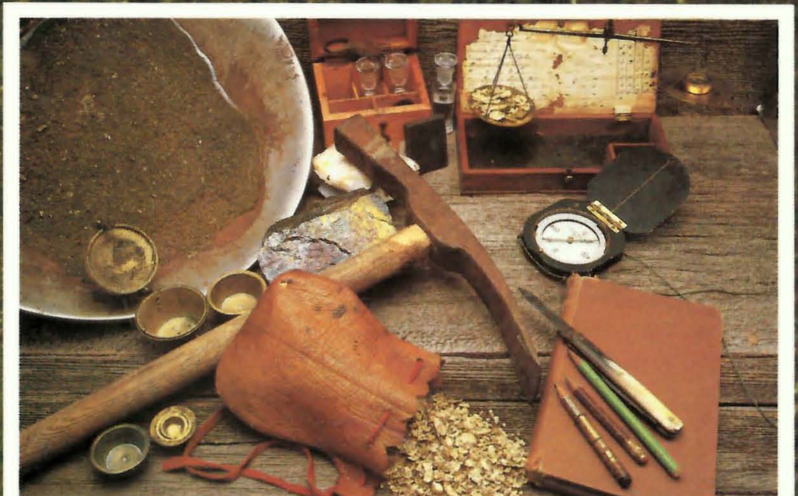
MINERAL EDUCATION SERIES



# Gold In Manitoba

Manitoba
Energy and Mines

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*Aussi disponible en francais.*

*Front cover photo insert courtesy of the Canadian Co-operative Credit Society*

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# MESSAGE FROM THE MINISTER OF ENERGY AND MINES

Manitoba's abundant mineral resources form a vital part of our province's rich natural resource heritage. It is almost impossible to spend even a day in our province without using some item which contains a tiny part of this heritage. Your home or workplace, no doubt, has concrete which includes our abundant sand and gravel. Or perhaps it uses building stone from one of Manitoba's quarries. Somewhere in your home there is likely to be copper pipe or wire which may well have originated from a northern Manitoba mine. The same mines produce the zinc which is used to galvanize much of the metal in your car to retard rust. You probably sit down to dinner with stainless steel cutlery which require nickel -- one of Manitoba's richest mineral resources. Your car may use gasoline refined from Manitoba oil. You may even use Manitoba's gold when you exchange rings on your wedding day.

In getting these resources out of the ground and into your life, Manitoba's mining, quarrying and oil industries create thousands of jobs for Manitobans, including everything from clerks to miners to executives. These people, in turn, spend their salaries on goods and services which provide the lifeblood for countless more employees and businesses. In total, these industries and their spin-off benefits make a major contribution to Manitoba's prosperity and stability.

These resources also provide a significant source of income for the provincial government. Royalties and taxes ensure that revenues from our natural resource heritage contribute to maintaining the level of services Manitobans expect. These revenues help pay for the quality schools, hospitals and roads which make Manitoba a fine place to live.

In the Mineral Education Series, we hope to increase Manitobans' awareness of the wealth and variety of our mineral resources and their importance. Each booklet in the series explains one aspect of our mineral industry, describing the mineral resources, the history of its development in Manitoba and the industry today. We hope the series will convey some of the importance and excitement of exploiting Manitoba's mineral resource heritage.

In **Gold in Manitoba,** we look at an industry which is experiencing a resurgence in strength, not only in Manitoba, but worldwide. For the first time in almost two decades, Manitoba is a gold mining province, and several new gold mines are being opened in the north. Companies are also devoting more and more of their exploration money to the search for gold in Manitoba. In **Gold in Manitoba,** we examine some of the reasons for this renewal in Manitoba's gold industry.

Throughout this history, Manitoba Energy and Mines and its provincial predecessors have played a role in strengthening Manitoba's mining industry, and ensuring our mineral heritage is carefully developed. In **Gold in Manitoba,** J. W. Stewart, formerly a geologist with the Department, introduces us to the history, geology, and technology of Manitoba's gold industry. Mark Fedikow, a geologist in the Geological Services Branch, helped to update the text in this revised edition. I would like to thank them, and all the other staff of our Department, for sharing this part of Manitoba's mineral resource story.

Jerry Storie
Jerry Storie
Minister

# Gold in Manitoba

## INTRODUCTION

### New Life for Manitoba Mining

Until 1985, Manitoba's gold reserves had lain dormant for almost two decades. Since 1968, about 1 525 kilograms of gold had been produced annually, as old mine dumps were reworked in the Rice Lake area, and gold was recovered as a by-product of mining base metal concentrates in the Thompson, Flin Flon, Snow Lake, and Lynn Lake areas. Still, there had been no operating gold mines in the province for 17 years.

In May 1985, a rainbow of hope in Lynn Lake gave way to a pot of gold. Sherritt Gordon Mines Limited indicated it was prepared to construct and operate the MacLellan gold mine near Lynn Lake. This was a critical economic decision for a town facing the imminent shutdown of its major employer, the Fox Mine, a depleted producer of copper and zinc. Ore reserves of 1.45 million tonnes were established at MacLellan, sufficient for about five years of production from the new gold mine.

With a continuing poor outlook for the prices of most base metals, many mining companies worldwide are shifting resources to gold -- a metal for which ready profits still exist. They are spending about 80 per cent of their exploration money on the search for gold.

In Manitoba, many reserves of other common metals, such as copper, nickel, and zinc, are near depletion. The MacLellan Mine, expected to produce 2 000 kilograms of gold per year, employs 211 Manitobans. MacLellan is only the first of a number of developments that could help to revive Manitoba's mining and mineral processing industry.

Exploration drilling is being conducted at a gold find at Alberts Lake, 35 kilometres northeast of Flin Flon. Prospectors, geologists and investors predict the property's reserves could be sufficiently high-grade to merit a mining operation.

Eight kilometres west, at Tartan Lake, Granges Exploration Limited and Abermin Corporation brought a new gold mine into production in 1987. Pioneer Metals' Puffy Lake Mine is also scheduled to go into production very late in 1987.

Bissett's San Antonio Mine, a gold producer from 1932-68, could be brought back into production as the Bissett Mine in the latter half of 1988. The mine and mill could employ up to 155 people.

At the Snow Lake gold recovery plant, owned by Snow Lake Gold Corporation, stockpiled arsenical gold concentrates could begin to be processed late in 1987.

Manitoba Mineral Resources and its partner, Farley Lake Gold Incorporated, could decide to begin constructing a mine on the Farley Lake gold deposit in 1988. The companies are spending roughly $2 million for drilling about 39 kilometres east of Lynn Lake, and prospects are encouraging.

At Snow Lake, an underground exploration program from 1987-91 is scheduled at the old Nor-Acme Mine and mill, which produced from 1948-58. Nor-Acme Gold Mines and its partner, High River Resources, expect to spend $6 on the project.

On the Snow Lake Property, Snow Lake Mines, a subsidiary of Silver Hart Mines, may bring a mine and mill into production in the fall of 1988, just north of Snow Lake.

In the same area, Zenco Resources have launched an exploration program worth $250,000 in 1987-88 on the Squall Lake Property.

On the High Rock Island Property, at Island Lake, Big Horn Development has built a test mill which is expected to be brought into full production in 1989. Twenty-six employees now staff the mill, with a potential for 50-60 employees at full production.

A 1987 drill program at the Lasthope Property, south of Lynn Lake, is costing Balcor Resources $800,000.

On the Goldbeam Property, near West Hawk Lake, Goldbeam Resources has mounted a $2 million exploration program, and will sink $5 million into the property if development is warranted. A potential open pit mine and a tank leaching operation could be developed at this site.

### Gold Exploration and Development in Manitoba: A Brief History

After the 1879 gold discoveries in the Black Hills of South Dakota, prospectors moved north. Manitoba's first documented gold discovery occurred in 1911 in the southeast at Rice Lake, near the present town of Bissett, when Major E. A. Pelletier, of the North West Mounted Police, staked the Gabrielle claims. Pelletier's assistant, Alex Desautels, later staked the claim that, in 1932, was to become the prosperous San Antonio Mine.

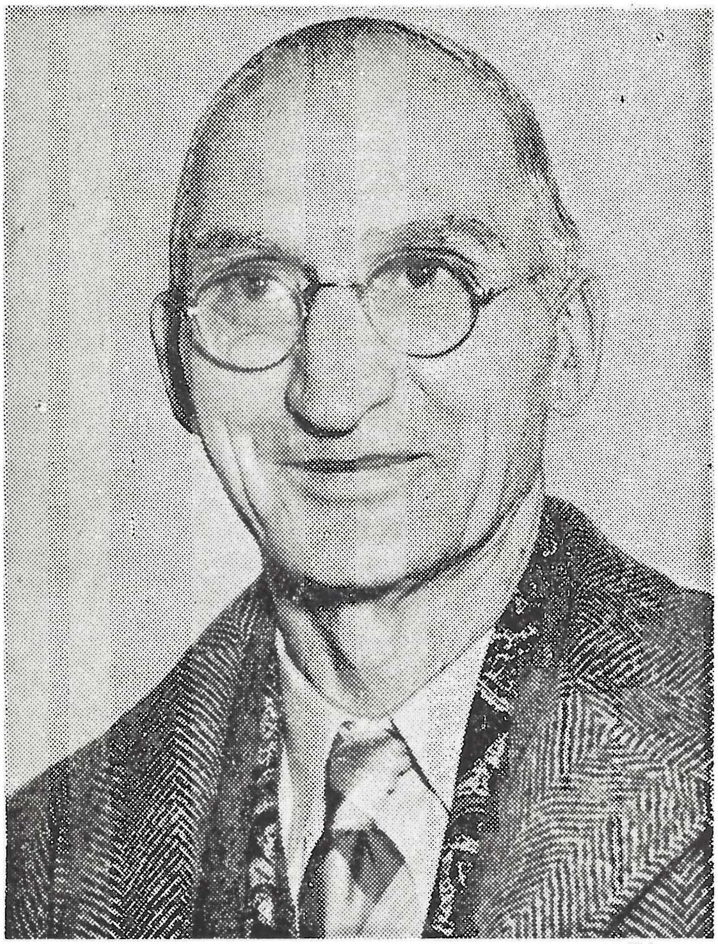
From 1896 onward there was some prospecting north of The Pas, but the first systematic searches didn't begin until 1907. The 1912 incorporation of The Pas as a rail and supply staging town to the north quickened the pace of northern prospecting.

Gold was discovered in 1914 on the east shore of Wekusko (Herb) Lake, 140 kilometres northeast of The Pas. A shaft was sunk on one of the properties staked at that time, the Moose Horn claim, in order to explore it further. In the first recorded shipment of gold (and metal) from Manitoba, 25.4 tonnes of gold-bearing quartz were shipped in 1917 from Moose Horn to Trail, BC, bringing an average of $81 a ton. 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.

In 1918, the Rex claims at Wekusko Lake produced 43 kilograms of gold valued at $27,000. In 1924-25, these claims produced 172 kilograms. In 1933, the Rex claims became the Laguna Gold Mines Limited operation, which produced gold and silver valued at $1.8 million.

The first of many small gold mines in the Rice Lake area was the Kitchener Mine at Long Lake, operated by Central Manitoba Mines Limited from 1927 to 1937. Others that followed were the Tene, Growler and Hope Mines next to Kitchener, operated by Central Manitoba from

**The Telegram**, Friday, February 25, 1949



Telegram

A mining man "should always stick with what he thinks looks right," says Chris Parres, smiling broadly as success is achieved after 25 years of struggle to make a mine.

# Went Broke Thrice But Finds A Mine

A quarter century has passed since Chris. R. Parres, 72, of Saskatoon, staked a small piece of mining property at Herb Lake, northern Manitoba, but his tenacious pioneer faith has been rewarded.

Nor-Acme Mines, under guidance of Howe Sound Exploration Co., has spent $7,500,000 to enable it to start production in mid-March at 2,000 tons daily. Howe Sound, one of the major U.S. mining companies, took up the Nor-Acme option in 1940, and guaranteed to bring the property to production. Had not the war interfered it would have been brought to completion before this.

The veteran prospector, one-time rancher, mining camp cook, cattleman, farmer, storekeeper—and First War veteran—must have No. 3 as his jinx.

Visiting Toronto, Mr. Parres says he made three financing deals with brokers for Nor-Acme, of which he now is vice-president, and three times they fell through. He went broke three times, and three times he mortgaged his home.

The original claims were a fraction under three in number, the Toots, Birdie and Chum—called after his daughter, his wife and his boys. In 1941 three light X ray drills were used after Howe Sound showed interest in the property. Late in the same year three heavy drills completed 40,000 feet of drilling to outline the big gold orebody that is expected to run $5 to $7 per ton in value.

1932 to 1937; the San Antonio Mine, by far the biggest operation in the district, which ran continuously from 1932 to 1968 and was re-opened for a year by Brinco Limited in 1982; the Oro Grande from 1932 to 1934; the Gunnar Mine from 1936 to 1941; Ogama-Rockland from 1941 to 1942 and 1948 to 1951; and the Jeep Mine from 1947 to 1950.

San Antonio turned out to be Manitoba's most important gold mine. By the time production ceased in 1968, it had yielded 37 320.4 kilograms of gold. As well, San Antonio yielded 5 978.2 kilograms of silver during this period.

Farther north and east, high-grade gold was discovered at Island Lake in 1928 and on Elk Island in Gods Lake in 1932. Island Lake Gold Mines Limited produced 156 kilograms in 1934. The renowned prospector R. J. (Bob) Jowsey, who discovered the Elk Island deposit, established the prosperous Gods Lake Mine in this wilderness in 1935. This mine eventually produced 475 000 tonnes of gold ore, with a market value of $6 million, before closing in 1943.

The Gurney Mine, 40 kilometres east of present-day Flin Flon, produced 778 kilograms of gold between 1937 and 1939. The large Nor-Acme Mine on the northeast shore of Snow Lake, discovered by C. R. (Chris) Parres in 1925, produced 15.9 million grams of gold and 1.3 million grams of silver between 1949 and 1958.

The histories of the Mandy Mine and the Moose Horn property were to some extent prophetic with regard to future mining trends in Manitoba -- Mandy having turned out to be primarily a copper producer and Moose Horn ceasing production soon after it began. Many base metal deposits, mainly of copper, zinc, and nickel, were discovered during gold prospecting. Eventually, they became the mainstay of the Manitoba minerals industry. Gold mining, by comparison, has led a checkered career. Despite subsidies from the Emergency Gold Mining Assistance Act from 1948 onwards, gold mining was unable to survive between 1968 and 1985, except for Brinco's brief re-opening of San Antonio in 1982.

# USES OF GOLD

Gold is the ultimate symbol of wealth. In any culture in the world, whenever people talk about gold, they think of the eternal treasure -- the pot at the end of the rainbow.

Some 20 000 types of gold coins have been minted all over the world since it was first used as a currency. History shows that the use of gold as money began around 7000 B.C., in ancient Libya. It was not until about 6 000 years ago, however, that the first major gold mining began, with Egypt establishing its dominance as a gold producer. Between that time and the discovery of gold in North America, gold has been mined by the Romans in Spain, by the Spanish and Portuguese in Mexico and South America, and by the Russians in their own country.

In the nineteenth century, prospectors found gold in California and the western United States, as well as in Australia. The northern part of the continent joined the ranks of the gold producers around the turn of the century, with discoveries in the Yukon, Alaska, Quebec, and Ontario.

The largest gold deposit in the world to date was discovered in Witwatersrand, South Africa, in 1886. 'The Rand' has yielded over one-third of the world's all-time gold production, and South Africa now supplies two-thirds of the gold produced in the world each year.

The second largest producer is the Soviet Union. Major new discoveries at Hemlo, Ontario, and in Brazil have yet to be explored to reveal their size and value.

Gold has historically been a world currency. The eighteenth century saw the first successful attempt to arrive at a standard price for gold, when Sir Isaac Newton, Master of the Mint in London, England, made gold the standard currency and fixed its price at 84 shillings, 11 pence.

It was not until 1900 that the United States adopted the gold standard, making it possible for all currency to be converted into gold. In 1934, with the passage of the Gold Reserve Act, gold ceased to be a legal medium of domestic exchange in the U.S., and it became illegal for individuals and firms to own gold bullion, or uncoined gold in bars or ingots. At that time, gold was assigned a fixed international price of $35 U.S., and U.S. federal reserve notes had to have a 25 per cent gold backing.

In 1968, the international price of gold was finally allowed to rise in response to changes in supply and demand, and in 1970, the dollar was completely removed from the gold standard in the U.S.

Today, Switzerland is the only country that requires its currency to be backed by gold, and only by a small percentage. Most gold is purchased by Swiss banks. In general, gold's only monetary role is its use as an asset in official monetary reserves, and nowhere is it the regulator of domestic currency. Its international price is fixed twice a day in London, England. There, agents of five British banking concerns meet to assess daily supply and demand, and to set the free market price.

Traditionally, gold has served as the most reliable of investments and a hedge against inflation. Despite its loss of value as a world currency, speculators all over the world continue to purchase gold. Its value will not collapse in a recession or shrink with inflation, it cannot be taxed, and gold will not mildew or rust away. Gold doesn't merely represent value; it is value.

Roughly 80 per cent of exploration money being spent worldwide by mining companies is in the search for gold. This is due, in part, to recent good prices for gold and optimistic price forecasts.

Mining companies are also taking another look at gold properties that would not have been economic to mine a decade ago. Over the past few years, free world gold production has been compounding at 4 per cent.

The Gold Institute in Washington expects the world production of gold to increase by 21 per cent between 1985 and 1989, to 58.9 million ounces. Increased demand for gold on the part of investors and jewellers bears out the belief held by experts that an oversupply of gold is impossible.

Part of the reason demand remains high for gold may be the fact that, in addition to its value as a speculative investment, gold has growing industrial uses. These include dentistry, jewellery, and manufacturing. Gold's resistance to corrosion, high conductivity, malleability, and ductility make it ideal for applications in microcircuit, computer chip, and silicon diode production. Gold has a range of other uses, from plating parts in heat sinks in order to obtain better thermal conductivity to plating decorative objects. Gold vapour is also used for plating glass, since it enhances the beauty of a building and is an effective solar reflector. Finally, there continues to be a demand for gold used in the minting of coins.

*Kitchener Gold Mine, 1930.*

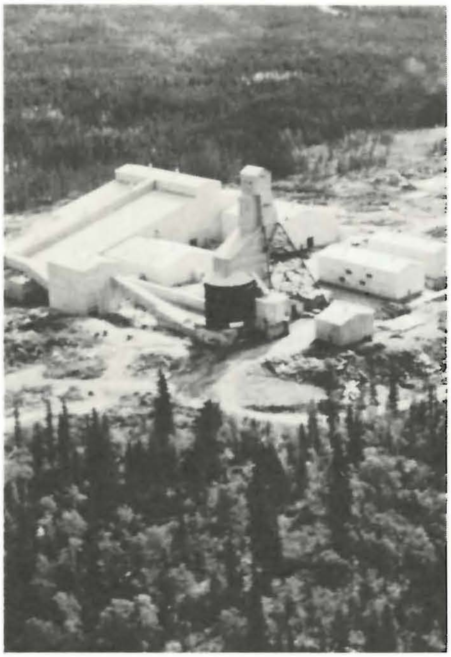
# DISTRIBUTION OF GOLD OCCURRENCES

Pioneer gold prospectors in Manitoba, unlike their predecessors in California and Australia, did not make their 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. The gold resources of Manitoba occur exclusively in Precambrian bedrock, and no alluvial gold deposits are known to exist.

'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 and quartz porphyry.

Precambrian gneiss belts -- broad regions of gneissic and granitic rocks, which separate and enclose the greenstone areas -- are now being recognized as potential hosts for gold mineralization. This is particularly true for the southern flank of the Kisseynew gneiss belt.



*Nor-Acme Gold Mine, 1949.*

The unmetamorphosed Paleozoic sedimentary strata, which cover the western part of the province, south of Flin Flon, and a zone about 150 kilometres wide around the southern margin of Hudson Bay, are apparently 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 rock of the province (see Figure 1). It should be clearly understood that the 'deposits' shown on the map consist of mines which produced over 155 kilograms of gold, and five geologically interesting deposits. two of which have been partially developed but which have not yet become producers.

For each of the fourteen deposits shown, there are, on average, seven prospects or showings where known grade and tonnage do not 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 the known gold mineralization of Manitoba is considered to be of hydrothermal 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 structure.

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 green chromian micas (fuchsite-mariposite). 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 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 Mines was exceptional in this respect, in that copper and lead were recovered from the concentrate at the smelter.

The underground workings of most of Manitoba's gold mines have been inaccessible for years. 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 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 are a ready source of information for those requiring further particulars about any specific deposit. Mineral Inventory cards are available from the Geoscience Data Section, Manitoba Energy and Mines, Winnipeg, or from the Mining Recorder's office, The Pas.

The recent development of a mineral deposits open file supplements the mineral inventory file and provides detailed geological sketch maps, documentation of the location of mineral occurrences, assay and geochemical results and classification of type of mineralization at each locality. This information represents another source of detailed information for Manitoba gold and other mineral deposits.

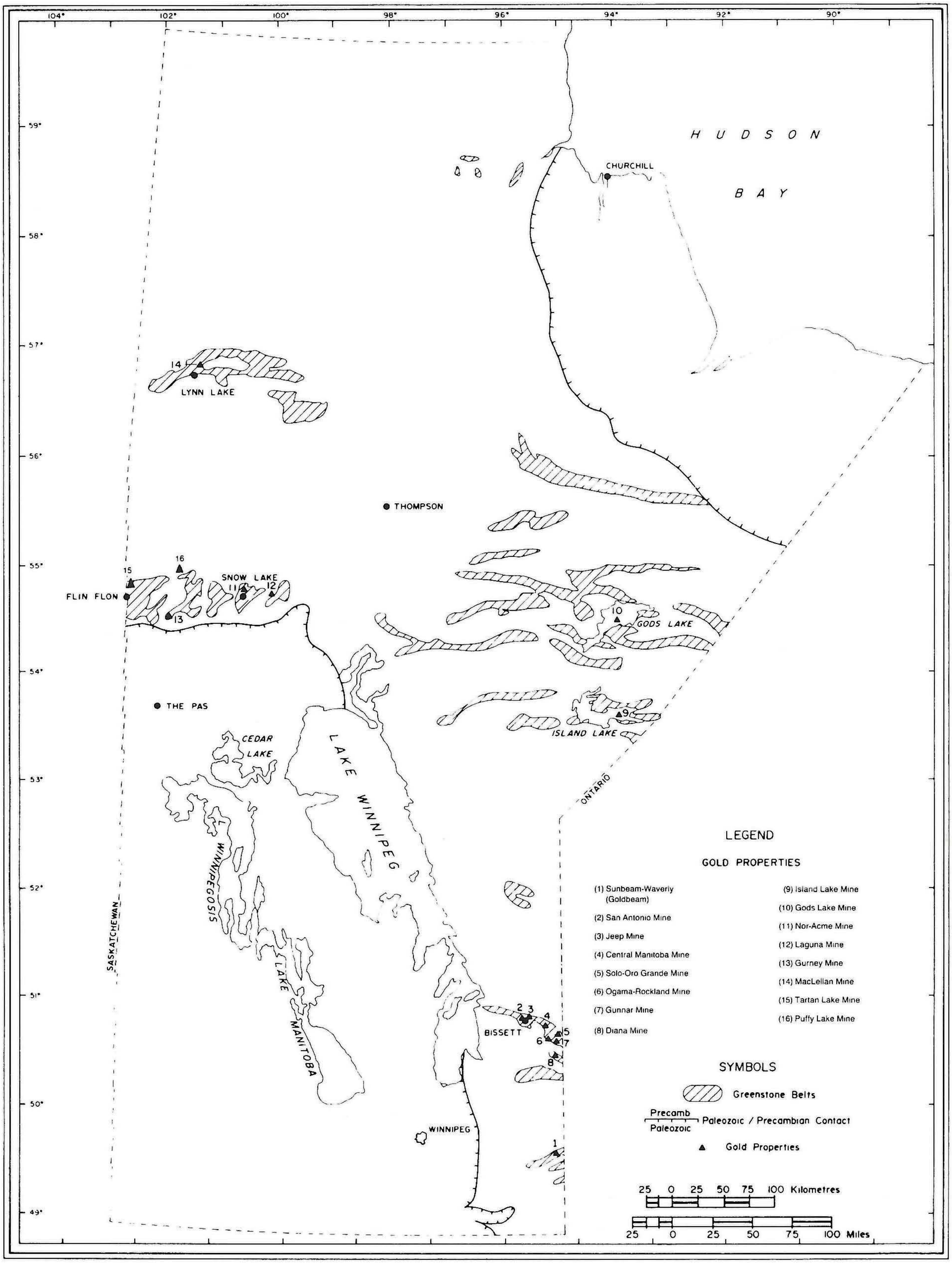



*Figure 1: Distribution of gold occurrences in Manitoba*

# 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.

It is likely that the constituents which make up the ore and gangue materials of gold deposits, and impregnate the wall rocks, were derived, to a large extent, from: (1) the country rocks of the wider vicinity; and (2) residual fluids from the crystallization of intrusions at depth. 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. 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.

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 styles: (i) vein deposits, formed in fractures and other channelways, and (ii) stratabound deposits of syngenetic, or 'exhalative', affinity.

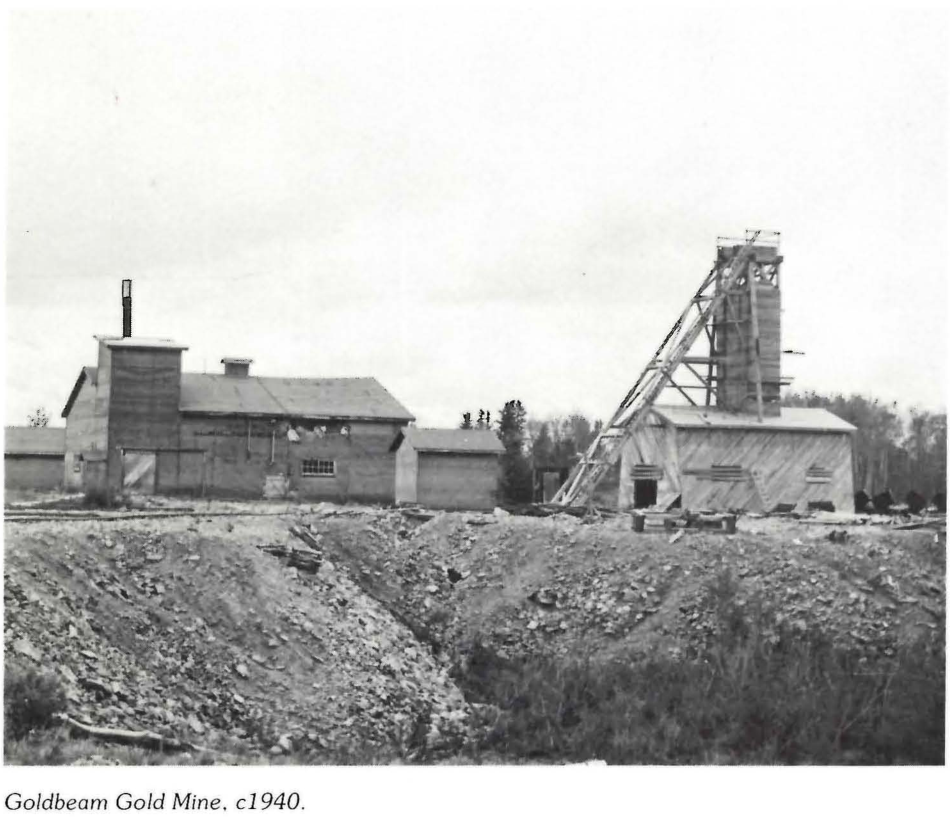
Deposits of the first type are sufficiently well-known to require no further comment. The San Antonio, Gunnar, Ogama-Rockland, Solo-Oro Grande and Diana mines, and numerous other minor occurrences of gold mineralization in the Rice Lake gold district, evidently belong to this category.

Submarine exhalites, or syngenetic deposits, 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 and sulphides. The primary mineralization of certain important gold mines has been attributed to the exhalite process; for example, the Homestake Mine of South Dakota (carbonate ore) and the Agnico-Eagle Mines, Quebec (sulphide ore).

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. Present geological opinion overwhelmingly supports a syngenetic-hydrothermal origin for such massive sulphide bodies.

Turning to gold deposits, the Central Manitoba, Gurney, Island Lake, Gods Lake and Agassiz properties all meet one important requirement of syngenetic 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 deformation and recrystallization. Although a syngenetic association is suspected, with the exception of the MacLellan deposit, 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. This is exemplified by the Sunbeam-Kirkland pipe, and by gold-bearing quartz porphyry dykes at a number of widely scattered localities.

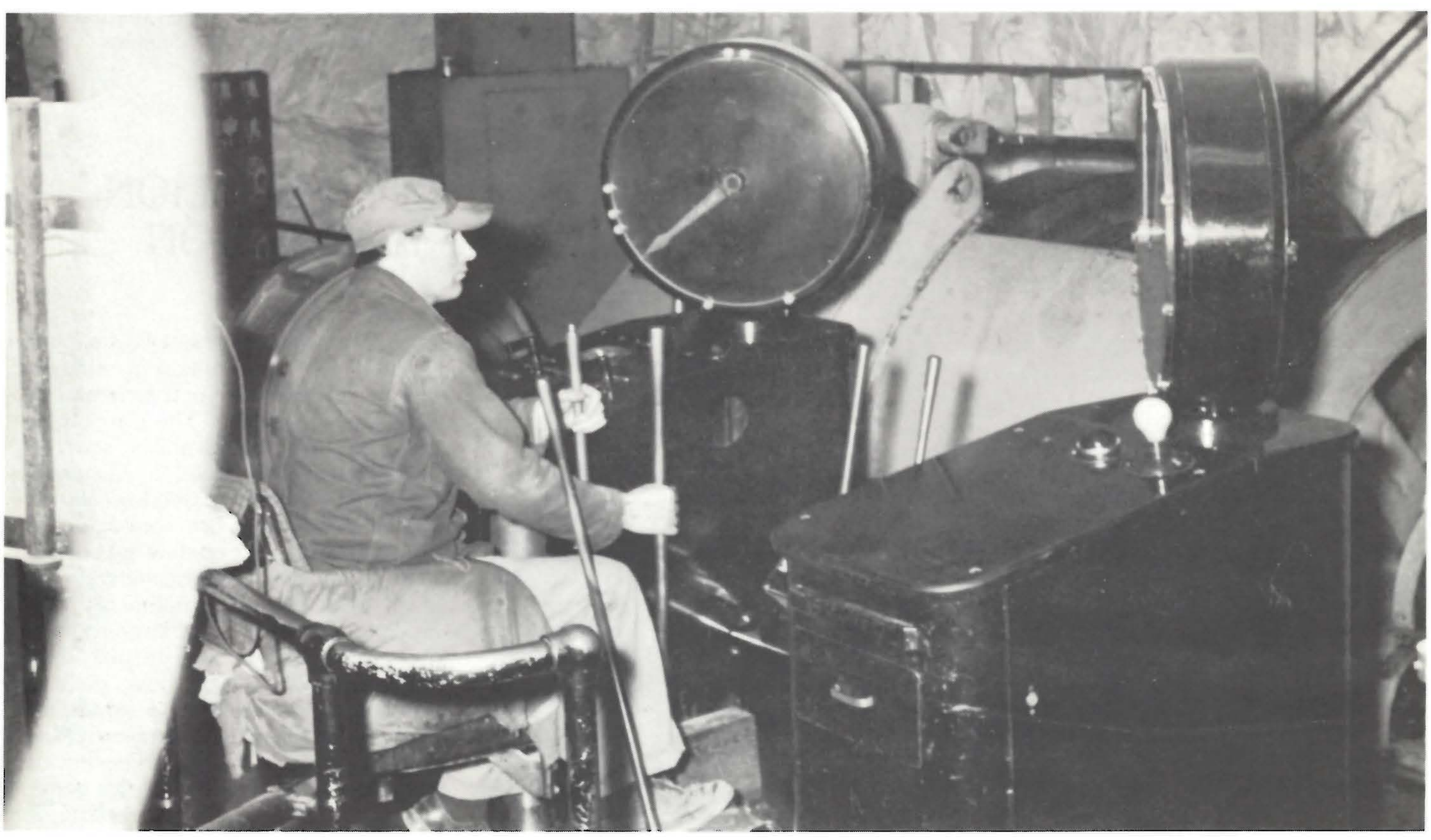


*Goldbeam Gold Mine, c1940.*

# GOLD BULLION PRODUCTION

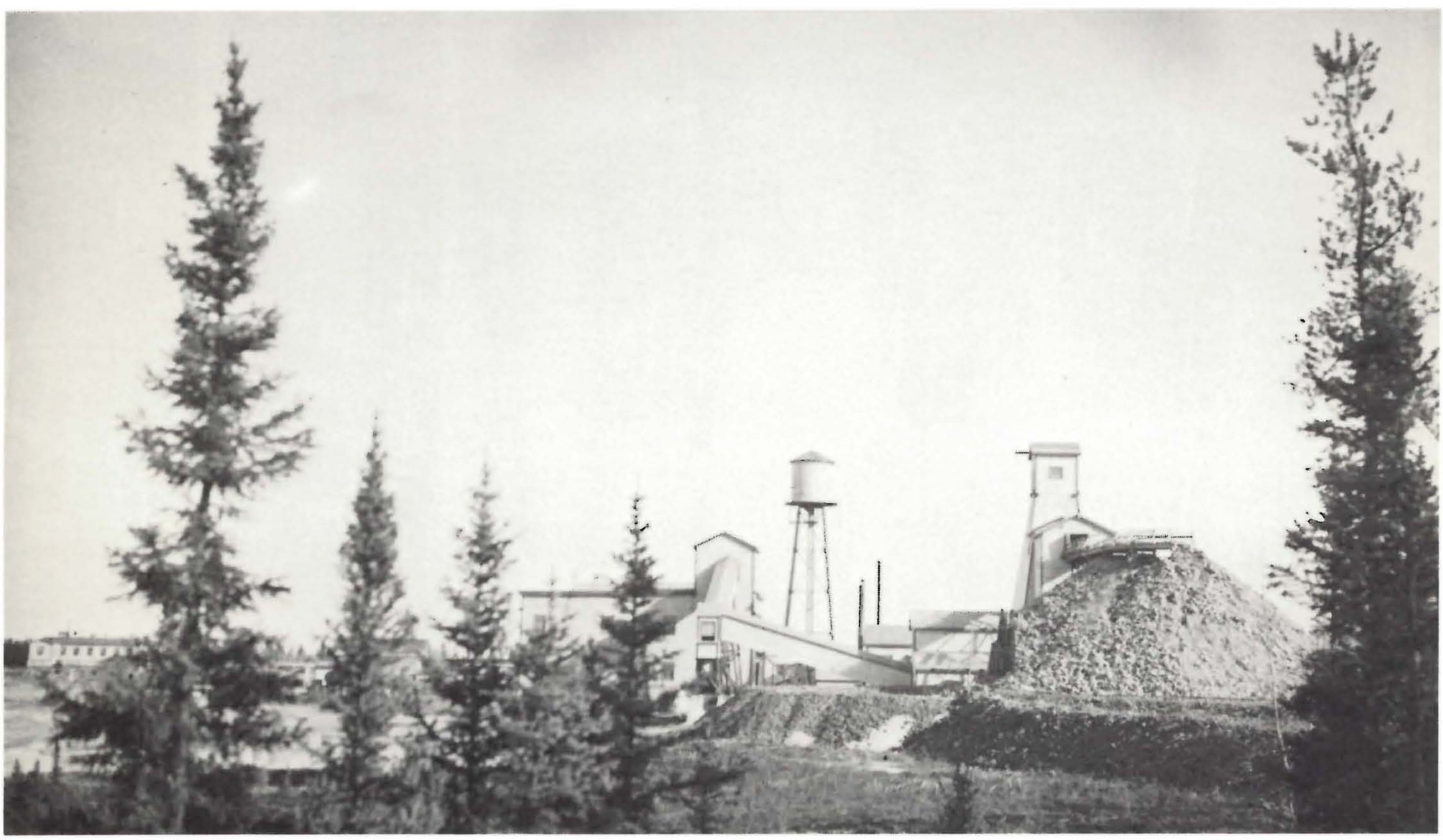
A diagrammatic flow sheet illustrating the production of gold bullion from mined, gold-bearing sulphide-rich mineralization is depicted in Figure 6. There are numerous variations in gold milling schemes, each of which is designed for efficient extraction of gold from mineralogically variable ores. Grade of ore, tonnage of the deposit and sulphide content are but a few of the characteristics of the mineralization which will determine the nature of the milling circuit. For instance, large-tonnage, low-grade deposits such as placer-type gold are processed using a heap leach carbon absorption method, a significantly different approach than that generally utilized for lode gold deposits. The flow diagram in Figure 6 illustrates the general procedure for the cyanide leaching of a sulphide-rich, gold-bearing mineralization.

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



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

*Earl Brydges' dog team at Gurney Camp, 1936.*



*Gurney Gold Mine, 1939.*

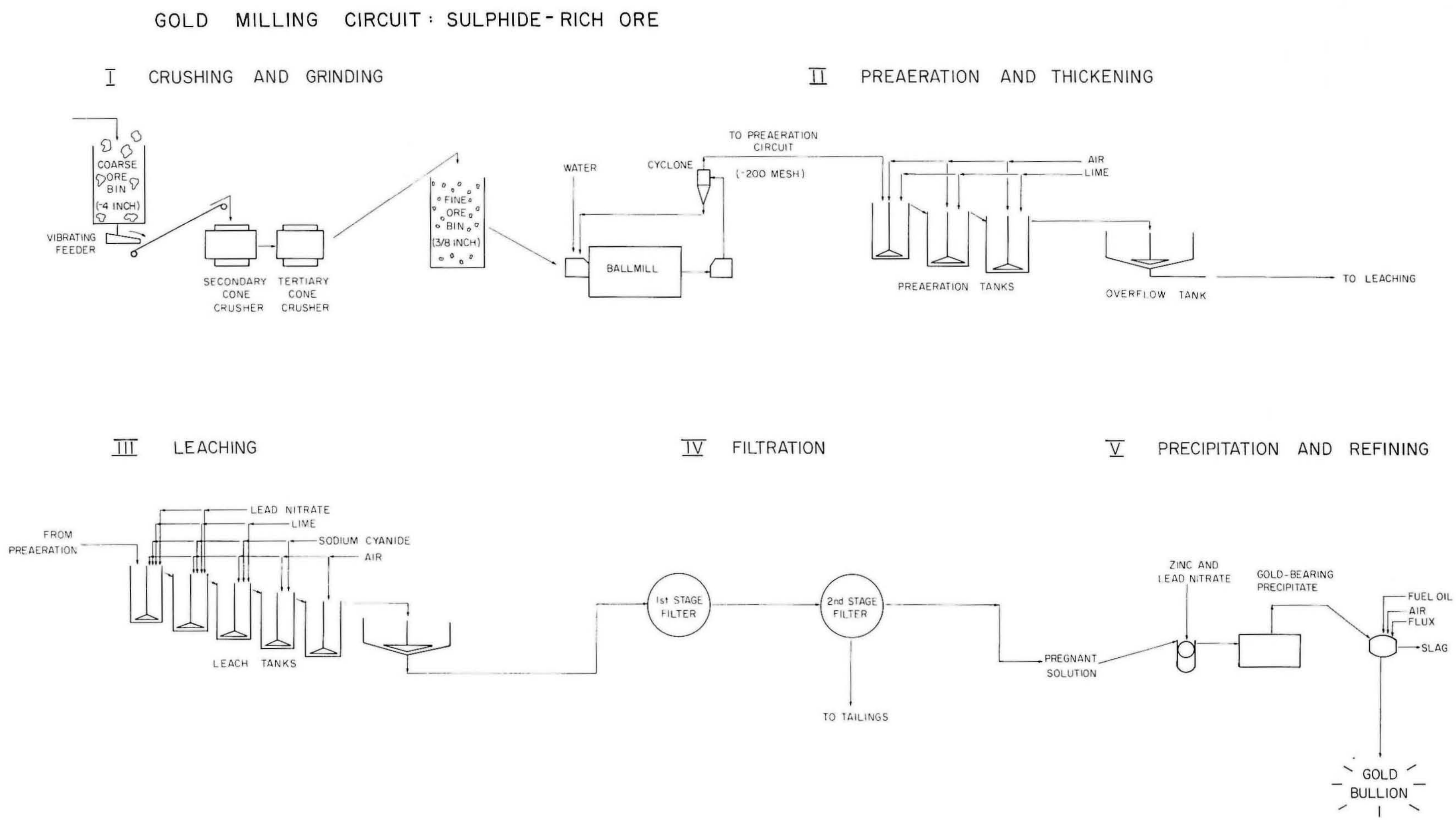



*Figure 2: Production of gold bullion*

Leaching is a technique for dissolving soluble minerals or metals out of ore by using a percolating solution. The ore must be transformed in certain ways before leaching can go ahead.

**Crushing and Grinding:** In the crushing circuit, the ore arrives at the crusher in 10 centimetre pieces, which are subsequently reduced in two stages via the secondary and tertiary ore crushers until the ore passes a -1.9 centimetre screen. This 'fine' ore is conveyed to 910-tonne ore bins ready for the grinding circuit.

The crushing circuit operates at about 91 tonnes per hour, and it may process up to 1 365 tonnes per day.

The ore is ultimately reduced to -200 mesh by passing the ore through a series of rod and ball mills.

**Pre-aeration and Thickening:** The ore powder is mixed with water and pumped as a slurry to the pre-aeration circuit. The sulphide-rich ore is oxidized in the pre-aeration circuit in order to reduce the amount of chemicals necessary for the leaching of the ore, as well as to ease gold extraction.

**Leaching:** After pre-aeration, the gold-bearing slurry is fed into a shallow settling tank. In the leaching circuit, gold within the sulphide ore is taken into solution by reacting the ore within sodium cyanide, air and water in five consecutive leach tanks, while the ore is continually agitated. Overflow from the last leach tank containing the bulk of the gold flows into the 'pregnant' solution tank.

**Filtration:** This solution of dissolved gold mixed with waste solids then proceeds to the filtration circuit, where a series of vacuum filters separates these two components. The filter cake is washed with water and returned to the leach circuit. The pregnant wash solution is filtered to remove any remaining solids and then deoxygenated.

**Precipitation and Refining:** Gold is precipitated from the solution by the addition of zinc dust. After the addition of fluxes, the precipitate is smelted in the bullion furnace to produce gold bullion and slag.

The slag is reprocessed through the mill circuit.

The gold bullion contains approximately 85 per cent gold, 12 per cent silver, and 3 per cent base metals. The bullion is then forwarded to either the Royal Canadian Mint or to a private company for further refining to produce a more pure gold and silver product.

# CONCLUSION

Excitement and optimism accompany the resurgence of gold mining in Manitoba in the 1980s. As new potential is explored and developed at Tartan Lake-Alberts Lake, at Lynn Lake, and elsewhere throughout the province's greenstone belts, a new chapter is being written in the history of Manitoba's gold mining industry.

*Gunnar Gold Mine, c1934.*

# GLOSSARY

**Alluvial** — A term to describe a sedimentary rock deposited by a stream or running water.

**Alteration** — Any physical or chemical change in a rock or mineral subsequent to its formation.

**Amphibole** — A group of dark-coloured minerals containing magnesium, iron, calcium sodium, silica, aluminum, and copper.

**Arsenopyrite** — A white or silver-white to steel-grey mineral composed of arsenic iron and sulphur; generally associated with gold mineralization. FeAsS

**Assay** — To test ores or minerals to determine the amount of valuable minerals/metals/elements they contain.

**Assimilation** — The process of incorporating solid or fluid material into magma.

**Carbonate** — A mineral compound of calcium, carbon, and oxygen formed by chemical precipitation from an aqueous solution.

**Chalcopyrite** — A bright brass-yellow mineral that represents the most important ore mineral for copper. $CuFeS_2$

**Chlorite** — A group of platy, greenish minerals composed of magnesium, iron, aluminum, silica, and oxygen that may occur in metamorphic and igneous rocks. $Mg(Fe^{2+}, Fe^{3+})_6 Al Si_3O_{10}(OH)_8$

**Claim** — A plot of Crown land containing a mineral and staked out for mining purposes.

**Clastic** — A term to describe a rock composed primarily of broken fragments derived from pre-existing rocks or minerals.

**Deformation** — Any change in the original shape of rock masses. Folding and faulting are common modes of deformation.

**Deposit** — A mass of naturally-occurring mineral material, usually of economic value, without regard to mode of origin. Organic fuels such as coal and petroleum are sometimes called mineral deposits.

**Diabase** — A term to describe a mafic intrusive rock with a predominance of plagioclase feldspar over augite.

**District** — A section of country having described or understood boundaries within which mineral is found and which is worked under prescribed acts and regulations.

**Dyke** — A crosscutting rock unit that is older than the rocks it intrudes.

**Enrich** — To increase the metallic content of an ore.

**Fuchsite-Mariposite** — A group of bright green micas containing the element chromium.

**Gangue** — The minerals associated with ore that are valueless.

**Gneiss** — A metamorphic rock composed of alternating layers of silicate minerals with flaky or elongate forms.

**Greenstone** — Generalized name given to Precambrian lavas.

**Hydrothermal** — A term to describe the formation of a mineral deposit by hot water.

**Igneous** — Rock or mineral that solidified from molten or partly-molten material.

**Intrusion** — A mass of igneous rock which, while molten, was forced into or between other rocks.

**Leaching** — The removal in solution of the more soluble minerals by percolating waters.

**Mafic** — An igneous rock composed of one or more dark-coloured minerals.

**Magmatic** — Derived from a magma or molten rock source beneath the earth's surface.

**Metamorphism** — The mineralogical and structural adjustment of solid rocks to changes in physical and chemical conditions, usually deep within the Earth.

**Molybdenite** — A greenish, lead-grey mineral composed of molybdenum and sulphur occurring in scaly masses in granitic rocks and quartz veins. $MoS_2$

**Ore** — Naturally-occurring material from which a mineral or minerals of economic value can be extracted.

**Paleozoic** — A portion of the geological time scale beginning at the end of the Precambrian (about 600 million years ago) and lasting until the beginning of the Mesozoic (about 225 million years ago).

**Placer** — A mineral deposit formed on the surface by mechanical concentration of mineral particles.

**Precambrian** — The earliest part of the geological time scale, including all corresponding rocks, equivalent to about 90 per cent of geologic time; from the beginning of time until the beginning of the Paleozoic, about 600 million years ago.

**Pyrite** — A mineral consisting of iron and sulphur that is commonly yellowish-brown to bronze in colour.

**Pyrrhotite** — A reddish-brown to brownish-bronze mineral composed of iron and sulphide which may contain nickel and/or gold.

**Quartz Monzonite** — An intermediate intrusive rock.

**Quartz Porphyry** — A term to describe a rock with quartz crystals larger than the mineral grains in the matrix.

**Recrystallization** — The formation of new mineral grains in a rock while in the solid state. The new grains may have the same chemical and mineralogical composition as in the original rock, or entirely new minerals may be formed.

**Scheelite** — A yellowish-white or brownish mineral composed of calcium, tungsten, and oxygen, which is in an ore mineral of tungsten, often occurring in veins. $CaWO_4$

**Sediment** — Fragmental material, either inorganic or organic, that forms in layers on the Earth's surface at ordinary temperatures in an unconsolidated form.

**Shaft** — A vertical or inclined excavation for the purpose of opening and operating a mine. It is usually equipped with a hoist at the top which raises and lowers the cage and skip. A shaft may also be used for ventilating underground workings.

**Shear zone** — A tabular area of rock that has been crushed and brecciated by many parallel fractures resulting from shear strain; often becomes a channel for underground solutions and the seat of ore deposition.

**Silica** — Silicon dioxide, the most abundant constituent of the earth's crust.

**Siliceous** — Of or pertaining to silica; containing silica, or partaking of its nature.

**Slag** — Gangue minerals and the flux which is removed in smelting operations.

**Slurry** — A thin, watery mixture containing fine, insoluble materials.

**Sphalerite** — A brown, black, yellow, or white mineral which represents the most important mineral of zinc ore. (Zn, Fe)S

**Stope** — An underground excavation formed by working in a series of steps when mining a vertical orebody.

**Strata** — Layers of sedimentary rock of varying thickness, each of which possesses characteristics different from the layer above and below.

**Sulphide** — A compound of sulphur with one more positive element or radical.

**Syngenetic** — A term to describe a mineral deposit that was deposited at the same time as the host rocks.

**Telluride** — A mineral compound that is a combination of a metal, such as mercury, with the element tellurium. $Hg_2Te$

**Tourmaline** — A group of minerals containing the chemical elements: sodium, calcium, magnesium, iron, aluminum, lithium, boron, silica, and oxygen; it occurs in granitic rocks, claystones, and slates. (Na, Ca)(Mg, Fe2+, Fe3+, Al, Li)3(Bo3)3 Si6O18(OH)4

**Volcanic Rock** — Any rock of volcanic origin. Volcanic igneous rocks erupted as molten masses, forming lava flows, dykes in the crater walls, volcanic plugs, etc. Volcanic sedimentary rocks are the fragmental materials ejected in explosive eruptions.

**Witwatersrand** — An area in South Africa characterized by numberous gold deposits in a clastic sedimentary geological environment.

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# METRIC CONVERSION CHART

**Into Metric**

| If you know | multiply by | to get |
|---|---|---|
| Length | | |
| inches | 25.40 | millimetres |
| inches | 2.54 | centimetres |
| feet | 0.30 | metres |
| yards | 0.91 | metres |
| miles | 1.61 | kilometres |
| Area | | |
| sq. inches | 6.45 | sq. centimetres |
| sq. feet | 0.09 | sq. metres |
| sq. yards | 0.84 | sq. metres |
| sq. miles | 2.59 | sq. kilometres |
| acres | 0.40 | hectares |
| Mass (Weight) | | |
| ounces | 28.35 | grams |
| pounds | 0.45 | kilograms |
| tons (short) | 1.02 | tonnes |
| Volume | | |
| Imp. -- not U.S. | | |
| fluid ounces | 28.41 | millilitres |
| pints | 0.57 | litres |
| quarts | 1.13 | litres |
| gallons | 4.54 | litres |
| cubic inches | 16.39 | millilitres or cubic centimetres |
| cubic feet | 0.03 | cubic metres |
| cubic yards | 0.76 | cubic metres |
| Temperature | | |
| Fahrenheit | Subtract 32, then multiply by 5/9ths | Celsius |

**Out of Metric**

| If you know | multiply by | to get |
|---|---|---|
| Length | | |
| millimetres | 0.04 | inches |
| centimetres | 0.39 | inches |
| metres | 3.28 | feet |
| metres | 1.09 | yards |
| kilometres | 0.62 | miles |
| Area | | |
| sq. centimeres | 0.15 | sq. inches |
| sq. metres | 10.76 | sq. feet |
| sq. metres | 1.19 | sq. yards |
| sq. kilometres | 0.40 | sq. miles |
| hectares | 2.47 | acres |
| Mass (Weight) | | |
| grams | 0.035 | ounces |
| kilograms | 2.20 | pounds |
| tonnes | 0.98 | tons |
| Volume | | |
| | | Imp. -- not U.S. |
| millilitres | 0.03 | fluid ounces |
| litres | 1.76 | pints |
| litres | 0.88 | quarts |
| litres | 0.22 | gallons |
| millilitres or cubic centimetres | 0.06 | cubic inches |
| cubic metres | 35.31 | cubic feet |
| cubic metres | 1.31 | cubic yards |
| Temperature | | |
| Celsius | Multiply by 9/5ths, then add 32 | Fahrenheit |

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