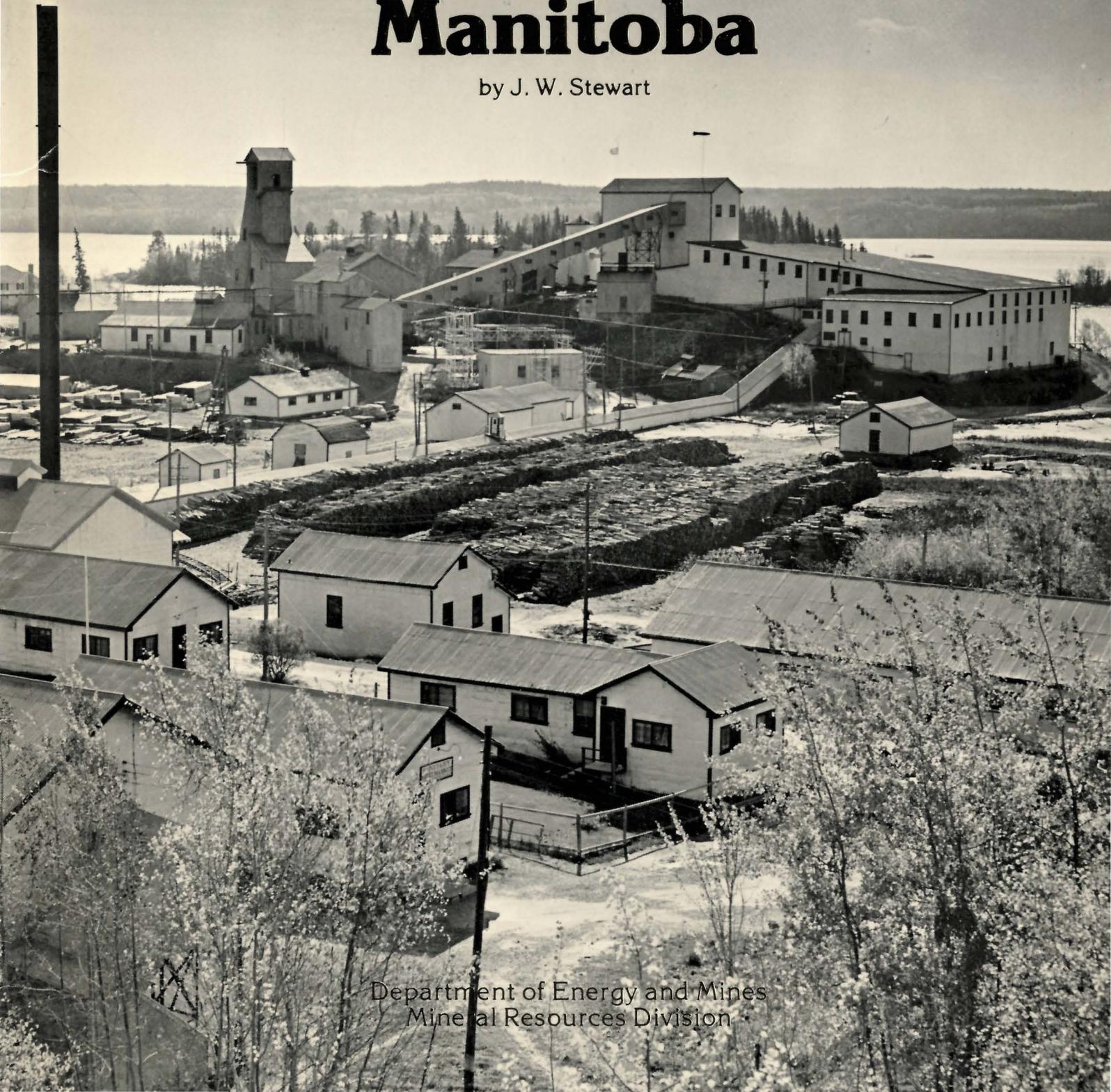


JUL 25 1980

Gold Mines of Manitoba

by J. W. Stewart



Department of Energy and Mines
Mineral Resources Division

**Cover Plate: San Antonio Mine, Bissett Area,
circa 1940.**

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INTRODUCTION

The first significant gold discovery in Manitoba was made at Rice Lake, 160 km (99 miles) northeast of Winnipeg, in 1911. This event was followed by prospecting and staking in the surrounding region, leading to the opening of the Central Manitoba Mine, about 26 km (16 miles) southeast of Rice Lake. This mine commenced production in 1927 and continued in operation for 10 years. In 1932, the San Antonio Mine commenced operations on the north shore of Rice Lake, close to the original 1911 discovery site. This turned out to be the Province's most important gold mine and by the time production ceased in 1968, had yielded 37 320.4 kg (1 199 878 oz) of gold and 5 978.2 kg (192 205 oz) of silver.

In northern Manitoba, gold was discovered in 1914 on the east shore of Wekusko (Herb) Lake, 140 km (87 miles) northeast of The Pas. One of the properties staked at that time, the Moose Horn claim, was explored by a shaft, and in 1917 a consignment of 25.4 tonnes (28.5 tons) of gold-bearing quartz was shipped to the smelter at Trail, B.C. On the basis of this operation, it has been stated that the Moose Horn property and the Mandy Mine near Flin Flon share the distinction of being the first gold producers in Manitoba. The Mandy Mine, however, was primarily a copper producer, and a successful one, whereas the Moose Horn operation soon came to a halt.

The histories of the Mandy Mine and the Moose Horn property were to some extent prophetic with regard to future mining trends in the Province. Base metal deposits (principally of copper, zinc, and nickel), some of them discovered during gold prospecting, eventually became the mainstay of the Manitoba minerals industry: gold mining, by comparison, led a chequered career, and despite being subsidized by the Emergency Gold Mining Assistance Act from 1948 onwards, was unable to survive beyond 1968. Currently, there is no operating gold mine in Manitoba, although old mine dumps are being reworked in the Rice Lake area. The gold production of the Province — about 1 525 kg (49 000 oz) annually, in recent years — is predominantly a by-product of refining the concentrates from base metal mines in the Flin Flon, Snow Lake, Thompson and Lynn Lake regions.

DISTRIBUTION OF GOLD OCCURRENCES

The gold resources of Manitoba occur exclusively in Precambrian bedrock, and no alluvial gold deposits are known to exist. The pioneer gold prospector in Manitoba, unlike his predecessors in California and Australia, did not make his initial discoveries in the gravels of river beds; this is a principal reason why discovery of gold in the Province was delayed until the present century.

“Gold is where you find it”: in fact, the situation is not quite as bad as that old prospector's adage would imply, and some places are very much more favourable than others for the occurrence of gold mineralization. In Manitoba, the most favoured places for the occurrence of gold are the *greenstone belts* — areas of metamorphosed Precambrian volcanic rocks, their sedimentary derivatives, and associated intrusions of diabase, quartz porphyry, etc. Precambrian *gneiss belts* — broad regions of gneissic and granitic rocks, which separate and enclose the greenstone areas — contain but few occurrences of gold mineralization. The unmetamorphosed Paleozoic sedimentary strata which cover the western part of the Province, south of Flin Flon, and a zone about 150 km (93 miles) wide around the southern margin of Hudson Bay, are devoid of gold mineralization.

The distribution of gold occurrences then, is closely tied to the distribution of greenstone belts, and the latter are scattered throughout the Precambrian of the Province (see Figure 1). It should be clearly understood that the “deposits” shown on the map consist of mines which produced over 5 000 oz (155 kg) of gold, and two geologically interesting deposits which have been developed underground, but which have not become producers. For each of the 14 deposits shown, there are *on average* seven prospects or showings where known grade and tonnage do not at present appear to meet the economic criteria for a viable mining operation: not all of these occurrences have been exhaustively explored.

NATURE OF THE DEPOSITS

All of the known gold mineralization of the Province is considered to be of hydrothermal

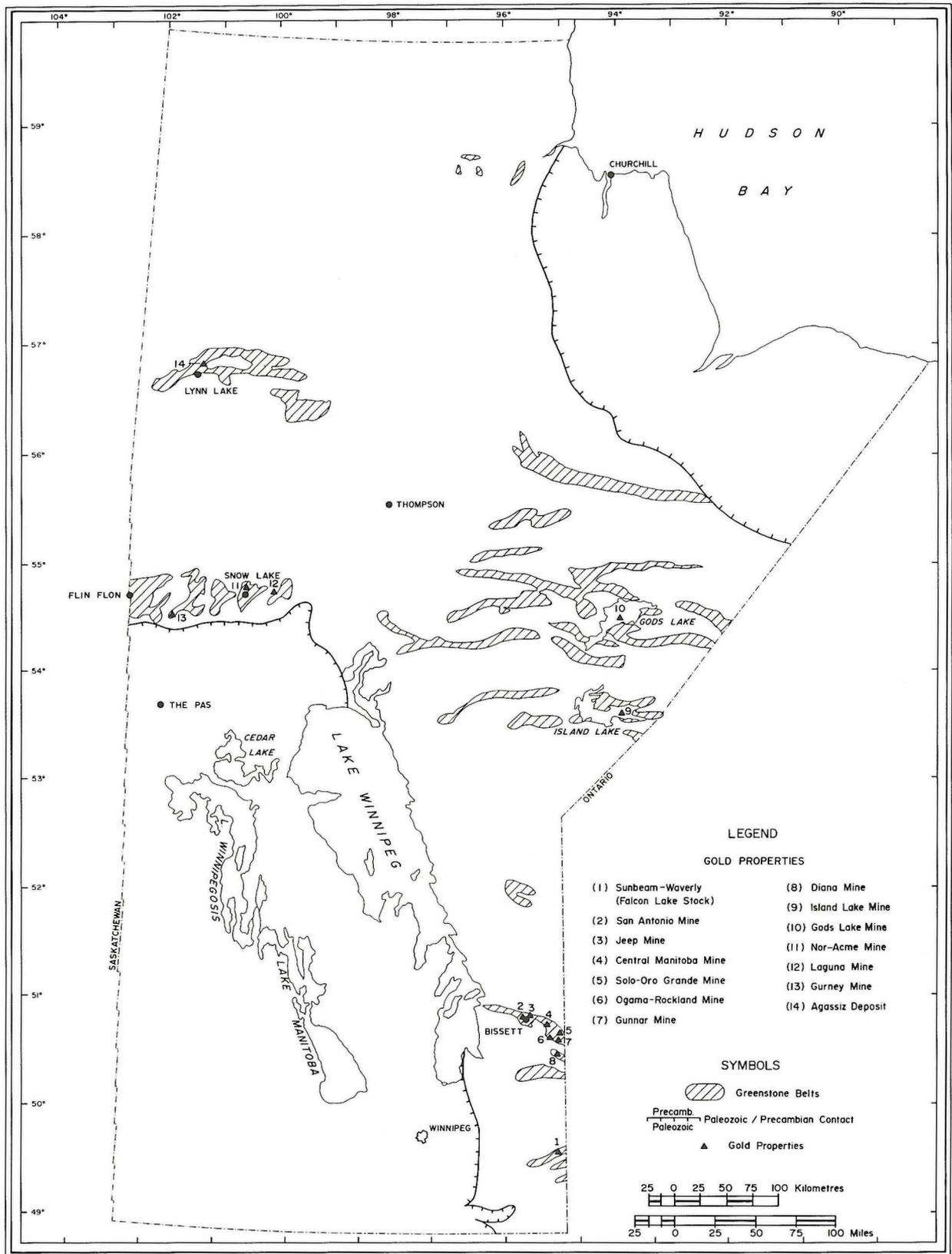


Figure 1. Distribution of greenstone belts and gold mines in Manitoba

origin; no evidence has yet been brought forward of fossil placer deposits of the Witwatersrand type. Most of the mineralization formed in fractures and shear zones, giving rise to tabular vein structures. The vein gangue material is predominantly quartz, which in many instances is accompanied by carbonate, and in local instances by minor amounts of black tourmaline and fuchsite, a green chromian mica. The wall rock of the veins generally shows some degree of alteration, the nature of this alteration depending to some extent on the composition of the wall rock. Where the latter is a mafic rock such as basalt or diabase, the vein typically is flanked by a zone of chlorite-carbonate-pyrite alteration. (Where higher metamorphic grade has prevailed, fibrous amphibole takes the place of chlorite). Ore material is not always confined to the vein, and in places it has been profitable to mine part of the wall rock due to its content of disseminated ore minerals.

The Sunbeam-Kirkland deposit in the Falcon Lake greenstone belt provides an interesting contrast to the more usual vein configuration. At this locality, disseminated mineralization occurs as a steeply plunging rod-shaped body, within a quartz monzonite intrusion.

The ore material of the gold mines consists of free gold, and sulphide minerals. The principal sulphides are pyrite, pyrrhotite and arsenopyrite, occurring singly or in various combinations; minor, sporadic amounts of galena, sphalerite, chalcopyrite are of widespread occurrence, whereas traces of scheelite, molybdenite and tellurides are strongly localized. Gold is present partly as free gold, and partly in the sulphides. The gold produced by the mines contained a certain amount of silver which was recovered during refining of the bullion.

Base metals in the Manitoba gold ores were rarely present in sufficient quantity to merit recovery. The Central Manitoba Mine was exceptional in this respect, in that copper and lead were recovered from the concentrate at the smelter.

DEPOSIT DESCRIPTIONS

The underground workings of most of Manitoba's gold mines have been inaccessible for many years, and only at the San Antonio Gold Mine at Bissett is the hoisting equipment still in place. The surface outcrops of the deposits have, in a few cases, been stoped out; more generally, they have been covered by

waste rock from the underground operations. With the passing of the years, the surface installations at almost all of the mines have been removed, and the shafts capped with concrete as a safety measure. The waste rock piled at the mine sites has been a boon to road builders, particularly in the Rice Lake district.

The following deposit descriptions are largely based on accounts written by Company or Government geologists at a time when the mines were still functioning, or at least accessible. Further information was gleaned from numerous unpublished reports submitted for assessment and now in the records of the Geoscience Data Section of the Mines Branch, Mineral Resources Division; some of this information is accessible in open files; some remains confidential.

With the exception of the Gurney Mine, all of the deposits described were visited by the writer, the geological setting evaluated, and the rock waste dumps exhaustively examined (Stewart, 1977a, 1977b). Although a poor substitute for an underground visit, these activities helped make the old descriptions meaningful, and enabled some conflicting observations to be resolved.

The Manitoba Mineral Inventory File, maintained by the Geoscience Data Section, contains summary accounts of most recorded mineral occurrences in the Province. Each occurrence is represented by one or more cards carrying a short geological description of the occurrence, a history of exploration and mining activities, output figures and a complete bibliography. These inventory cards have been invaluable in the preparation of the following deposit descriptions, and are a ready source of information for persons requiring further particulars about any specific deposit*.

1. Deposits of the Falcon Lake Stock

Gold deposits of contrasting geometric form are associated with this intrusion. The stock, which measures about 3.6 x 2.4 km (2.2 x 1.5 miles) is emplaced in mafic volcanic country rocks. It is a composite body, consisting of a cylindrical felsic unit surrounded by a unit of mafic to intermediate composition.

The first deposit type is characterized by the Sunbeam-Kirkland "pipe", a rod-like body of intensely silicified and sericitized granitic rock with a surface area of 205 m² (2 200 ft²),

* Mineral Inventory cards are available from the Geoscience Data Section, Mineral Resources Division, Winnipeg, or from the Mining Recorder's office, The Pas.

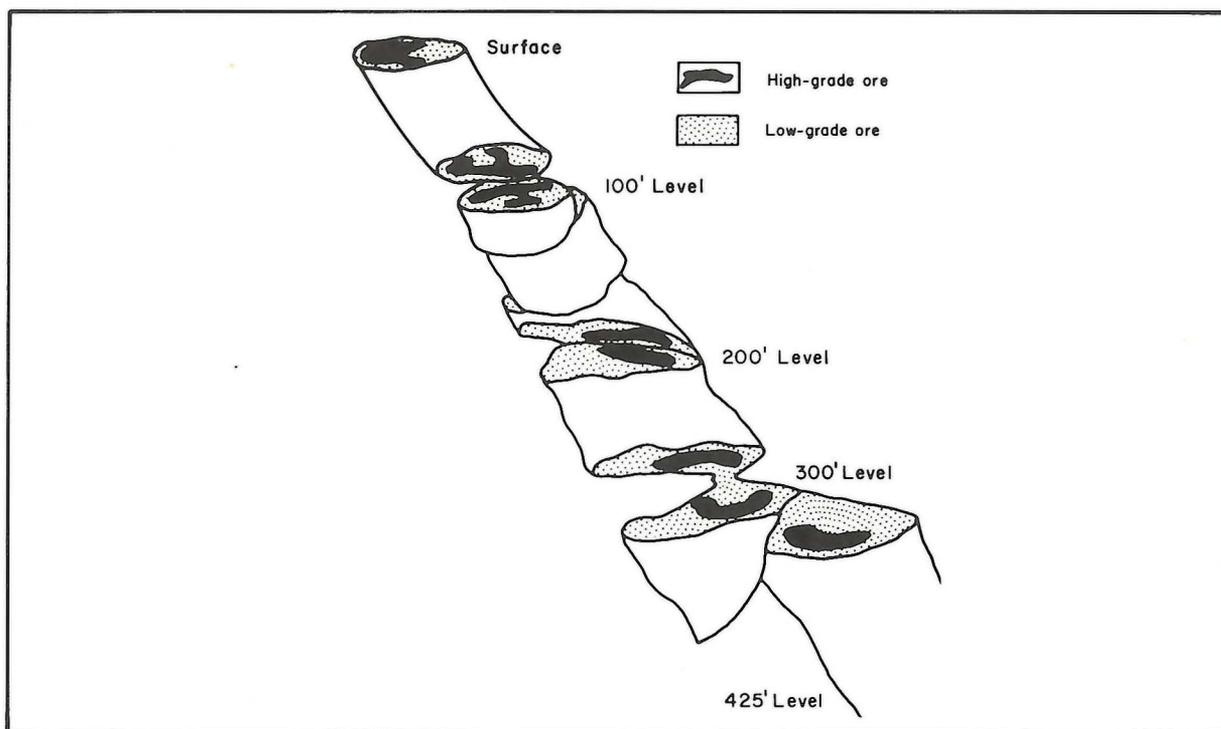


Figure 2. Sunbeam-Kirkland pipe-like gold-bearing zone (Davies et al, 1962)

located at the periphery of the quartz monzonite intrusion (Figure 2). The mineralization, which is disseminated throughout the silicified "pipe", comprises abundant pyrite, accompanied by pyrrhotite and arsenopyrite, with accessory galena and sphalerite; minor molybdenite, tennantite and chalcopyrite have been recorded. Some of the gold, at least, is present in the free form.

The second type of deposit takes the form of quartz veins which occupy steeply inclined shears and fractures within the felsic unit. The mineralization, wall rock alteration and gold grade are so similar to those encountered in the Sunbeam-Kirkland "pipe" that a related origin for both types of deposit is evident.

These deposits were never placed in production. About 100 000 tonnes (110 000 tons) reserves grading 8.77 g/tonne (0.256 oz/ton) were developed in the Sunbeam "pipe". Total indicated reserves of the "pipe" and the nearby veins, are 501 090 tonnes (550 650 tons) averaging 10.4 g/tonne (0.293 oz/ton).

References: Brownell, 1941; Davies, 1954; Stewart, 1977b.

2. San Antonio Mine

Although the original staking of the property took place in 1911, production commenced

only in 1932*. Over the years, the capacity of the mill was increased from 136 to 499 tonnes (150 to 550 tons)/day, and exploration and mining extended on to other nearby properties.

Mineralization in this deposit occurs in quartz veins within a diabase sill which intrudes a sequence of volcanic and sedimentary strata. The sill dips northeast at 45° and mining operations have followed it down to a vertical depth of 1640 m (5379') by a succession of winzes interconnected by horizontal haulage ways (Figure 3). The productive veins are mainly restricted to a particularly thick part of the sill, and essentially confined to the sill itself. The mineralized veins form three groups or sets, oriented in three different attitudes, and developed in shear and fracture zones which cut the sill. In all, 132 separate veins were worked.

The quartz veins are mineralized with pyrite, minor chalcopyrite, sphalerite and galena, and contain ankerite and albite. Carbonate, albite and pyrite have developed in the wall rock as alteration products. Gold occurs mainly in the

* Production statistics for Manitoba gold mines producing over 155 kg (5 000 oz) gold are given in Table 1.

TABLE 1: PRODUCTION FIGURES FOR MANITOBA GOLD MINES*

Map Ref. No.	MINE	TONNES (tons) MILLED	KILOGRAMS (troy ounces) GOLD RECOVERED	KILOGRAMS (troy ounces) SILVER RECOVERED	AVERAGE GRADE Au GRAMS/ TONNE (oz/ton)	YEARS IN PRODUCTION
2	San Antonio	4 059 580 (4 474 921)	37 320.4 (1 199 878)	5 978.2 (192 205)	9.2 (0.27)	1932-68
3	Jeep	15 932 (17 562)	423.9 (13 629)	not available	26.6 (0.77)	1948-50
4	Central Manitoba	413 719 (456 047)	4 953.3 (159 252)	809.7 (26 032)	12.0 (0.35)	1927-37
5	Solo - Oro Grande	14 374 (15 845)	160.7 (5 166)	15.0 (482)	11.2 (0.33)	1938-40**
6	Ogama-Rockland	126 192 (139 103)	1 410.3 (45 343)	not available	11.2 (0.33)	1942 1948-51
7	Gunnar	271 093 (298 829)	3 155.9 (101 463)	not available	11.6 (0.34)	1936-42
8	Diana	16 690 (18 398)	190.3 (6 117)	11.7 (375)	11.4 (0.33)	1934-36 +
9	Island Lake Gold Mine	7 819 (8 619)	198.8 (6 390)	not available	25.4 (0.74)	1934-35
10	Gods Lake Gold Mine	490 914 (541 140)	4 994.0 (160 561)	881.9 (28 354)	10.2 (0.30)	1935-43
11	Nor-Acme	4 893 328 (5 393 971)	19 075.7 (613 298)	1 562.6 (50 238)	3.9 (0.11)	1949-58
12	Laguna	92 904 (102 409)	1 643.8 (52 849)	not available	17.7 (0.52)	1936-40
13	Gurney	91 902 (101 305)	782.7 (25 164)	2 226.8 (71 593)	8.5 (0.24)	1937-39

Note — metric weights are followed by avoirdupois short ton and troy ounce equivalents in brackets.

*Mines which produced over 155 kilograms (5 000 ounces) of gold.

**Minor production 1932-34. Estimated totals of all production — 15 085 tonnes (16 628 tons) containing 169.6 kilograms (5 451 ounces) of gold and 16.3 kilograms (525 ounces) of silver.

+ Minor production 1928-32 and 1937-41. Estimated totals of all production — 22 680 tonnes (25 000 tons) containing 235.6 kilograms (7 574 ounces) of gold and an uncertain amount of silver.

vein pyrite, but is also present locally as free gold. In 1961, a mass of native gold weighing 6 564 g (211 oz) was discovered and is now in the collection of the National Museum of Natural Sciences in Ottawa. The gold:silver ratio in the mine averaged 6:1.

The San Antonio reserves are not yet exhausted, and some 726 000 tonnes (800 000 tons) of material with an average grade of 7.9 g/tonne (0.23 oz/ton) remain underground. The surface installations, including the mill, have been maintained, and could be rehabilitated. The mill was formerly famous for its high recovery — about 98% Au from heads assaying about 9.9 g/tonne (0.288 oz/ton).

References: Marr, 1971; Stephenson, 1971, 1972; Stockwell, 1938, 1945; Wright, 1932.

3. Jeep Mine

This mine was worked by San Antonio Gold Mines Limited from 1948 to 1950 and ore was

trucked to the mill at Bissett, 14.5 km (9 miles) away. The shaft was 180 m (590') deep.

Several lenticular quartz veins, rarely more than 0.5 m (1.6') in thickness, occupy parallel shear zones in mafic to intermediate plutonic host rocks. These veins carry pyrite mineralization with subsidiary amounts of pyrrhotite and arsenopyrite, and minor chalcopyrite; a little scheelite is present. Apart from quartz, gangue minerals are scarce. Silicification is perhaps the most prevalent wall rock alteration. Sheared wall rock shows carbonate and chlorite alteration with some pyrite.

Gold is associated with arsenopyrite and also occurs in the native form — frequently visible. Although small in terms of tonnage — about 23 tonnes (25 tons)/day average — this mine was nevertheless quite profitable thanks to a grade which averaged 27 g/tonne (0.78 oz/ton) over the life of the operation.

References: Marr, 1971; Russell, 1948; Stephenson, 1971, 1972.

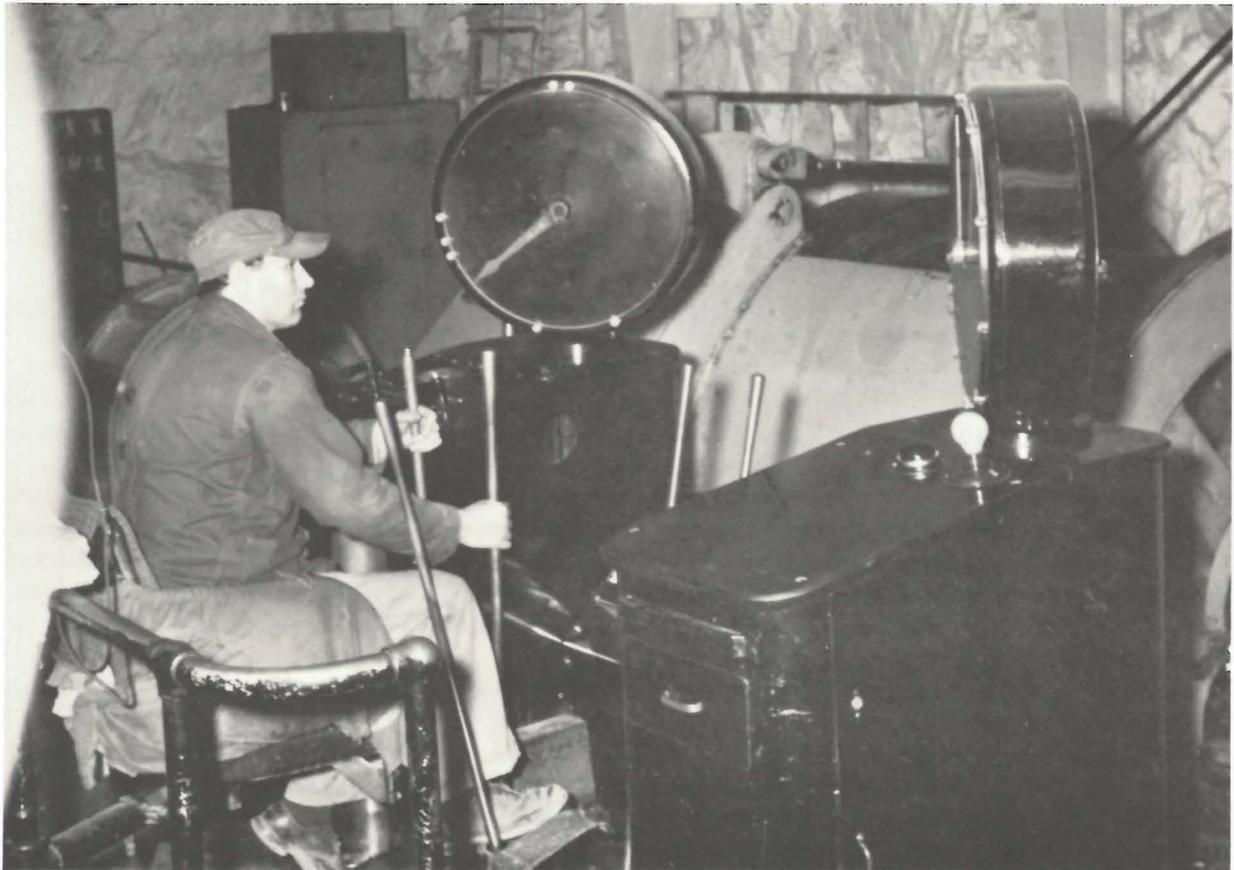


Plate 1. Hoist operator, No. 3 winze, San Antonio Gold Mine, 1958

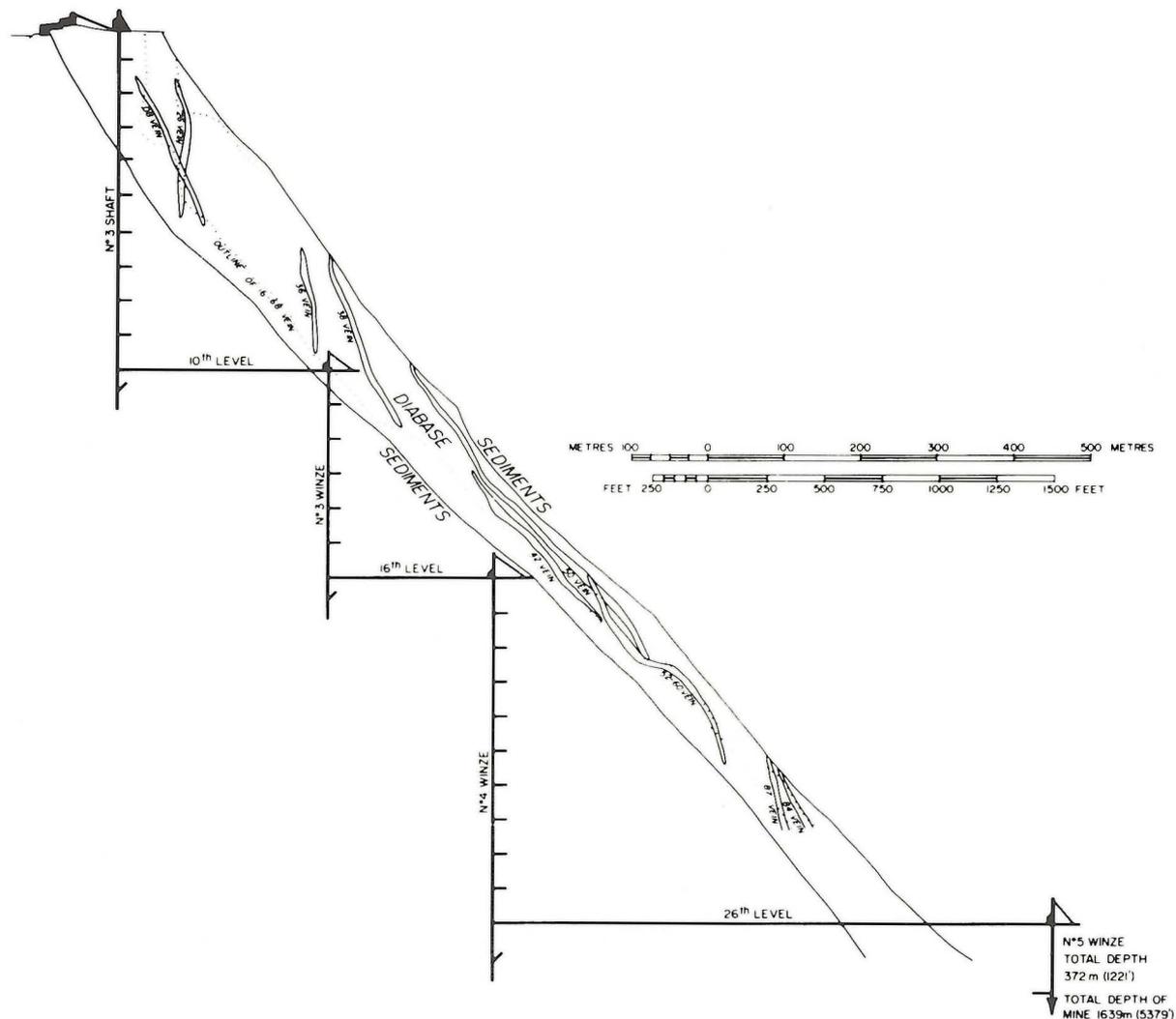


Figure 3. Diagrammatic cross section through the San Antonio Gold Mine, looking west. The gold-bearing veins occur in a sheet of diabase sandwiched between metasediments. Vertical distance between levels averages 45.72 m (150 feet).

4. Central Manitoba Mine

This, Manitoba's first gold mine, was in production from 1927 to 1937. In all, eight separate deposits were mined, within a narrow tectonized belt about 2.8 km (1.7 miles) long. Five shafts were in use at various times, and over 16 km (9.9 miles) of galleries were driven. Although a depth of 277 m (908') was reached late in the life of the mine, little ore was found deeper than 114 m (374').

The deposits are located at or close to the contact between volcanic rocks and a mafic sill. A band of cherty tuff is host to several of the more productive veins. The veins occupy subparallel shear zones, and are flanked by quartz-chlorite-carbonate-pyrite alteration of the wall rocks. The ore material in the veins consists of pyrite, chalcopyrite and some pyrrhotite. Gold is present partly as microscopic free gold, and partly in the pyrite and

chalcopyrite. The ore contains 0.5% copper — an unusually high figure in this district.

References: Campbell, 1971; Russell, 1952a; Stephenson, 1971, 1972; Stockwell and Lord, 1939; Weber, 1971a, 1971b; Wright, 1932.

5. Solo - Oro Grande Mine (Beresford Lake)

Gold was produced on a small scale at this property during 1932-34 and again from 1938 to 1940. Hoisting was from two shafts which were connected underground. The deeper of these reached 160 m (525') below surface. Mineralization occurs in rather weak and discontinuous systems of quartz stringers and lenses in shear zones which cut a mafic sill. The ore mineralogy is pyrite, chalcopyrite, pyrrhotite, sphalerite and gold — the latter occur-

ring erratically, often in the free state. Wall rock alteration is principally quartz-carbonate-chlorite-pyrite, with biotite and specular hematite.

References: Russell, 1952a; Stephenson, 1971, 1972; Stockwell and Lord, 1939; Weber, 1971b; Wright, 1932.

6. Ogama-Rockland Mine

In contrast to the geological setting of most deposits of the district, the country rock at this locality is quartz diorite. The Ogama and Rockland deposits are of similar type, occurring in veins which occupy shear zones about 500 m (1640') apart. The Ogama vein is for the most part less than 30 cm (1') wide, and the Rockland vein varies in thickness from 30 cm (1') to almost 1 m (3').

The ore assemblage is pyrite and chalcocopyrite, with minor sphalerite, galena and arsenopyrite, and the gangue is quartz with a little sericite. Free gold was observed on the dumps. Wall rock alteration reflects the granitic composition of the host and is largely quartz, sericite, carbonate and pyrite; chlorite is scarce.

The Ogama shaft reached a maximum depth of 314 m (1 092') and the Rockland shaft 83 m (272'). During the initial phase of production, cut short by the Second World War, ore from the Ogama deposit was trucked 13 km (8 miles) to the Gunnar mill, the Gunnar operation having at that time (1942) already ceased. In 1946, the Gunnar surface installation was moved to the Ogama-Rockland site and the mine resumed production from 1948 to 1951.

References: Russell, 1952a; Stephenson, 1971, 1972; Stockwell and Lord, 1939; Weber, 1971b; Wright, 1932.

7. Gunnar Mine

The country rocks at this locality are a series of mafic to intermediate lavas, some showing distinct pillow structures, which indicate underwater volcanic eruption. These rocks are intersected by a large dyke-like body of albite granite which is probably an apophysis of an underlying granitic pluton emplaced in the core of an anticline.

Quartz lenses, veins, and stockworks — rarely exceeding 1 m (3') in width, occur in a group of shear zones which cut both the volcanic rocks and the granitic body. Mining was mainly restricted to the veins of one of these zones, which crosses the southern extremity of the felsic dyke. Ore grade mineral-

ization is confined to mafic host rock, and the productive ore bodies are near the margin of the granitic dyke.

The ore assemblage consists of abundant pyrite, with lesser amounts of sphalerite, pyrrhotite and galena. Gold occurs principally as the native metal, predominantly in quartz, and quite often visible to the naked eye. In addition to quartz, the gangue material contains some ferruginous carbonate and subsidiary amounts of calcite, albite, sericite and tourmaline. Minor amounts of fuchsite occur sporadically. The sheared wall rocks show strong chlorite-carbonate-pyrite alteration.

The main shaft reached a depth of 625 m (2 050').

References: Campbell, 1971; Russell, 1952a; Stephenson, 1971, 1972; Stockwell and Lord, 1939; Weber, 1971a, 1971b; Wright, 1932.

8. Diana Mine (Gem Lake)

Operated during its early history by Gem Lake Mines Limited, this mine was later the property of Diana Gold Mines Limited.

The mineralized quartz veins at this locality are in shear zones which cut gabbro. The sulphide minerals are pyrite and pyrrhotite, with lesser chalcocopyrite, arsenopyrite, sphalerite and galena; free gold was seen in dump material. Ankerite, calcite, chlorite and minor tourmaline are present in the veins as gangue minerals. The sheared wall rock has undergone chlorite-carbonate-pyrite alteration.

This small mine — 45 tonnes (50 tons)/day maximum — had six levels at 38 m (125') intervals, served by a 236 m (775') vertical shaft. The bulk of the production took place during the years 1934-36.

References: Russell, 1952b; Stephenson, 1971, 1972; Weber, 1971b; Wright, 1932.

9. Island Lake Mine

The country rocks in this vicinity consist of a varied suite of metamorphosed volcanic and sedimentary strata, intersected by minor felsic intrusions. The deposit lies at or close to the folded contact between argillaceous metasedimentary rocks and a sericitic schist which probably represents a sheared, altered felsic igneous rock. Sinuous, boudinaged, dyke-like bodies of carbonate are thought to be of primary — perhaps volcanic exhalative — origin. The rocks are strongly folded and faulted (Figure 4).

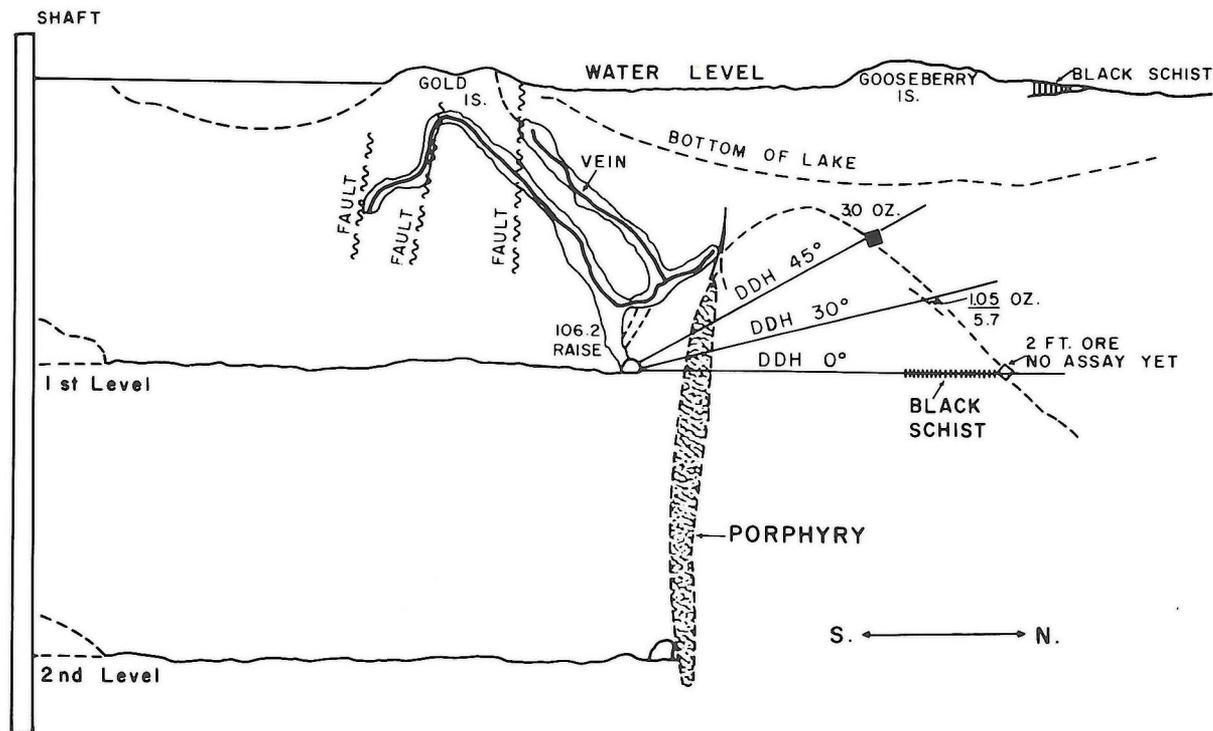


Figure 4: Diagrammatic cross section (not to scale), looking west, of the Island Lake Mine (The Northern Miner, April 11, 1935).

The principal area of mineralization underlies a tiny islet and is connected by a cross-cut to the 83 m (273') shaft situated on a larger island close by. Several quartz veins, lenses, and stockwork systems were intensively explored by underground workings and diamond drilling. The veins, like their host rock, proved to be contorted and faulted, and zones of mineralization, sufficiently continuous to support a profitable mining venture, proved elusive. After a little more than a year of operation, production ceased.

Both the vein material and its adjacent wall rock are reported to be mineralized with pyrite, galena, sphalerite and minor chalcopyrite; gold is associated with the sulphides.

References: Godard, 1963; McMurchy, 1944.

10. Gods Lake Mine

This deposit consists of mineralized quartz veins within a steeply dipping layer of water-laid tuff intercalated in a sequence of pillow lavas. A thick mafic dyke lies close to the tuff bed and in places cuts it. Minor felsic dykes cut all of these rock types.

The ore assemblage comprises pyrite, arsenopyrite, pyrrhotite, rare chalcopyrite and sporadic native gold. Other than quartz, no gangue minerals of importance are present.

The tuffaceous wall rock shows extensive silicification, with disseminated pyrite and pyrrhotite.

The mining operation was centred on the No. 1 shaft, 276 m (905') deep. Late in the history of the mine, a second shaft was sunk on the ore horizon at a distance of 1 895 m (6 215') from shaft No. 1, reaching a depth of 572 m (1 876'). Exploration from the second shaft failed to increase the ore reserves.

An interesting feature of this deposit is the stratabound nature of the mineralization. The gold-bearing veins are confined to the tuff bed, and no mineralization of any significance has been found in shear or fracture zones in the pillowed lavas. Nearly all of the gold occurrences in the God's Lake and Knee Lake regions are of similar type.

References: Baker, 1935; Barry, 1961; Dix, 1951.

11. Nor-Acme Mine

This deposit lies close to the contact between strongly folded felsic and mafic volcanic sequences which may be part of an ancient volcanic centre. Both felsic and mafic units have been penetrated by numerous small hornblende intrusions, and all of the rocks mentioned have been intensely metamorphosed.

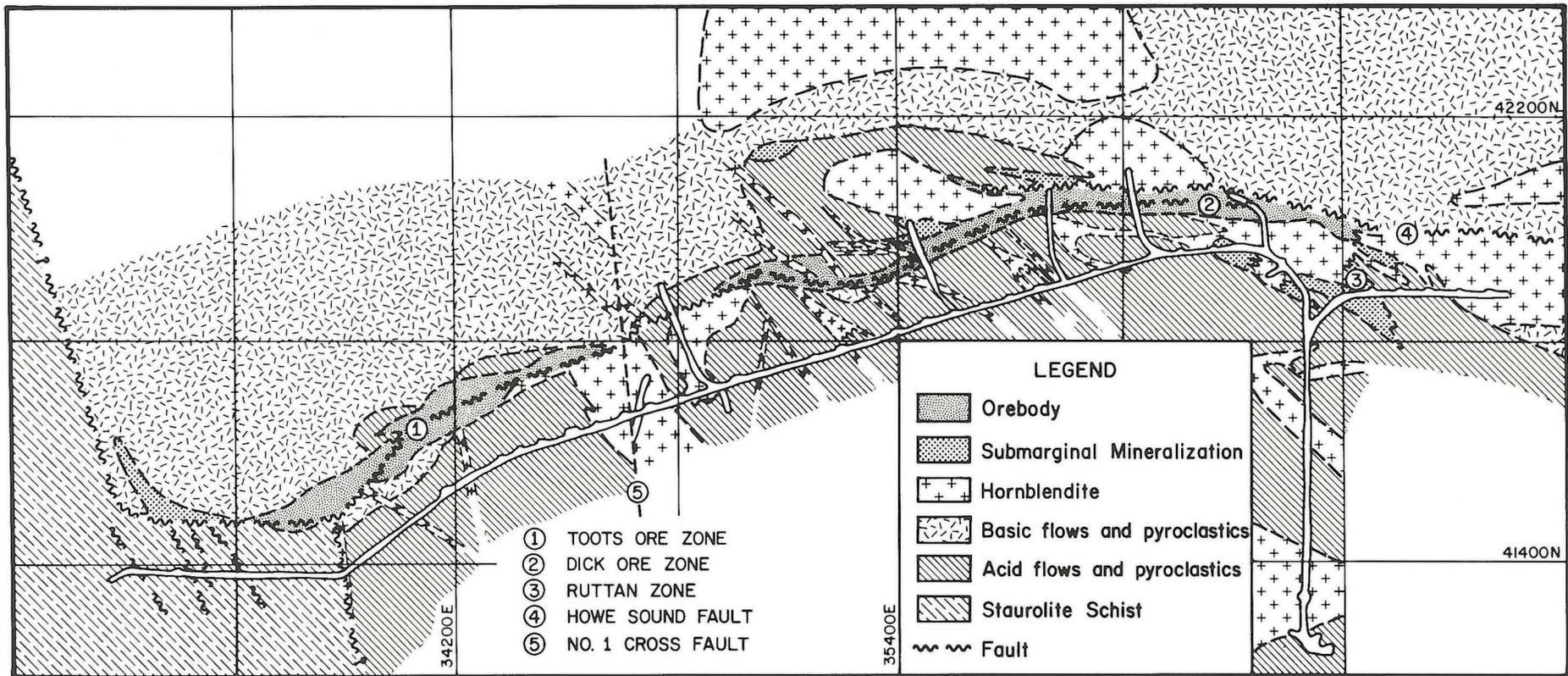


Figure 5. Geological plan, 1,300 level, Nor-Acme Mine (Hogg, 1957).

Mineralization appears to be closely related to a fault which lies roughly parallel to the contact between the volcanic units; in places the fault coincides with the contact, elsewhere it persists for hundreds of metres in one or other of the volcanic units (Figure 5). The mineralized zone, which has an average inclination of 45°, is a more or less continuous quartz vein system, commonly manifest as a stockwork of veinlets and stringers, accompanied by intense silicification. It is known to follow the fault for a length of 600 m (1 968') and down to the greatest depth explored (~590 m), (1 935'). The widest and richest parts of the mineralized zone occur in the felsic volcanic unit.

The ore material consists of arsenopyrite, pyrite and pyrrhotite, in an abundant gangue of sugary quartz containing numerous inclusions of the wall rocks, commonly in an advanced state of silicification. Gold is present as microscopic particles, closely associated with needles of arsenopyrite which, in the richer sections, form felt-like aggregates. Wall rock alteration consists principally of silicification, particularly in the felsic rocks; in the mafic rocks, and above all in the hornblendite, there is also strong carbonate replacement. Disseminated pyrrhotite and minor chalcopyrite are also present in the wall rock.

In terms of tonnage mined — over 4.5 million tonnes (five million tons) and milling rate — 1 810 tonnes (2 000 tons)/day capacity — this was the largest gold mining operation in Manitoba. Although grade was low (3.87 g/tonne — 0.11 oz/ton average over the life of the mine), stoping widths of as much as 30 m (98') and good continuity of the ore body allowed mining costs to be kept low.

References: Ebbutt, 1944; Harrison, 1949; Hogg, 1957; Russell, 1957.

12. Laguna Mine

This mine was the most important of a group of quartz vein deposits of rather similar characteristics located within or close to a belt of elongated stocks of felsic porphyry which intrude metamorphosed volcanic and sedimentary strata on the eastern shore of Wekusko Lake. The veins occupy planar fissure openings with only weak accompanying shearing.

The main Laguna vein, which occurs principally within porphyry host rock, has a total length of 640 m (2 100') and an average width of 0.75 m (2.5'). Mineralization is predominantly of arsenopyrite, with associated minor amounts of galena, sphalerite, pyrite and

native gold. Pyrrhotite is found from the 152 m (498') level downward. Small quantities of tourmaline, carbonate, feldspar and muscovite are present in the vein quartz. The wall rock contains disseminated arsenopyrite, a little carbonate and some sericite; the degree of silicification is uncertain.

The main shaft reached a depth of 343 m (1 125').

References: Stockwell, 1937.

13. Gurney Mine

This deposit is located in a sector of greenstones surrounded and intruded by granite bodies. The greenstones consist of basalt and tuff layers, with intercalated lenses of iron sulphides. The gold does not occur in these sulphide concentrations, but instead is located in quartz veins in shear zones which cut the volcanic rocks — particularly the tuffs. The sulphide minerals are pyrite, pyrrhotite, chalcopyrite and galena, with minor sphalerite and molybdenite. Besides quartz, the chief gangue mineral is carbonate. Gold is present mainly in the free form, as microscopic granules. Wall rock alteration is dominated by a quartz-chlorite-carbonate assemblage.

This was a 113 tonnes (125 tons)/day operation, served by a 200 m (656') shaft. An interesting feature, unusual in the gold deposits of Manitoba, is the exceptionally high silver: gold ratio of 2.84:1 (as opposed to a more usual ratio of 1:6 or less).

References: Hage, 1944; Podolsky, 1951; Radvak, 1973.

14. Agassiz Deposit

This deposit lies within a narrow, steeply inclined sequence of alternating volcanoclastic beds and mafic flows, intercalated between more massive lava sequences. The volcanoclastic layers include a felsic tuff of cherty aspect, reminiscent of "cherty tuff" horizons which occur at the Gods Lake Mine. The rocks have been strongly metamorphosed.

Mineralization takes the form of disseminated microscopic gold, and sulphides (pyrrhotite and pyrite, lesser arsenopyrite, sparse galena and sphalerite) in a rather diffuse tabular vertical zone characterized by intense replacement of the host rocks by sugary quartz, and carbonate. Quartz stringers are common in this zone, but well defined quartz veins are absent. The mineralized zone is known to persist for a strike length of 1 240 m



Plate 2. Dr. M.H. Frohberg on the discovery outcrop, Nor-Acme Mine, 1943.

(3 400'); widths of more than 10 m (32') persist for considerable distances, and widths of over 25 m (82') are present locally.

One hundred and five diamond drill holes with an aggregate length of nearly 22 000 m (72 000') have been drilled on this property, and underground workings consist of a 149 m (488') shaft and 803 m (2 636') of lateral development. To date, however, there has been no production.

Extensive diamond drilling from surface and underground indicates possible reserves of 2 720 000 tonnes (3 000 000 tons) averaging 4.45 g/tonne (0.13 oz/ton).

References: Milligan, 1960; Worobec, 1979.

ORIGIN OF THE DEPOSITS

It is unusual to find two geologists who agree entirely on the explanation of any geological process, and the origin of gold deposits is no exception. The following summary is nevertheless thought to be in reasonable accord with general geological opinion at the present time (e.g. Hutchinson, 1975; Anhaeusser, 1976).

It is likely that the constituents which make up the ore and gangue materials of gold deposits, and impregnate the wall rocks, were to a large extent extracted from the country rocks of the wider vicinity (Fyfe and Henby, 1973; Kerrich and Fryer, 1979). In a majority of cases, such rocks would be of mafic composition. Extraction of the necessary amounts of gold, sulphur, silica, lime and other substances is thought to have been achieved by systems of circulating hot water (Fripp, 1976). Such systems find a parallel in certain geothermal fields of present day New Zealand, where hot spring deposits carry approximately the grade of gold which formerly was mined in Manitoba (Ellis, 1969). However, in Precambrian Manitoba, the circulating waters, believed to have been the concentrating agents of the gold deposits, were active, in some cases at least, beneath the ocean floor. Much of the heat required to maintain the activity of such systems would have been provided by the mafic and felsic intrusions which abound in most of the greenstone areas, and perhaps by less localized regional metamorphic processes.

The circulating waters led to primary mineralization of two principal contrasting



Plate 3. Earl Brydges' dog team at Gurney Camp, 1936.,

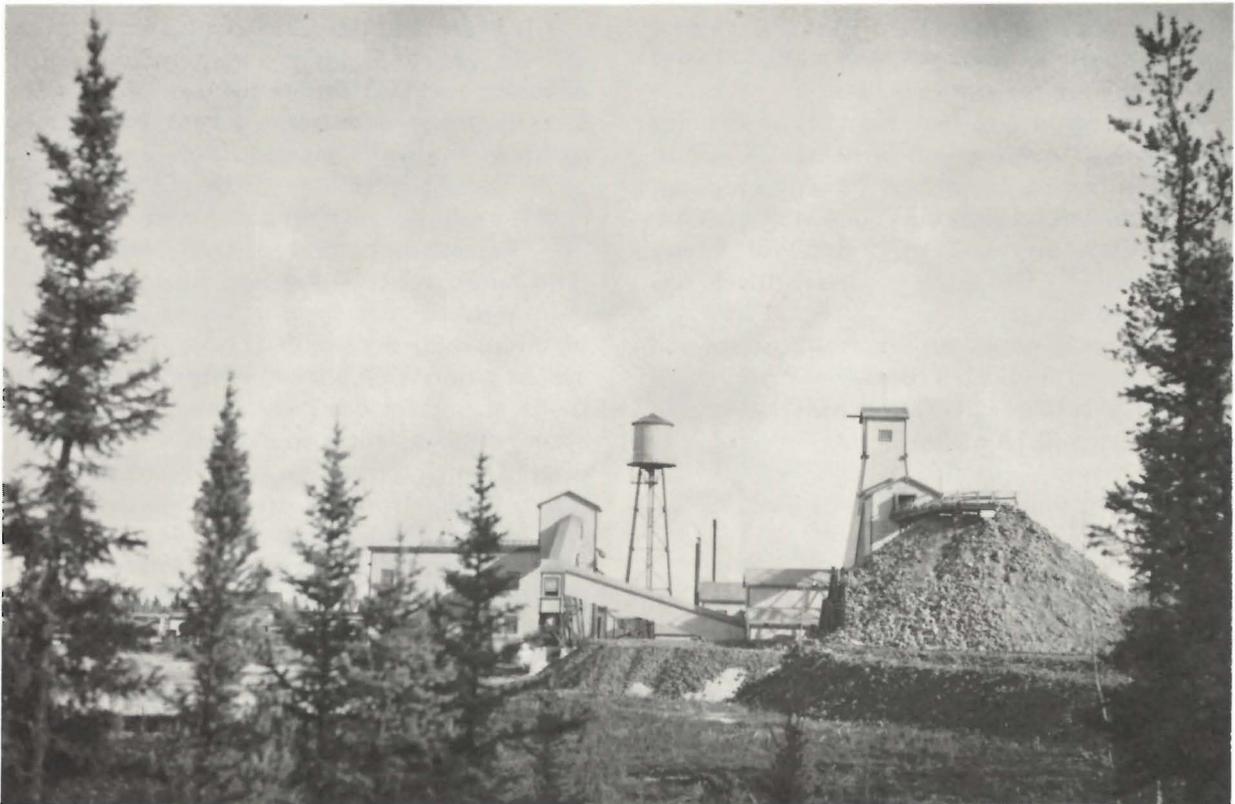


Plate 4. Gurney Gold Mine, 1939.

styles: (i) vein deposits, formed in fractures and other channelways, (ii) stratabound exhalite deposits (Ridler, 1973). Deposits of the first type are sufficiently well known to require no further comment. The San Antonio, Gunnar, Ogama-Rockland, Solo - Oro Grande and Diana mines, and numerous other minor occurrences of gold mineralization in the Rice Lake gold district, evidently belong to this category.

Submarine exhalites are chemical sediments formed where hot springs emerged at the sea floor and deposited their dissolved mineral substances (including gold) as stratified accumulations of silica, carbonate, sulphides, etc. The primary mineralization of certain important gold mines has been attributed to the exhalite process: e.g. the Homestake Mine of South Dakota (carbonate ore) (Rye and Rye, 1974) and the Agnico-Eagle Mine, Quebec (sulphide ore) (Barnett et al, in press).

In Manitoba, gold of presumed exhalative origin is a significant constituent of the *massive sulphide deposits* of the Flin Flon and Lynn Lake greenstone belts (Price, 1977). Present geological opinion overwhelmingly supports an exhalative origin for such massive sulphide bodies (Hutchinson, 1973; Sangster, 1976). Turning to gold deposits, the Central Manitoba, Gurney, Island Lake, Gods Lake and Agassiz properties all meet one important requirement of exhalite mineralization: namely, they seem to a large extent to be stratabound, occurring within bedded, water-laid deposits. However, all these deposits have been overprinted to a greater or lesser degree by defor-

mation and recrystallization. Thus, although an exhalative association is suspected, it has not yet been rigorously proven.

Gold disseminated in felsic igneous rocks, particularly quartz porphyry, is of fairly widespread occurrence in the Province. It is speculated that gold extracted from mafic country rocks by magmatic assimilation or by hydrothermal leaching was in many instances incorporated in felsic magmas and enriched in late, siliceous magmatic fractions exemplified by the Sunbeam-Kirkland pipe (Stewart, 1977b), and by gold bearing quartz-porphyry dykes at a number of widely scattered localities.

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Photographs used in this publication are from the archives of the Manitoba Mineral Resources Division.

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REFERENCES

- Anhaeusser, C.R.
1976: The nature and distribution of Archaean gold mineralization in southern Africa; *Mineral Science and Engineering*, v. 8: 46-84.
- Baker, W.F.
1935: Geology of Gods Lake Gold Mines Limited; *Trans. Can. Inst. Min. Met.*, v. 38: 155-162.
- Barnett, E.S., Hutchinson, R.W., Adamcik, A. and Barnett, R.,
in press: Geology of the Agnico-Eagle gold deposits, Quebec; *Econ. Geol.*, Robertson Volume.
- Barry, G.S.
1961: Geology of the Gods Narrows area; *Man. Mines Br.*, Publ. 60-1.
- Campbell, F.H.A.
1971: Geology of the Dove Lake-Tinney Lake area; *Man. Mines Br.*, Map 71-1/7.
- Davies, J.F.
1954: Geology of the West Hawk Lake-Falcon Lake area; *Man. Mines Br.*, Publ. 53-4.
- Dix, W.F.
1951: Geology of the Gods Lake area; *Man. Mines Br.*, Preliminary Report 47-4.
- Ebbutt, F.
1944: The Nor-Acme property of the Howe Sound Exploration Company; Snow Lake, Herb Lake Division, Manitoba; *The Precambrian*, v. 17, no. 7: 6-11.
- Ellis, A.J.
1969: Present day hydrothermal systems and mineral deposition; *9th Commonwealth Mining and Metallurgy Congress, Mining and Petroleum Geology Section*, Paper No. 7, I.M.M., London: 1-30.

- Fripp, R.E.P.
1976: Stratabound gold deposits in Archean banded iron formation, Rhodesia; *Econ. Geol.*, v. 71: 58-75.
- Fyfe, W.S. and Henby, R.W.
1973: Some thoughts on chemical transport processes with particular reference to gold; *Mineral Science and Engineering*, v. 5: 295-303.
- Godard, J.D.
1963: Geology of the Island Lake-York Lake area; *Man. Mines Br.*, Publ. 59-3.
- Hage, C.O.
1944: Geology of the Gurney Gold Mine area, Manitoba; *The Precambrian*, v. 17, no. 4: 5-7, 25.
- Harrison, J.M.
1949: Geology and mineral deposits of the File-Tramping Lakes area, Manitoba; *Geol. Surv. Can.*, Mem. 250.
- Hogg, N.
1957: Nor-Acme Mine; in *Structural Geology of Canadian Ore Deposits, Volume II: C.I.M.M.*: 262-275.
- Hutchinson, R.W.
1973: Volcanogenic massive sulphide deposits and their metallogenic significance; *Econ. Geol.*; v. 68: 1223-1246.
1975: Lode gold deposits: the case for volcanogenic derivation; from Pacific Northwest Metals and Minerals Conference, Fifth Gold and Money Session and Gold Technical Session, Portland Oregon, April 6-9, 1975; *State of Oregon Dept. of Geol. and Mining*.
- Kerrick, R. and Fryer, B.J.
1979: Archean precious-metal hydrothermal systems, Dome Mine, Abitibi Greenstone Belt. II. REE and oxygen isotope relations; *Can. J. Earth Sci.*, v. 16: 440-459.
- McMurchy, R.C.
1944: Geology of the Island Lake area; *The Precambrian*, v. 17, no. 9: 4-9.
- Marr, J.M.
1971: Geology of the Wanipigow River suite, Wanipigow River area, Southeastern Manitoba; *Man. Mines Br.*, Map 71-1/8.
- Milligan, C.C.
1960: Geology of the Lynn Lake district; *Man. Mines Br.*, Publ. 53-1.
- Phillips, K.A.
1979: Minerals of Manitoba, Volume II: Metallic Minerals; *Man. Mineral Res. Div.*, MRD Educational Series 78/2.
- Podolsky, T.
1951: Cranberry Portage (east half); *Geol. Surv. Can.*, Prelim. Map 51-17.
- Price, D.
1977: Tour Guide Flin Flon-Snow Lake geology, October 3-6, 1977 (C.I.M. Field Trip); *H.B.M.&S. Co. Ltd.*, Flin Flon, Man.
- Radvak, S.
1973: Report on the Royal Agassiz property, Lynn Lake, Manitoba; in 1973 Prospectus of Royal Agassiz Mines Limited.
- Ridler, R.H.
1973: Exhalite concept: a new tool for exploration; *The Northern Miner*, Nov. 29, 1973.
- Russell, G.A.
1948: Geology of the Wallace Lake area; *Man. Mines Br.*, Prelim. Rept. 47-1.
1952a: Structural studies of the Long Lake-Halfway Lake area; *Man. Mines Br.*, Publ. 49-6.
1952b: Geology of the Lily Lake-Kickley Lake area; *Man. Mines Br.*, Publ. 50-3.
1957: Structural studies of the Snow Lake-Herb Lake area; *Man. Mines Br.*, Publ. 55-3.
- Rye, D.M. and Rye, R.O.
1974: Homestake Gold Mine, South Dakota: 1. Stable isotope studies; *Econ. Geol.*, v. 69: 293-317.
- Sangster, D.F. and Scott, S.D.
1976: Precambrian, stratabound, massive Cu-Zn-Pb sulfide ores of North America; in *Handbook of Stratabound and Stratiform Ore Deposits: II Regional Studies and Specific Deposits* (K.H. Wolf, Ed.), *Elsevier*, v. 6: 129-222.
- Stephenson, J.F.
1971: Gold deposits of the Rice Lake-Beresford Lake greenstone belt, Manitoba; in *Man. Mines Br.*, Publ. 71-1: 337-374.
1972: Gold deposits of the Rice Lake-Beresford Lake area, southeastern Manitoba; Univ. of Man., unpubl. Ph.D. thesis.
- Stewart, J.W.
1977a: MEA-1 Gold evaluation program; in Report of Field Activities 1976; *Man. Mineral Res. Div.*, Mineral Eval. & Admin. Br.:9.
1977b: MEA-1 Gold evaluation program; in Report of Field Activities 1977; *Man. Mineral Res. Div.*: 105-108.
- Stockwell, C.H.
1937: Gold deposits of the Herb Lake area, northern Manitoba; *Geol. Surv. Can.*, Mem. 208.
1938: Rice Lake gold area, southeastern Manitoba; *Geol. Surv. Can.*, Mem. 210.
1945: Rice Lake; *Geol. Surv. Can.*, Map 810A.
- Stockwell, C.H. and Lord, C.S.
1939: Halfway Lake-Beresford Lake area; *Geol. Surv. Can.*, Mem. 219.
- Weber, W.
1971a: Geology of the Wanipigow River-Manigotagan River region; *Man. Mines Br.*, Map 71-1/4.
1971b: Geology of the Long Lake-Gem Lake area; *Man. Mines Br.*, Map 71-1/5.
- Worobec, A. (Ed.)
1979: Canadian Mines Handbook 1979-1980; *Northern Miner Press*.
- Wright, J.F.
1932: Geology and mineral deposits of a part of southeastern Manitoba; *Geol. Surv. Can.*, Mem. 169.

