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, Summary of Geological Fieldwork, 1975, Geological Paper 2/75, p.24-25.
1974: Utik Lake-Bear Lake project; in Manitoba Department of Mines, Resources and Environmental Management, Mineral Resources Division, Summary of Geological Fieldwork, 1974, Geological Paper 2/74, p.
1971a: Geology of the Wanipigow River-Manigotagan River region, Winnipeg Mining District; in Geology and Geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber eds., Manitoba Department of Mines and Natural Resources, Mines Branch Publication 71-1, Map 71-1/4, scale one inch to one mile.
1971 b: Geology of the Long Lake-Gem Lake area; in Geology and Geophysics of the Rice Lake region, southeastern Manitoba (Project Pioneer), W.D. McRitchie and W. Weber eds., Manitoba Department of Mines and Natural Resources, Mines Branch Publication 71-1, pp. 63-106 and Map 71-1/5, 1:31,680.

1971c: The evolution of the Rice Lake-Gem Lake greenstone belt, southeastern Manitoba; in Geoscience Studies in Manitoba (A.C. Turnock, ed.), Geological Association of Canada, Special Paper No.9, p.97-103

Weber, W., Gilbert, H.P., Neale, K.L. and McGregor, C.R.
1982: Island Lake; in Manitoba Department of Energy and Mines, Mineral Resources Division, Report of Field Activities, 1982, p.34-43.

Weber, W. and Mezger, K.
1990: An oblique cross section of Archean continental crust at the northwestern margin of the Superior Province, Manitoba; in Exposed Cross sections of the Continental Crust (M.H. Salisbuy and D.M. Fountain, eds.); Kluwer Academic Publishers, p. 327-341.

Weber, W. and Schledewitz, D.C.P.
1980: Molson Lake-Kalliecahoolie Lake project; in Manitoba Department of Energy and Mines, Mineral Resources Division, Report of Field Activities, 1980, p. 33-37.

Weber, W. and Scoates, R.F.J.
1978: Archean and Proterozoic metamorphism in the northwestern Superior Province and along the Churchill-Superior boundary, Manitoba; in Metamorphism in the Canadian Shield (J.A. Fraser and W.W. Heywood, eds.); Geological Survey of Canada, Paper 78-10., p. 5-16.

Whalen, J.B.
1993: Geology of the Elbow Lake sheet, Manitoba (NTS 63K/15); Geological Survey of Canada, Open File 2709, 1:50 000 map with descriptive notes.

White, D.J. and Lucas, S.B.
1994: A closer look at the Superior boundary zone; in Trans-Hudson Orogen Transect Report of Fourth Transect Workshop, Z. Hajnal and J. Lewry, eds., Lithoprobe Report 38, p. 35-41

White, D.J., Lucas, S.B., Hajnal, Z., Green, A.G., Lewry, J.F., Weber, W, Bailes, A.H., Syme, E.C. and Ashton, K.E.
1994: Paleoproterozoic thick-skinned tectonics: LITHOPROBE seismic reflection results from the eastern Trans-Hudson Orogen; Canadian Journal of Earth Science, v. 31, p. 458-469.

Whiting, B.H. and Sinclair, A.J.
1986: New conclusions concerning the lithology and lithogeochemistry of the San Antonio gold mine, Bissett, Manitoba; in Gold '86, an International Symposium on the Geology of Gold Deposits, Toronto, Canada, September 28-0ctober 1, Proceedings Volume, p. 171.

Williams, H.
1966: Geology and mineral deposits of the Chisel Lake map area, Manitoba; Geological Survey of Canada, Memoir 342, 38 p.

Williamson, B.L. and Eckstrand, O.R.
1995: A summary of new contributions on the Reed Lake mafic complex; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1995, p. 61-70.

Wilson, H.D.B. and Brisbin, W.C.
1961: Regional structure of the Thompson-Moak Lake nickel belt; in Canadian Institute of Mining and Metallurgy, Bulletin LXIV, p.470-477.
1962: Tectonics of the Canadian Shield in northern Manitoba; in Royal Society of Canada, Special Publication, no. 4, p. 60-75.

Wright, P.
1989: Property summaries, Lynn Lake gold properties; LynnGold Resources Inc., internal unpublished report, 10 p.

Wright, J.F.
1943: Internal report; Manitoba Mines Branch
1940: Gold mines and prospects in Rice Lake-Beresford Lake area, Manitoba; Canadian Institute of Mining and Metallurgy, Transactions, p. 613-626.
1938: Geology and mineral deposits of a part of southeastern Manitoba; Geological Survey of Canada, Memoir 169, 150 p.
1932: Geology and gold prospects of the areas about Island, Gods, and Oxford Lakes, Manitoba; in The Canadian Mining and Metallurgical Bulletin, May, 1935, p. 155-162.
1931: Geology and mineral deposits of part of northwest Manitoba; in Geological Survey of Canada, Summary Report, 1930, Part C, p. 1-124.
1928: Island Lake area, Manitoba; Geological Survey of Canada, Summary Report, 1927, Part B, p. 54-80.
1923: Rice Lake Map-Area, southeastern Manitoba; in Geological Survey of Canada, Summary Report, 1922, Part C, p. 45.

Zwanzig, H.V.
1996: Kisseynew belt in Manitoba: an 1845 to 1825 Ma analogue with the Mediterranean basin and Aegean arc; in Geological Association of Canada/ Mineralogical Association of Canada Annual Meeting, 1996, Program with Abstract, v. 21, p. A-105.
1994a: Stratigraphy and structure sections, Puffy Lake to Jungle Lake: The Flin Flon belt-Kisseynew belt transition zone; in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1994, p. 27-34.
1994b: Geological setting of the Nokomis Lake gold deposit: in Manitoba Energy and Mines, Minerals Division, Report of Activities, 1994, p. 35-38.
1990: Kisseynew gneiss belt in Manitoba: stratigraphy, structure, and tectonic evolution; in Lewry, J.F. and Stauffer, M.A., eds.: The Early Proterozoic Trans-Hudson Orogen of North America: Geological Association of Canada, Special Paper 37, p. 95-120.
1985: Kisseynew Project; in Manitoba Energy and Mines, Report of Field Activities 1985, Report GS-12, p. 51-53.
1984: Kisseynew Project: Lobstick Narrows-Cleunion Lake, Puffy Lake and Nokomis Lake areas; in Manitoba Mineral Resources Division, Report of Field Activities 1984, Report GS-12, p. 38-45.
1983: Kisseynew project: Lobstick Narrows (parts 63K/13,14 and 63N/3,4); in Manitoba Mineral Resources Division, Report of Field Activities 1983, Report GS-4, p. 15-22.
1981: Granville Lake project; in Manitoba Mineral Resources Division, Report of Field Activities 1981, Report GS-5a, p. 17-21.
1971: Structural geology at Long Lake, Manitoba; in Geology and Geophysics of the Rice Lake Region, Southeastern Manitoba (W.D. McRitchie and W. Weber, eds.); Manitoba Mines Branch, Publication 71-1, p. 285-298.

Zwanzig, H.V. and Cameron, H.D.M.
1981: Granville Lake Project; Manitoba Mineral Resources Division, Report of Field Activities 1981, Report GS-5, p. 17-21.

Zwanzig, H.V., Parent, M. and Machado, N.
1996a: Kisseynew belt in Manitoba: 1.84 to 1.79 Ga staging of progressive continental collision and tectonic wedging; Geological Association of Canada/ Mineralogical Association of Canada, Annual Meeting 1996, Program and Abstract, vol. 20, in press.

Zwanzig, H.V., Parker, J.S.D., Schledewitz, D.C.P. and Van Schmus, W.R.
1985: Lynn Lake regional compilation and geochronology; in Manitoba Energy and Mines, Geological Services, Report of Field Activities 1985, Report GS-1, p. 6-8.

Zwanzig, H.V. and Schledewitz, D.C.P.
1992: Geology of the Kississing-Batty Lakes area: Interim report; Manitoba Energy and Mines, Minerals Division, Open File Report OF92-2, 87 p.

Zwanzig, H.V., Schledewitz, D.C.P., Ashton, K.E., Froese, E. and Dohar, V.
1996b: Geological compilation map of Flin Flon belt-Kisseynew belt transition zone, Manitoba-Saskatchewan: a preliminary NATMAP product; Geological Association of Canada/Mineralogical Association of Canada, Annual Meeting 1996, Program and Abstract, vol. 20, in press.

Zwanzig, H.V., Thomas, M.W. and Keay, J.P.
1980: Laurie Lake; Manitoba Mineral Resources Division, Map GP80-1-3 (in Geological Paper GP80-1).

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