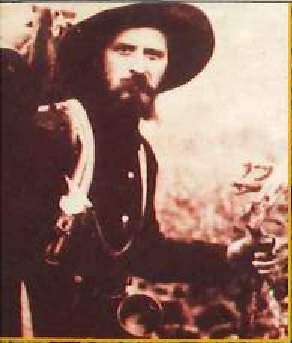
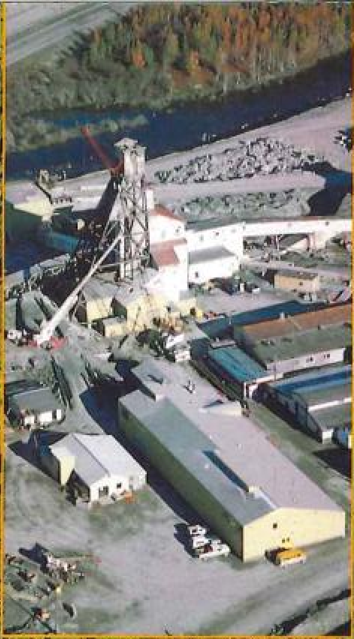
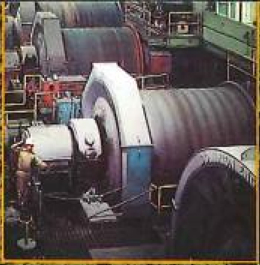






Mining: Our Northern

A potential barely tapped

Mining contributes many millions of dollars today to the economy of the Northwest Territories. In 1989 alone, the total value of mineral production and exploration exceeded one billion dollars! In that same year, direct contributions to the northern economy through payroll, taxes, and local purchases by the mining and exploration companies exceeded $150 million. Mining is the N.W.T.'s second largest employer, second only to government itself. Today, over 2,000 workers are employed in the northern mining industry, and of these over 1,000 are Northerners.

The mining industry provides substantial additional benefits to the Northern economy. Royalty payments, and both corporate and personal taxes are paid to government. These return as transfer payments, which are used to pay for the basic services we Northerners require. As well, for every mine worker, there are at least four more jobs created in the service sector, to support mine and employee purchasing. These jobs provide considerable wage and tax benefits to the northern economy.

The industry is helping to further increase northern benefits. By working with government to provide northern training programs, the industry is providing new career options to our young and rapidly growing population. Increasingly, Northerners are taking advantage of the considerable employment opportunities which exist for professionals and the trades alike in mining.

Mining and Northern development have marched side-by-side since Gilbert LaBine's discovery of radium at Great Bear Lake in 1930. His prospecting brought the aeroplane into the Northern skies. His Eldorado Mine created the Northern Transportation Company, and also provided a market for Norman Wells oil. Later discoveries like the Con gold deposit in Yellowknife and the huge Pine Point lead/zinc deposit sparked the construction of the North's first highway and our only railroad. More recently, the Nanisivik and Polaris operations instigated the construction and operation of the world's highest technology ice-breaking cargo ship, the M.V. Arctic, which plies the waters of Canada's Arctic.

This booklet was prepared by the N.W.T. Chamber of Mines with financial assistance under the Mineral Initiatives of the Canada-G.N.W.T. Economic Development Agreement.

It's a story every Northerner should know.

Search for minerals opened the North

Furs, oil, whaling, and such factors as national defence and the need to maintain sovereignty, have all played a part in the Northwest Territories' development. However, minerals and mining, basically, have produced the modern North.

Long before Sir Martin Frobisher first mined for gold on Baffin Island in 1576, Northern Inuit and Dene had discovered that native copper, easily worked, made far better spearheads or knife blades than bone or ivory.

In 1770-71, nearly two centuries after Frobisher, Samuel Hearne and his native guide Matonabee made their incredible, eight-month overland journey from Hudson's Bay to Coppermine, hoping to find the copper from which the Yellowknife Indians made their knives. They did find copper, but disappointingly little.

The North slumbered on, virtually unknown to anyone but fur traders, whalers, an occasional explorer and its hardy native peoples.

Then ... gold fever swept the Yukon.

The Klondike gold rush and the famous Trail of '98 created an influx of southerners, all hoping to strike it rich. Most sailed up the west coast to Skagway, Alaska, before heading inland. Others followed the lake and river routes of the fur trade voyageurs, north to Great Slave Lake and then down the broad Mackenzie River before striking west over the Mackenzie Mountains.

One of them was a man named E. A. Blakeney. Who he was, and whether he survived the cruel mountain ordeal he faced, the records don't reveal. However, he did stake some claims as he made his way north, and a sample from one claim, sent to Ottawa for analysis in 1898, assayed 2.158 ounces of gold per ton. (Today, a mere tenth of that is well worth mining, if there's enough of it.)

> **"... the North was a difficult territory to reach near the turn of the century. Without improved transportation, its economic deposits would remain undiscovered for some time to come."**

Finds like Blakeney's attracted the interest of the Geological Survey of Canada. In 1900, one of the their geologists, J. McIntosh Bell and his assistant Charles Camsell, noted evidence of copper and cobalt mineralization on the east shore of Great Bear Lake.

The stage was being set for a major discovery.

However, the North was a difficult territory to reach near the turn of the century. Without improved transportation, its economic deposits would remain undiscovered for some time to come.

Then, in 1920, Imperial Oil Limited bought two Junkers aircraft on skis, with the idea of flying its workers into Norman Wells, well before spring breakup. While the theory was sound, the effort was a disaster; neither plane got farther north than Fort Simpson before breakup. Only one Junkers finally completed its journey ... on floats.

However, that first flight into the N.W.T. had proved aircraft could operate in the North, albeit with great difficulties. The mining industry was quick to recognize the possibilities of this new, speedy method of transportation to remote areas, and by the mid-1920's mineral exploration by air was under way all the way to the Arctic coast. The aircraft's usefulness soon would be proved.

Gilbert LaBine, a successful Toronto prospector and mining promoter, came across J. McIntosh Bell's report on Great Bear Lake in 1929, while looking over potential areas for exploration. LaBine perked up immediately when he saw the mention of cobalt bloom, because he knew cobalt was often associated with pitchblende, the ore in which radium was found.

In those days, cancer treatment relied on radium for its radiation source. Radium was a rare commodity, and fetched up to $73,000 a gram, or over $2 million an ounce! At that price, cancer treatment was confined only to those wealthy enough to afford it.

▲ ***Emergency Repairs, Contact Lake, 1936.***

Needless to say, radium was worth looking for, no matter where it was found in the world ... even the remote Northwest Territories! In the spring of 1930, LaBine flew in to Great Bear Lake with prospector Charlie St. Paul ... and found his pitchblende. Within four years, his Eldorado Mine was producing radium.

While radium was in high demand, there was little demand for radium's parent element, uranium, which accompanied radium in substantial quantities. No one could foresee that in less than ten years, its demand would exceed that for radium, and that Eldorado uranium would prove crucial in ushering in the nuclear age.

While Eldorado created the N.W.T.'s first mining rush, it also provided the first real impetus for the North's infant oil industry.

Imperial Oil had continued to develop its Norman Wells oilfield, but there was no demand for the oil until the Eldorado Mine was built. Soon after the mine went into production in 1933, Norman Wells logically became the source of their fuel.

By 1933 there were 300 people in and around Port Radium, the settlement which had grown up near the mine. Many of them were prospectors, and most of them were too late on the scene to find any good, unstaked ground left.

Some found jobs at Eldorado. Others began drifting back south, working their way on river boats, flying if they could afford it, walking if they had no money.

Among the latter was a young Torontonian named C. J. Baker and his partner, Herb Dixon. Attracted by prospecting activity, they headed for Yellowknife Bay. They were near the end of their journey, near the present Giant Mine, when Baker took out his mortar and pestle and went to work.

"And there it was," he wrote, years later, "the first Yellowknife gold."

Baker - better known then as Yellowknife Johnny - stayed in Yellowknife, prospecting and becoming the area's first mining recorder (he was elected to the position by the other prospectors, since there was no federal mining recorder then resident in the area.) And, forced to beach his canoe by a raging storm in Yellowknife Bay, Baker, in 1933, promptly discovered the Yellowknife area's first mine - the Burwash Mine on the east shore of the bay, just opposite Latham Island. The Burwash Mine proved a flash in the pan; it yielded only

▲ ***Gilbert Labine & Associates, Great Bear Lake, 1932.***

87 ounces of gold before closing in 1937. However, its discovery spurred on prospecting activity in the area.

Yellowknife was on the brink of a major find.

It was triggered in the fall of 1934, by the discovery of visible gold on the west side of Yellowknife Bay by Norman Jennejohn, a government geologist. Disclosure of his find created a frantic rush to get claims staked before freeze-up.

The N.W.T.'s first gold rush had begun.

The most significant showing staked was the Con showing. So great was their faith in the showing, that its owners, the Consolidated Mining and Smelting (now Cominco), took a major gamble and announced they would develop their Con Mine even before underground exploration had been done.

The gamble paid off. Con, now the Nerco Con Mine, poured its first gold brick in 1936, and by the end of 1990 had produced 4,626,895 ounces of gold.

In 1943, exploration ground to a halt. Even the Con Mine had to be shut down because of wartime shortages of both men and supplies.

However, the end of the war sparked a new exploration and development boom, capped when Giant Yellowknife Mines Ltd. went into production in 1948.

In their search for gold, prospectors fanned out all over the Yellowknife area, making numerous discoveries of the yellow metal. Some deposits, like Louis Garskie Gold Mines east of Yellowknife, were one-man operations on small, high-grade ore bodies not worth costly development.

Others, like the Discovery Mine, 85 kilometres north of Yellowknife, became new northern communities which lasted only as long as the ore bodies which had created them. Still other deposits, like the Colomac ore body, 220 kilometres north of Yellowknife, defied the best efforts of many companies until new techniques for mass production from low-grade ores were developed, many years after the original discoveries.

Gold was the prime target of most N.W.T. prospectors, especially after its price was freed in 1971. But the discovery of rich deposits of other minerals led to the production of lead, zinc, silver, nickel and tungsten in the N.W.T., as well.

The Keewatin's first mine, the North Rankin Nickel Mine, went into production at Rankin Inlet in 1957 and operated until 1962, bringing in materials and supplies and sending its concentrates out by ship. While the mine's life was short, it opened mining's eyes to the possibilities of sea-supported Arctic operations.

Uranium, was the glamour metal until the late 1950's. The Eldorado Mine produced up until 1960. Another uranium deposit in the Fort Rae area became the Rayrock Mine and produced uranium concentrate for two years - to 1959 - before its reserves were depleted.

As interest in uranium decreased, interest in lead and zinc increased.

Lead and zinc deposits had been originally found at Pine Point, on the south shore of Great Slave Lake, in 1898. Detailed exploration revealed the existence of a huge ore body, and in 1951 Pine Point Mines Ltd. was formed by Cominco to develop the property. Seven years later, Cominco had Canada's richest known lead/zinc deposit ... but no way of getting the concentrates out at a profit.

"... the discovery of visible gold on the west side of Yellowknife Bay created a frantic rush to get claims staked before freeze-up. The N.W.T.'s first gold rush had begun."

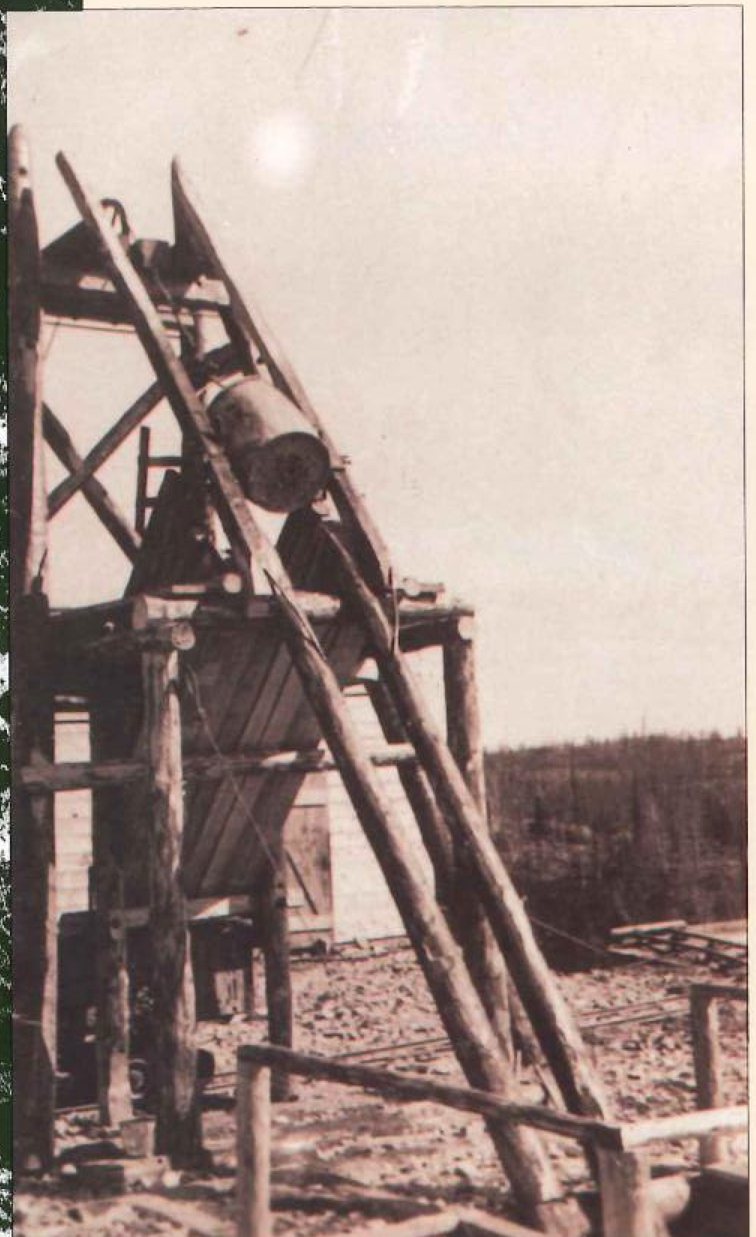
It wasn't until the railway was built from Grimshaw in northern Alberta, in 1964, that production could finally begin.

Canada Tungsten Ltd. had better luck than Pine Point when it discovered the Western Hemisphere's largest tungsten deposit at Tungsten, on the N.W.T. - Yukon border. The Cantung Mine began operations in 1962, trucking its concentrates out via Yukon's well-established highway system.

In 1974, work began on another eastern Arctic venture, the Nanisivik lead/zinc property on the northwestern tip of Baffin Island. The Nanisivik Mine was brought into production two years later, making it Canada's most northerly mine. Nanisivik ships its concentrates to Europe in ice-breaker supported freighters and the Canadian-built M.V. Arctic, Canada's only ice-breaking cargo ship.

Nanisivik's success with high Arctic mining convinced Cominco to develop a rich lead/zinc property it had discovered in 1960 north of Resolute, in the high Arctic. But the cost of building a mine on Little Cornwallis Island, 1,600 kilometres northeast of Yellowknife, would be fearfully high.

▲ ***Con Mine, 1936-38.***



▲ ***First Head Frame, Giant Mine, 1939.***

So in 1980, using bold ingenuity, Cominco built its concentrator, complete with a powerhouse, laboratories, repair shops and mine offices, in Trois Rivieres, Quebec ... atop a huge steel barge. Then they towed the whole thing north by tug!

At Polaris, the barge was carefully positioned at high tide

"Opening up and developing frontiers is the history of mining, and of the N.W.T., in whose development mining continues to play a crucial role."

above steel pilings in a basin which had been prepared on the shore in advance. As the tide went out, the barge settled down onto the pilings, and bulldozers hastily filled in the channel to the basin, to prevent the sea's return. The mill was in place!

Production at the Polaris Mine began the following year. Like Nanisivik, the mine stockpiles its concentrates, then ships them out during the short summer navigation season, using the M.V. Arctic. Today, the Polaris mill is still known as "The Barge," though it sits high and dry above the sea. And the barge's empty hull has become a million-gallon fuel storage tank, safely separated from the mill above it by its concrete deck. Without the engineering ingenuity Cominco used to build the mine, the Polaris deposits would still be locked in the Arctic's permafrost.

Innovative thinking is a hallmark of northern mines.

In 1982, also with daring innovation, Echo Bay Mines decided to develop the Lupin deposit on the shore of Contwoyto Lake, in the middle of the barren lands.

Using the experience they had gained at their Great Bear Lake silver mine, Echo Bay used aircraft to fly nearly all of the construction materials and mine equipment to the site. A winter road was completed to haul fuel and bulk materials necessary to operate for the next year. Once construction was completed, the cargo aircraft were replaced with a Boeing 727, which flies workers and cargo to and from the mine site.

Echo Bay's innovation paid off handsomely. Despite being the country's most remote and inaccessible operation, the Lupin Mine has become one of Canada's most profitable gold mines.

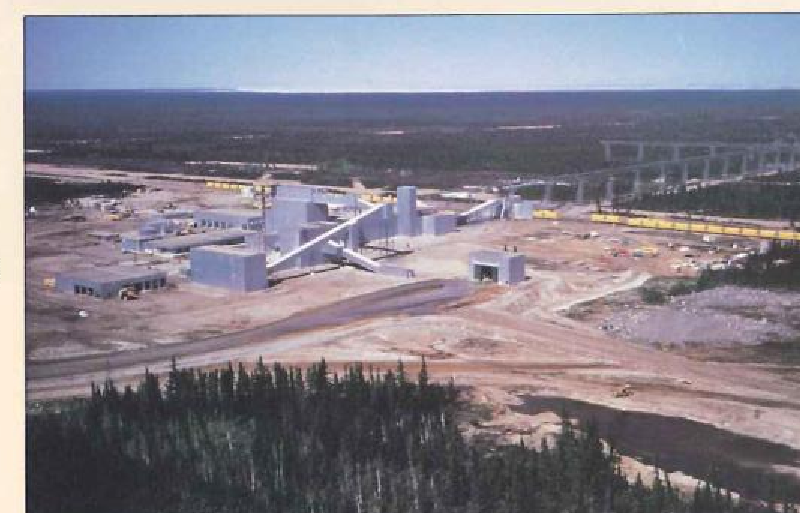
As much as the lives of mines are controlled by nature, they are also strongly controlled by world commodity markets. Supply and demand dictates the price of metals and minerals, and if zinc, for example, falls into a slump, Nanisivik and Polaris feel the pinch. Ore reserves decrease, and profits decline. If operating costs increase due to increased wages, overly stringent government requirements, or higher costs of fuel, for example, the lives of our northern mines are threatened. If serious enough, any one of these factors alone could result in the complete shut-down of operations, and substantial loss to our economy.

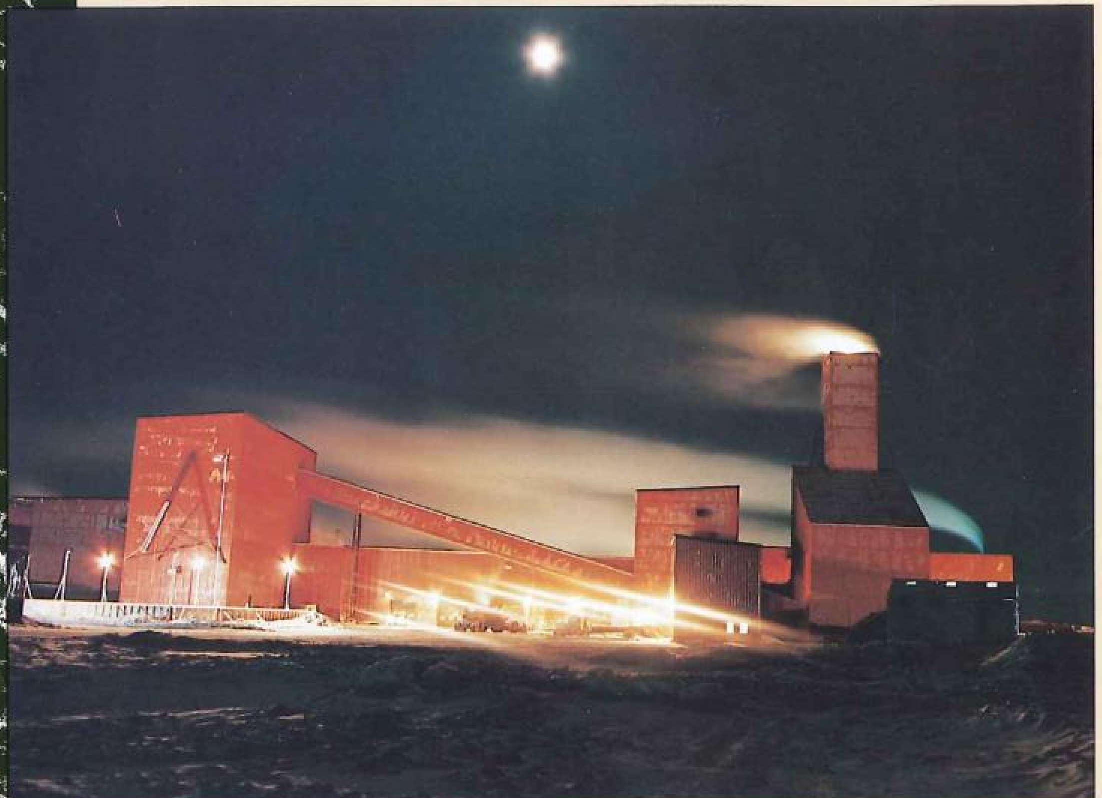
Over the years, there have been many mining operations that have been brought into production. Some have died from old age, while others have perished due to factors beyond the mine's control. For example:

- The Eldorado Radium mine underwent several rebirths, being mined for radium, then uranium, and finally silver and copper, before closing in 1982.
- The Ruth gold mine operated briefly in 1942 and in 1959.
- The Tundra Mine produced gold from 1964-68.
- In 1969 Terra Mines Ltd. began producing silver at its Silver Bear, Norex and Smallwood mines on the Camsell River, just south of Great Bear Lake.
- The Camlaren Mine yielded a total of 1,017 kilograms of gold in two short-lived bursts of activity.

▲ ***The Ruth Mine produced briefly, but is being re-examined. Note geologist mapping rocks below mine headframe.***

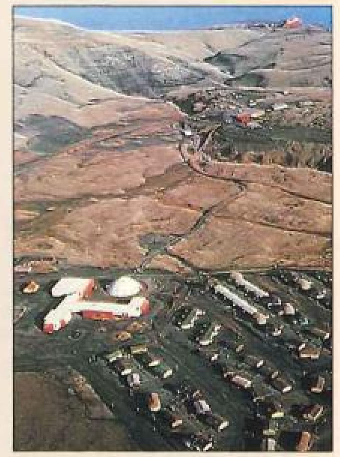
▶ ***Pine Point Concentrator with Rail Cars Taking Delivery***





▲ **Lupin Mine in an Arctic night.**

▼ ***Nanisivik Townsite. The mine and dock are in the distance.***



Largest deposit,... but...

The western world's largest tungsten mine, the Cantung Mine, is located in the Cordilleran Province. Despite its richness, operations have been suspended ever since the Chinese, with their very cheap labour, flooded the market with tungsten. This low price made the Cantung operation non-economic.

• Giant Yellowknife Mines opened its Salmita mine near the old Tundra Mine in 1983, and produced gold for four years.

• The Discovery Mine supported a thriving mini-community for 19 years of gold production, until lack of ore forced it to close its doors in 1968.

• The Keewatin's only gold mine, the Cullaton Lake Mine, operated for a brief three years until low reserves and high operating costs took their toll in 1984.

• The Cantung Mine, despite being the western world's richest tungsten deposits, was shut down in 1986.

• The Ptarmigan Mine, just east of Yellowknife, produced gold for two years during the war, and was rejuvenated by Treminco Resources Ltd. in the 1980's.

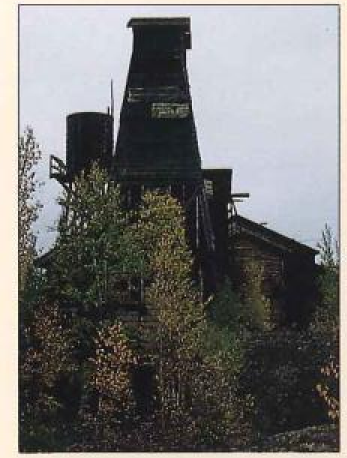
Despite the cycles of mine opening / mine closure, the long-term outlook for mining in the North still looks bright.

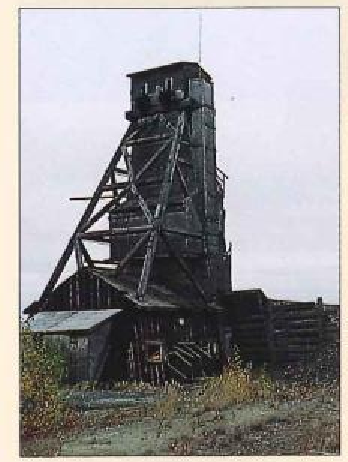
▲ ***Polaris Minesite.***

• Just southeast of Yellowknife, the Thor Lake rare earths deposit is waiting to provide its exotic metals to the automotive and aerospace industries.

• The Kiggavik uranium deposit in the Baker Lake area, contains enough economic reserves to support a mine. The jobs and benefits are desperately needed in the underdeveloped Keewatin district.

• Several gold properties in the George Lake, Nicholas Lake, Meliadine River, High Lake and Anialik River areas are generating a great deal of interest.





Past Producers. Clockwise from upper left: Ruth Mine, Terra Mine, Colomac Mine, Tundra Mine, Camlaren Mine.

Northern transportation benefits

When Eldorado Nuclear's Port Radium mine on Great Bear Lake opened in 1933, it relied on both aviation and marine transportation to support its operation. The mine's barging operation grew into the Northern Transportation Company Ltd., which now supplies isolated northern communities with fuel, groceries, and building materials every summer. The mine's airline, Eldorado Aviation, pioneered large scale air transportation in the N.W.T.

Similarly, the construction of Pine Point Mine instigated the construction of the N.W.T.'s only railroad, to haul concentrates to the smelter at Trail, B.C.

In the earliest days of mining, ice road technology was developed to bring in freight. This technology is now being used for ice roads to Lupin and Colomac Mine, to Tuktoyaktuk and to Lac la Martre, across the Mackenzie River, and in the Keewatin.

To service the Nanisivik and Polaris Mines in the High Arctic, the world's highest technology ice-breaking cargo vessel, the M.V. Arctic, takes concentrates to European markets. This technology provides the foundation for future ice-capable ships that could service both mining operations and communities in the Keewatin and Coronation Gulf areas.

• Substantial base metal reserves are known in the Coronation Gulf area. These deposits would be the scene of active mining operations were they in the more accessible southern areas of Canada. With winter road access to these deposits from the coast, and the construction of more ice-breaking cargo carriers like the M.V. Arctic, these deposits could provide substantial benefits to the North.

Opening up and developing frontiers is the history of mining, and of the N.W.T., in whose development mining continues to play a crucial role.

Oldest rock

In 1989, an outcropping of rock known as tonalite gneiss was discovered on an island in the Acasta River, 320 kilometres north of Yellowknife, in the Bear Province. Analyzed with an ion microprobe in Australia, the rock proved to be 3.962 billion years old... the oldest piece of intact rock yet found anywhere in the world!

Diamond Rush!

Diamonds have been the N.W.T.'s most elusive and tantalizing quarry.

Diamond exploration has occurred in the N.W.T. since the early 1900's and kimberlite, with which diamonds are associated, has been found in several locations. However, up until 1991, only minute specks of diamond had been found.

Then, in the summer of 1991, a diamond drill core intersected a diamond-bearing kimberlite underneath a small lake near Lac de Gras. A 160-tonne sample was removed and analyzed and was found to contain 101 carats of diamonds. About a quarter were of gem quality, and a few stones were in the 1-3 carat range.

This discovery set off one of the largest staking rushes in North American history, with over 10 million acres staked, an area larger than Switzerland!

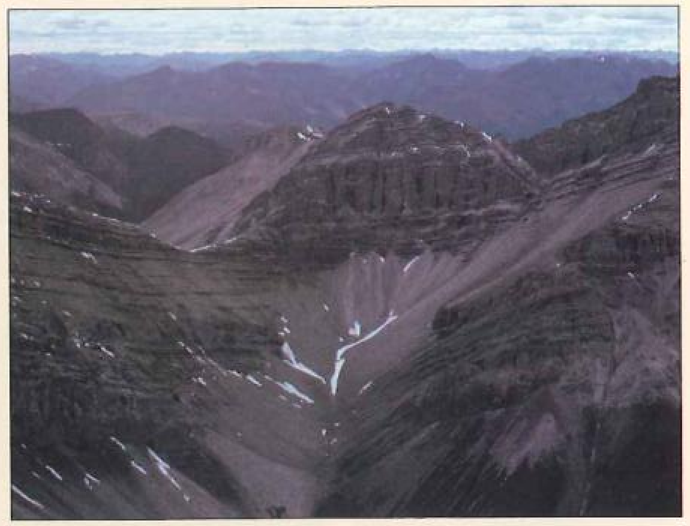
With further exploration, the N.W.T. may become North America's only diamond producer in the near future.

Geology

Geology is the study of the earth, including its rocks and minerals.

Geologists study the earth, and its rocks and minerals. They have divided the world's rocks into four major age groups. From the oldest to youngest, these are the Precambrian, the Palaeozoic, the Mesozoic and the Cenozoic.

Canada's geology can be divided into 3 geological regions: the **Precambrian Shield**, the **Platform**, and the **Mountains**. All three regions are present in the North. This makes our mining potential very high and very diverse.



▲ ***Layered sedimentary rocks in the Cordilleran Province.***

Seven "Provinces" are treasure-house

The Northwest Territories is further subdivided into seven distinct geological areas, known as **structural provinces**.

The Precambrian Shield, consists of three provinces - the **Slave**, **Bear** and **Churchill**. They were formed anywhere from 3.9 billion to 600 million years ago. As a whole, the Slave Province contains the oldest rocks. However, both the younger Churchill and Bear Provinces contain fragments of similarly old rocks. Many of the Precambrian rocks formed the roots of ancient continents which have been worn down over the years. Most recently, these rocks were carved and polished by glaciers which covered most of Canada.

The three Precambrian provinces have had a complex past that includes volcanic action, chemical reactions, and fracturing, faulting, and folding caused by crustal upheavals. This has tended to concentrate, to free and, in some cases, to expose their valuable mineral content. This makes the Slave, Bear and Churchill Provinces prime targets for prospecting.

The **Slave Province** contains many gold deposits, including all those being mined today. As well, substantial copper and lead/zinc deposits have also been found, but require transportation to get them to markets. One of the world's few rare earths deposits is also being investigated for production.

The **Bear Province** is best known for its uranium and silver, which have both been mined in the past.

The **Churchill Province** is underlain by rocks similar to both the Bear and Slave provinces, and thus, the mineral potential of the Keewatin is similarly high. Both nickel and gold have been mined in the past, and recent exploration is proving up gold, uranium, and lead-zinc-copper potential.

Three platforms, the **Arctic, Interior** and **Hudson Platforms**, border the Precambrian Shield. They consist of thousands of feet of relatively undisturbed younger sedimentary rocks which overlie the Precambrian basement. Many of the sediments forming the rocks were laid down under vast seas that once covered the N.W.T. Others were formed from sediments deposited by streams bringing sands, silts and gravels from nearby mountains. At one time, the platform rocks probably covered much of the presently exposed Precambrian Shield, but they have been worn, or eroded away since.

The platforms are best known for the lead-zinc deposits they host, such as those mined at Pine Point. They also host the bulk of Canada's oil and gas deposits, including the oil wells of the Norman Wells area.

The **Cordilleran Province** in the N.W.T. forms the mountainous western boundary with Yukon. This rugged country has seen some exploration in the past, and tungsten, silver, lead, zinc, copper, and placer gold deposits are known.

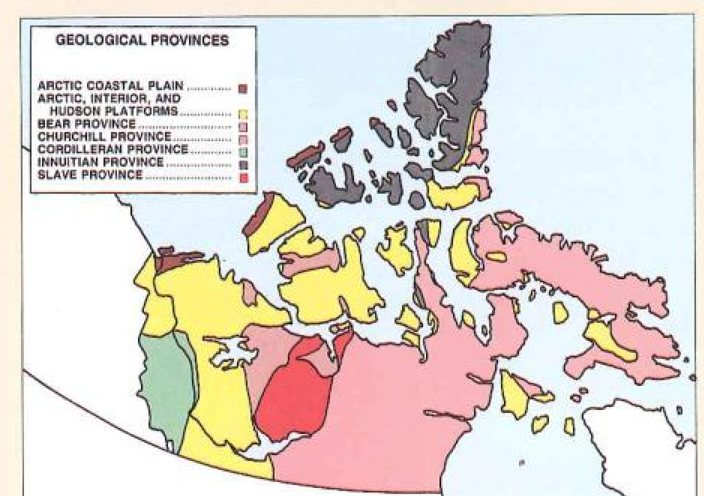
▶ ***Volcanic textures in rocks of the Precambrian Shield.***

Located in the high Arctic, the **Innuitian Province** is the least explored region of the North. Canada's most northerly mine, the Polaris Mine, is located in this province. In addition to base metals and coal, this area is also known for its vast, untapped reserves of oil and gas.

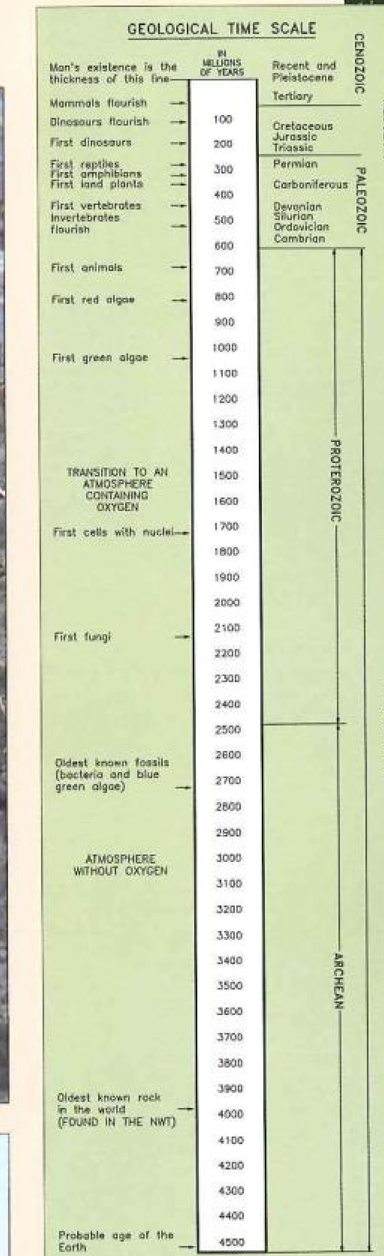
Very few mineral deposits are known in the **Arctic Coastal Plain** although some coal has been found. It contains substantial reserves of oil and gas.

"... prospectors and geologists have discovered everything from precious and base metals to tungsten, coal, rare earths and diamonds. However, geologists have just barely scratched the surface in the North."

Within these seven provinces, prospectors and geologists have discovered everything from precious and base metals to tungsten, coal, rare earths and diamonds. However, while some discoveries have been made, geologists have just barely scratched the surface in the North.



▶ ***Geological Provinces of the Northwest Territories.***



▲ ***Geological Time Scale.***

▲ ***To protect a mineral find, posts marking its corners are cut.***

Prospecting is high-tech now

There still are people who will pack off into the bush, the barrenlands, or the mountains by themselves in search of mineral riches. Armed only with maps, rock hammers, hand lenses, and enough grub to keep them going until they are picked up, they work as the prospectors of old did.

In the North of today, however, the independent prospector is becoming an endangered species. Modern prospecting is becoming very complex and costly for one individual. As a result, only large companies that have the financial resources can mount significant exploration programs.

Over the last 20 years, a dramatic increase in knowledge in satellite image interpretation, geology, geophysics and geochemistry, has produced a wide range of specialists. The strange term "Explorationist" is often heard now when describing these diverse professionals that make up modern exploration teams.

In the field, too, "high tech" has caught up with exploration.

The aircraft, which first made it possible for prospectors to penetrate areas almost inaccessible on foot or by water, has changed the very nature of prospecting itself.

The early prospector, or a couple of men working together, might live in isolated campsites for months at a time without seeing another human being, totally dependent on themselves for survival.

Today's prospector usually lives in a comfortable tent camp with such amenities as showers, fresh vegetables and meat, and radio communications with family and friends. Some camps even have satellite television!

Modern prospectors still are no sissies. They still have to trudge miles through swamps, through tangled forests and over jumbled rock. The terrain, the weather and the flies can still be cruel, and the beauty of the barrenlands or the mountains still masks a land in which a twisted ankle, a lost mitt or a piece of treacherous ice can prove deadly.

However, it's a rare prospector today who goes into the bush without radio contact with a base camp. An aircraft or helicopter can be on the spot within hours to help if trouble occurs. Most often they work in pairs, for safety's sake.

Modern prospectors often don't spend days getting to the sites they're exploring, or cut firewood or cook meals, either. Often, they work an eight-hour day, flying out in the morning with paper bag lunches, and then being picked up in time for supper at the end of the day.

Painful fly camp portages and hauling a canoe and camp gear between lakes or rivers, are somewhat of an anachronism today, much like the sled dogs and canoes on which the traditional prospector relied. Today, shifting camp often involves calling in a helicopter, which will sling a collapsible boat and outboard, tent and supplies to the new location in minutes. Increasingly, as well, preliminary examination of claims has already been done by an aircraft or helicopter carrying or towing sensitive electronic detection equipment.

▲ ***Prospecting methods have changed somewhat from this prospector's time.***

Looking beneath the overburden

To find mineral deposits, it is necessary to look at and sample the rocks themselves. Often, however, they are hidden beneath soil cover, heavy plant growth, or even water. In the past, this presented a problem. However, in these modern times, it is possible for explorationists to learn much about what is under the ground, often without even setting foot on it!

An eye in the heavens

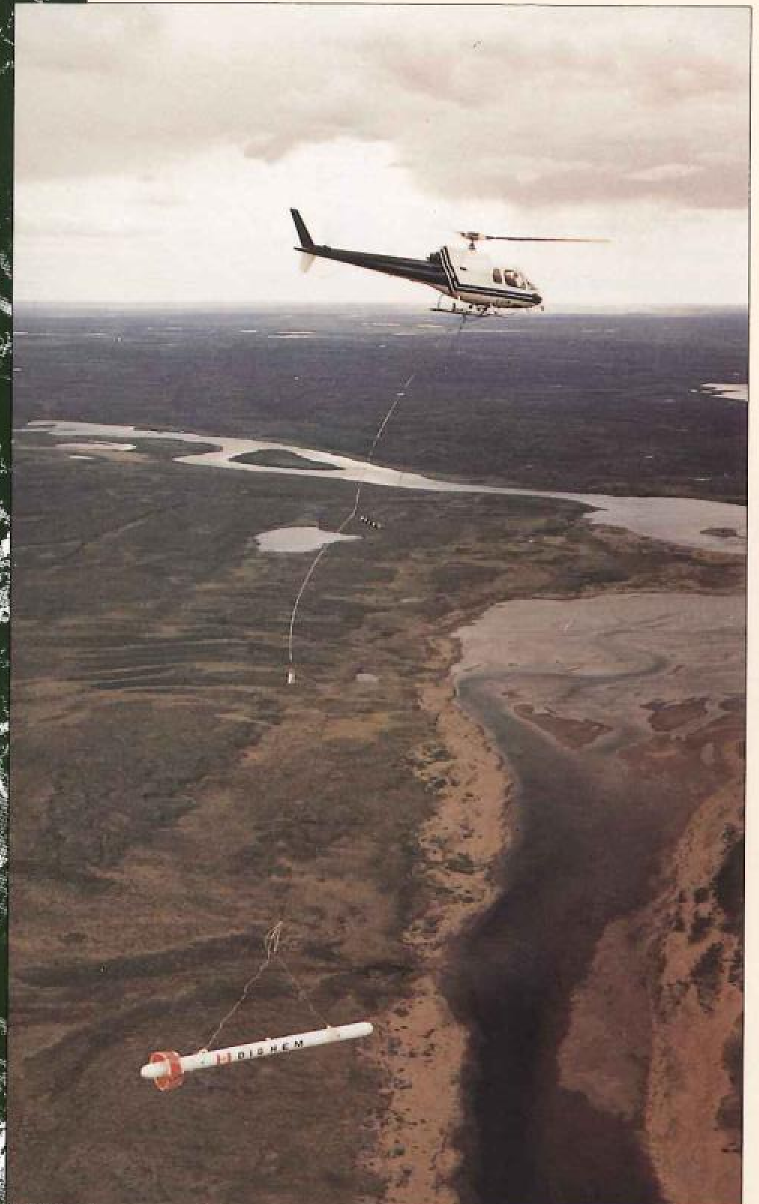
While still an important tool, aerial photographs are being complemented with satellite images taken from space. Several American and European satellites continuously circle the earth taking images in much the same way that a video camera takes television images. Imaged data can be manipulated and enhanced by computers, and in this way provide much more information than can be gained from a photograph with the naked eye. Although the science of satellite imaging is still quite young, increasingly it is becoming a valuable tool for explorationists in their search for prospective areas.

The "Bird" eliminates a lot of slogging

Aircraft flying over the land can also collect a great deal of information using sensitive airborne geophysical instruments. While some types of airborne sensors can be mounted in the aircraft itself, others must be towed some distance from it in a long, missile-like container known as a **bird**. Towing the equipment reduces the chance that electrical equipment and machinery in the towing aircraft will interfere with the detection instruments.

Airborne geophysical equipment produces computer-compatible data on the land over which

▼ ***Satellite Image of Yellowknife Volcanic Belt.***
Note Yellowknife City at end of the highway. The small white speck near the top of the photo, north of the large lake, is the Discovery Mine airstrip. This small speck produced over one million ounces of gold!



▲ *Helicopter conducting geophysical survey.*

the aircraft flies. Depending on the type of survey being conducted, detection equipment can include a radiometer, which picks up radioactive emissions from, say, uranium or potassium; an electromagnetic system which will record the electrical conductivity of the ground below (metallic ores are good conductors of electricity); or a magnetometer, which measures the magnetic character of the rocks. Anomalies in the data could indicate the presence of valuable mineral deposits in the rocks below.

Airborne geophysics is a demanding art for the survey crews who fly those aircraft. The air craft must fly a grid pattern over the property, the width of each pass depending on the type of survey being conducted. Ideally, a pilot not only keeps his flight lines at exact spacings, but at the same low height above the ground. Over rolling or mountainous terrain, towing a bird behind an aircraft at constant altitude is no task for technicians with queasy stomachs or pilots with slow reactions or bad nerves!

"Airborne geophysical anomalies could indicate the presence of valuable mineral deposits in the rocks below."

Once the geophysical data have been gathered, computers are used to create various geophysical maps. Geologists and geophysicists study the maps to find anomalies most likely to represent mineral deposits, and to help them understand the geology of the unexposed rocks.

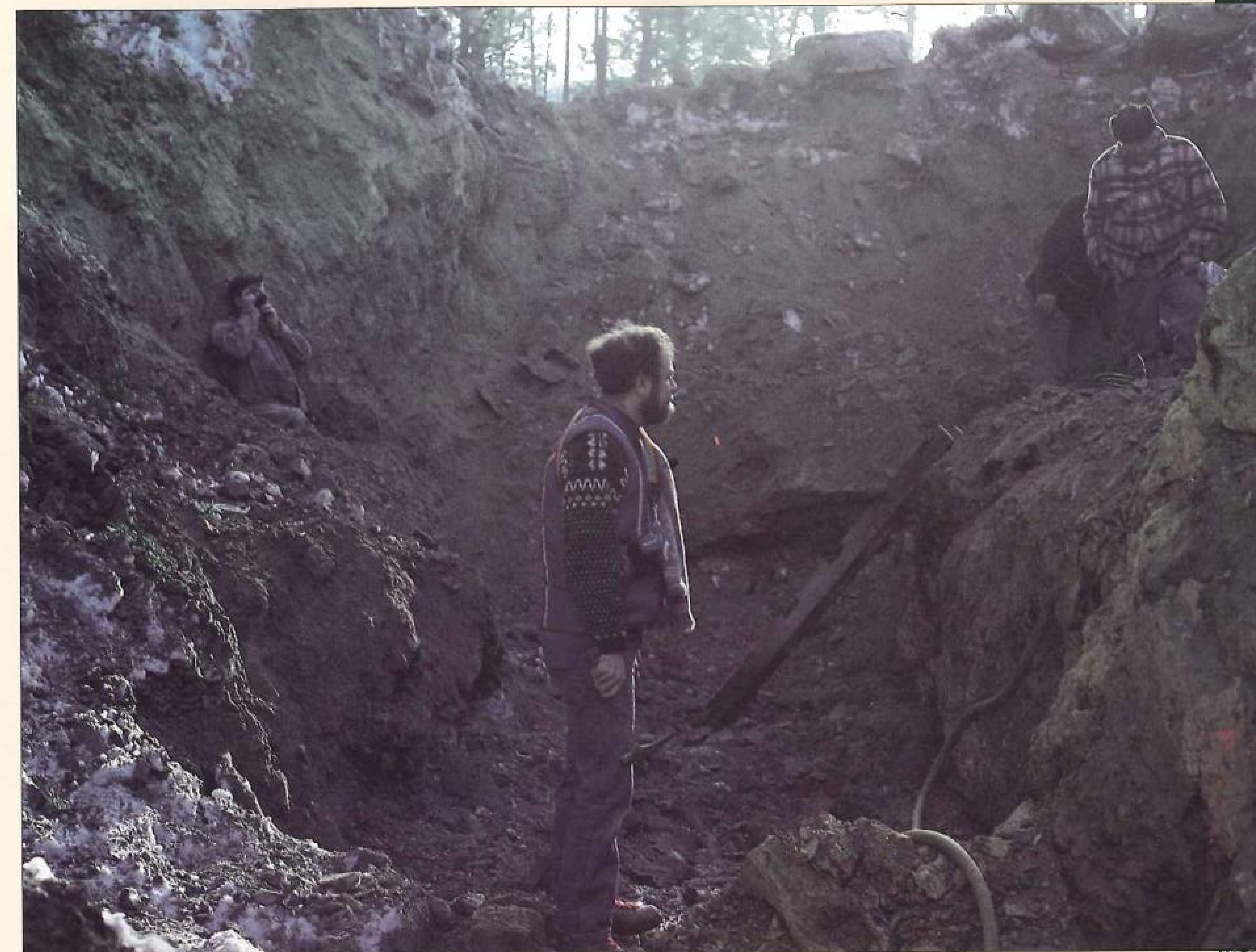
Airborne geophysical anomalies aren't always proof of mineral wealth below the surface; worthless minerals, barren rock formations, unconsolidated sediments, and even man-made structures all can produce similar readings as a concealed ore body. However, some anomalies are worth investigating more closely.

▲ *Geologist Mapping & Sampling on the Grid.*

Once the anomalies of interest have been chosen, they must be accurately located on the ground before further investigation can take place.

The first step for ground study is to establish a grid over the target area. Portable geophysical instruments that can be carried by one or two men are then used to take closely-spaced measurements along the grid lines. This will more precisely locate the anomaly.

At the same time, geologists walk the grid, mapping and sampling the rocks that are exposed, in order to better understand the geophysical data.



▲ *Geologist Sampling a Trench.*

Old methods are still used

To sample the rocks, **trenching** may be done. Where exposed rock looks interesting, dynamite is used to blast a **trench** and expose unweathered rock to a shallow depth of 1 to 2 metres. Extensive samples are sent back to the assay office for analyses.

Geochemistry: Another tool

Even using geophysics, many mineral deposits are still invisible, especially if they are covered with overburden. To find these deposits geologists often use another tool called **geochemistry**.

Many ore bodies are surrounded by a faint halo of mineralization, created when the deposit was formed, or sometime later by metamorphic processes, groundwaters, surface erosion, or even by plant uptake. As these halos are larger than the ore body, they are easier to find.

Not many years ago, chemical analyses were only precise enough to detect the presence of one part of an element in one thousand (called parts per thousand). Now, however, assaying can determine the presence of elements in parts per trillion. Detecting ore body halos is now a practical reality, making geochemistry increasingly valuable in mineral exploration.

The geochemical survey process is very much like traditional prospecting. Samples of soil or rock or even plants, are collected at stations on the grid. If samples produce higher values as the survey progresses, prospectors know they're getting close to the source of the mineralization. When returns begin decreasing in value, they know they've passed the areas of richest mineralization. Analyses are carefully plotted on a map to outline the anomalous zones.

By comparing the findings of geophysical and geochemical surveying on a combined map,

▲ ***Diamond drill precariously set up on mountain side. Note helicopter support.***

Incredible odds!

The odds are less than one thousand to one that a good mineral showing will eventually develop into a producing mine!

geologists have a pretty good idea of the extent of mineralization ... and where to start drilling if the indications are good enough.

Diamond drilling

Geophysics, geochemistry, or surface prospecting are tools that can help find an ore body. However, without samples of rock from below the surface, there is no proof that the ore body is really there. To sample anomalies at depth, a diamond drill is used to retrieve samples.

The diamond drill uses a cutting head, or **bit**, covered with diamond fragments, screwed onto a hollow stem. Diamonds, because of their great hardness, are the keenest cutting tool known. As the bit turns, it cuts a continuous cylinder, or core, of rock. The core is pulled from the drill pipe periodically, and carefully arranged in wooden core boxes, in the order in which it has been recovered.

Reading, or **logging** a drill hole is like reading a book. The geologist starts at the top, left-hand side of the first core box, and reads down, row by row. As he **logs** the hole, the geologist notes the rock types and any mineralization present. From the drill log data, a cross-section is drawn of the ground the drill has penetrated.

Sometimes the target mineral will be visible to the naked eye in the drill core. Most often, particularly in the case of gold, it

▲ ***Visible Gold in Diamond Drill Core – a rarity.***

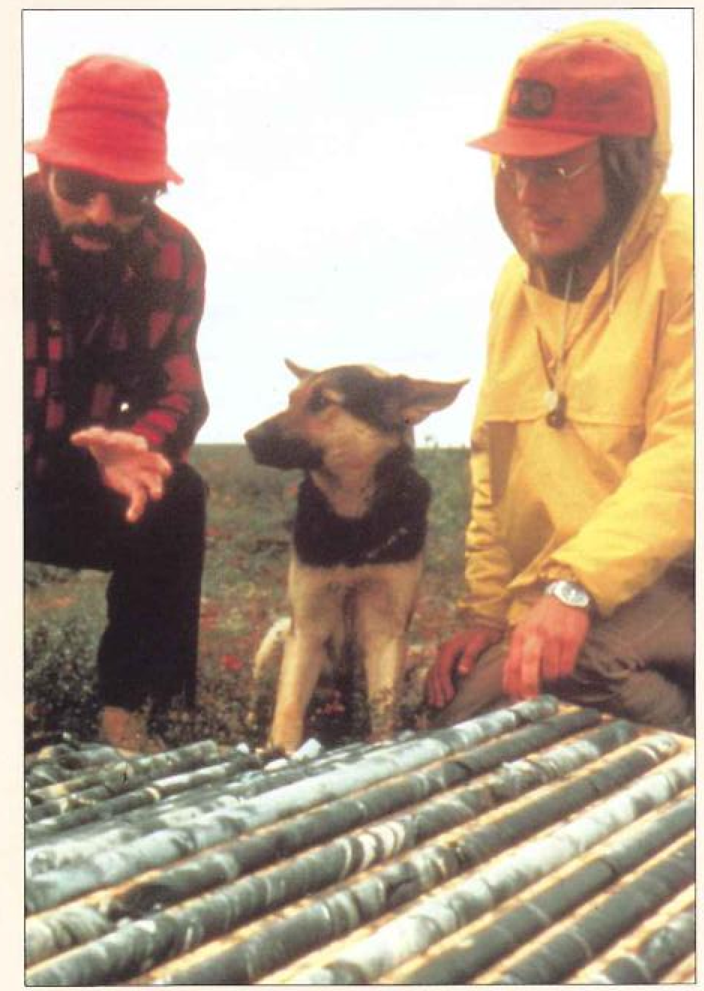
isn't; the geologist will select samples taken from the type of rock in which the mineral is most likely to be found and send them out for detailed analyses in an assay lab.

Drilling is frequently bitter work, since much is done in the depths of winter. To prevent environmental damage, heavy drilling rigs are shifted around after the tundra is frozen. Most often in the North, lighter rigs are used, which can be moved by helicopter. This allows year-round drilling.

The atmosphere on a drill site becomes electric as the drill bit nears the suspected ore body, because the odds against success are overwhelming ... less than one in a thousand! So even when the returns are exciting, drillers and geologists can't always be sure what they've found will become a mine.

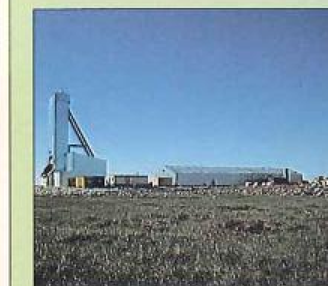
From drilling results, a company will decide either to develop a mine or, with a sigh, write off all the money it has already spent. Sometimes drilling results are not conclusive. In these cases, the company will bulk sample the deposit. Bulk sampling is the most costly method of underground sampling because it means going underground and literally mining many tons of ore for bulk analyses.

Despite all the tools available to the explorationist, there are still deposits that will not be found with the technology we have available today. With time, science will generate new geological theories, and new electronic technologies that will help the explorationist reveal the location of these elusive targets.



▲ ***Geologist (and friend) Examining Diamond Drill Core.***

▲ ***Close-up of Diamond Drill Bit.***



The Tundra Exploration Project.

Mining is not for the faint-hearted

In 1987, Noranda Minerals discovered what it believed could be a 25 million tonne gold ore body on its claims at Courageous Lake, 240 kilometres northeast of Yellowknife. Extensive drilling that year produced encouraging, but inconclusive, results.

There was only one way to be sure: go down and have a look. So, taking a deep breath, Noranda and its partner decided late that year to sink an exploration shaft, 425 metres deep, with a 900 metre-long exploration drift forming the top of an inverted "T". The price tag was $30 million.

The shaft and drift were completed in 1989, and more test drilling and sampling was done underground. That confirmed the gold was there. But it also proved the gold content of the ore was too low to mine at a profit at existing gold prices.

For $30 million, plus $11 million it had spent on a mostly-air-supplied exploration operation before the shaft was sunk, Noranda had a T-shaped hole in the ground ... plus the bill for removing all its structures, sealing the shaft and restoring the site to environmentally-satisfactory condition.

A 360 mile ice road links Lupin Mine with Yellowknife.

Echo Bay set world record!

At the time the Lupin Mine was designed and built, the only access to the region was by air. So, the company purchased a Hercules and a Convair aircraft, and flew every single item, from jars of jam for the dining tables to huge ore crushers and underground vehicles, to the site. From its staging area in Yellowknife, Echo Bay dispatched up to nine Hercules flights per day, 24 hours per day, six days a week, for 20 months! They eventually set a world record for the most tonnage hauled by any Hercules in a 12 month period - 24,000 tons! By the time construction was completed, 32,000 tons of cargo had been trnsported on more than 1,600 flights!

As if innovation in airfreighting wasn't enough, Echo Bay constructed an ice road from Yellowknife 360 miles across the barren lands to reach the mine. To meet the first year's operational requirments, 750 loads of freight, including 3.5 million gallons of diesel fuel and 7,500 tons of mine supplies, was hauled to the mine site during a short 10 week ice road season.

Building a mine in the wilderness

▲ **Echo Bay Uses a Boeing 727 for Moving Workers & Supplies.**

Constructing a mine in the Northwest Territories takes money, brains, courage, patience and faith, in about equal parts ... and plenty of each.

First, the engineers have to decide on the most efficient and economic way of reaching and mining the ore body. If the ore body is close to the surface, they may opt for an open pit mine. If that isn't feasible, they'll have to mine underground. In some cases they do both.

There's also the question of access to the property, to move supplies and equipment in, and in the case of a mine producing very large volumes of minerals too expensive to fly out, to ship out the product.

Transportation systems are limited in the North. The N.W.T. has only a rudimentary highway system, and all of that in the west. There's a four, sometimes-five-month navigation season on the Mackenzie River system; four to five months in which Arctic waters are open to shipping; and a railroad which serves the south shore of Great Slave Lake.

Unless a company is lucky enough to be developing a mine near one of those existing transportation routes, it will have to construct a winter road to its property. Besides flying, which is a costly proposition, it has no other way to move bulky, heavy equipment or the enormous quantities of fuel and other bulk supplies it needs.

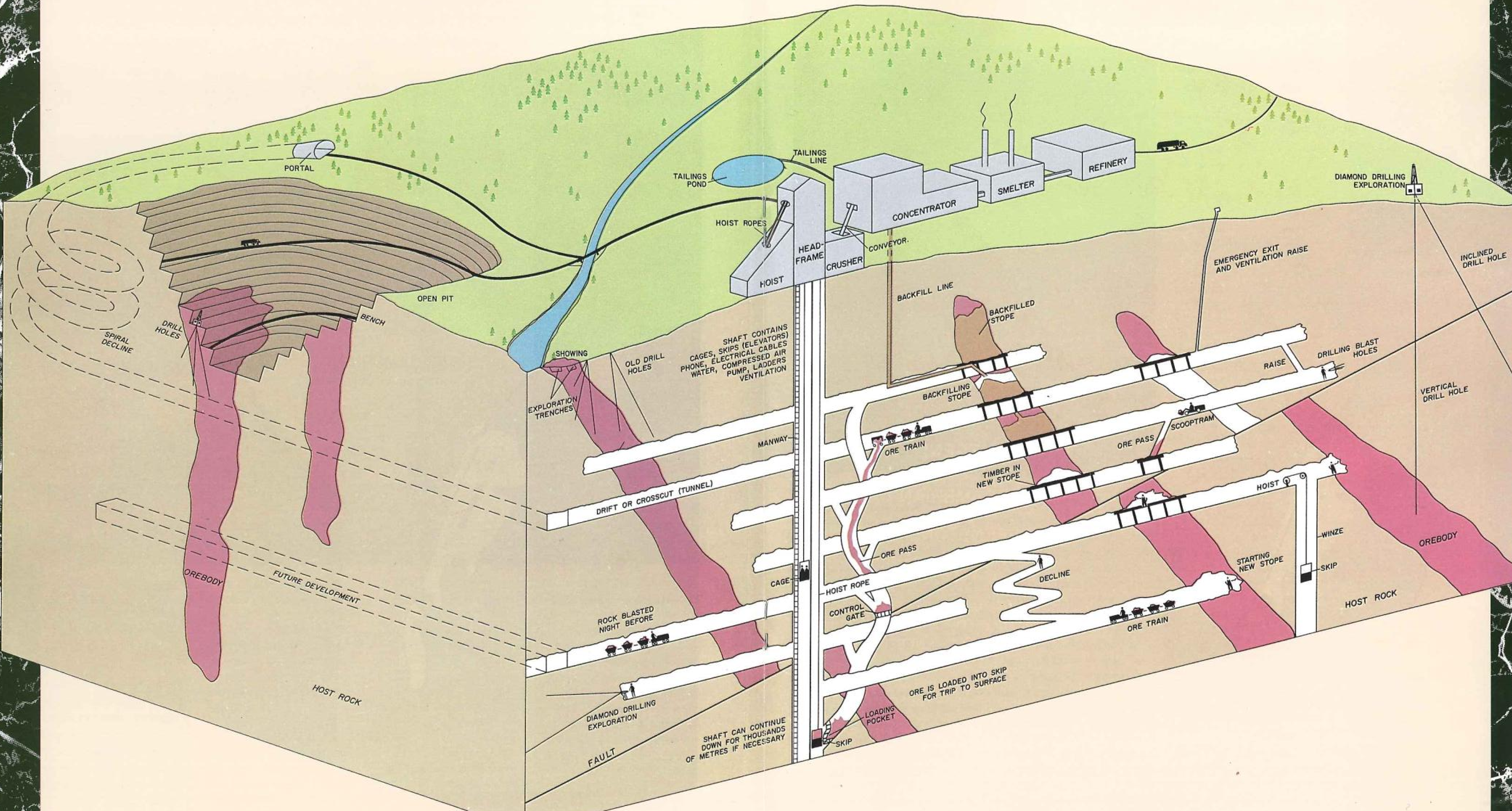
Once a company is committed to construction, April 1 often becomes the most important date on the calendar. It can't count on ice roads holding up after that date, and if its heavy machinery, fuel and other bulk supplies aren't on site by then, its schedule has been set back a full year.

Winter roads mean operating vehicles under severe winter conditions. At 40 or 50 degrees below zero steel snaps like an icicle; with howling winds a plowed road can disappear in a matter of minutes; and with weak ice a truckload of vitally-needed machinery can wind up on the bottom of a frozen lake ... hopefully without its driver. Waiting for equipment to arrive at the mine site can be a rapid aging process.

▲ **Construction at Colomac Mine Site.**

Huge powerhouses

Like a community, a remote mine needs power, and plenty of it. Colomac, with its huge mill designed to process 10,000 tonnes of low-grade ore per day, requires as much electricity as that needed to supply the needs of Yellowknife! Needless to say, to generate this power requires on-site storage of over 34,000,000 litres of diesel fuel!



▲ ***Cross-section of a typical underground mine.***

▲ *A Jackleg Miner.*

Mining the ore

Open pit more than a hole in the ground

Building an open pit sounds simple enough. It isn't.

Designing the shape of the pit itself takes many calculations. It costs just as much to mine waste rock as it does to mine ore. But a mine makes no money on waste rock. Therefore, the engineers' objective is to reach as much of the ore body as possible while removing the least amount of waste rock.

The pit's sides have to slope inward gradually enough to prevent their collapse.

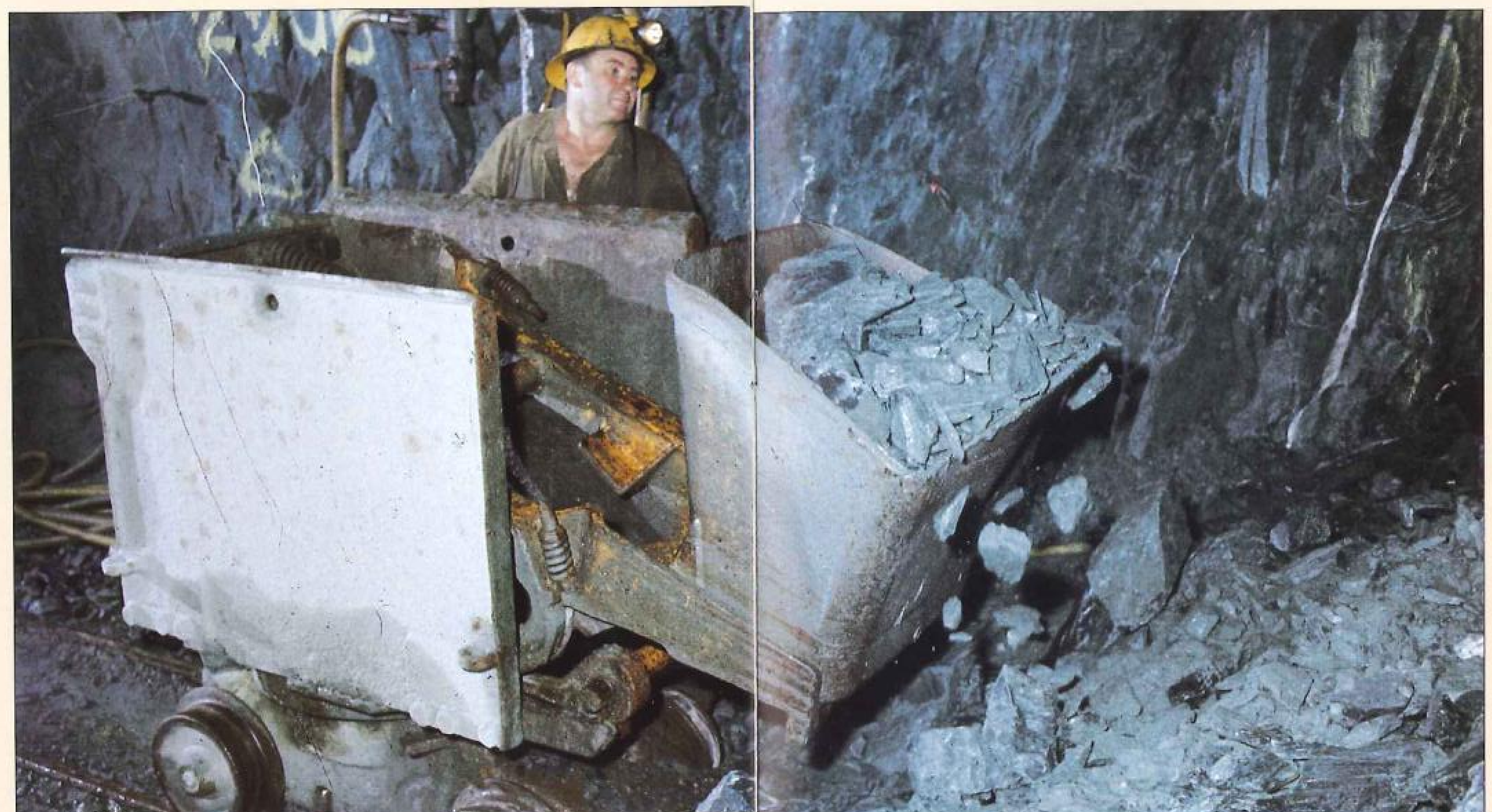
This is done by excavating **benches**, which form a series of giant steps around the circumference of the pit.

Roads lead down from one bench to the next to give access to the self-propelled drills and loaders, and the huge rock-hauling trucks. The grade of those roads has to be gradual enough for the equipment to handle as the pit grows deeper.

At Colomac, after removing the over-burden of waste rock, soil and vegetation which covered the ore body, the mine had to drill, blast, load and haul away three tonnes of waste rock for every tonne of ore it mined. Processing of 10,000 tonnes of ore per day, the mine's production target, would mean removing 30,000 tonnes of waste rock DAILY!

Underground, mining gets more complex

Where removing overburden would be too costly or ineffective to reach the ore, the decision is made to mine the orebody underground.



Where the terrain is relatively flat, a vertical shaft sunk down to the orebody provides the shortest route to underground. A **cage** carries men to and from the workings, while a **skip** transports ore and waste to surface. Many underground mines today use large, rubber-tired diesel machinery too large to fit down the shaft. Gently sloped **spiral ramps** or **declines** must be blasted down through the rock some distance from the shaft, to drive these vehicles underground. In a few mines, like the Polaris Mine, the orebody is shallow enough to access with a straight decline that also houses a conveyor belt to carry ore to the surface.

The ore body is developed by intersecting it at various **levels** blasted out and away from the shaft at different depths. Thus, the 2000 Level intersects the orebody 2,000 feet below surface.

From the levels, the miners blast various tunnels called **cross-cuts** and **drifts**, through the rock to access the ore body at several locations. Drifts run parallel to the ore body, while cross-cuts cut across the ore body. Additional tunnels, called **raises**, are blasted up to adjacent levels, and are used for access by men and equipment, for ventilation, and for moving rock to lower levels.

Ore mined on various levels is dumped down **ore chutes** which often feed a primary crusher and ore storage bin located at the bottom of the shaft. The **skip** picks up its load of ore from the storage bin and takes it to surface. The **mine headframe** that we are so familiar with, sits over the shaft and houses the large pulleys over which the cables for the skip and cage run.

Other methods may also be used to access the ore body. In hilly or mountainous terrain, as at Nanisivik, an entrance tunnel may be driven straight into the hillside,

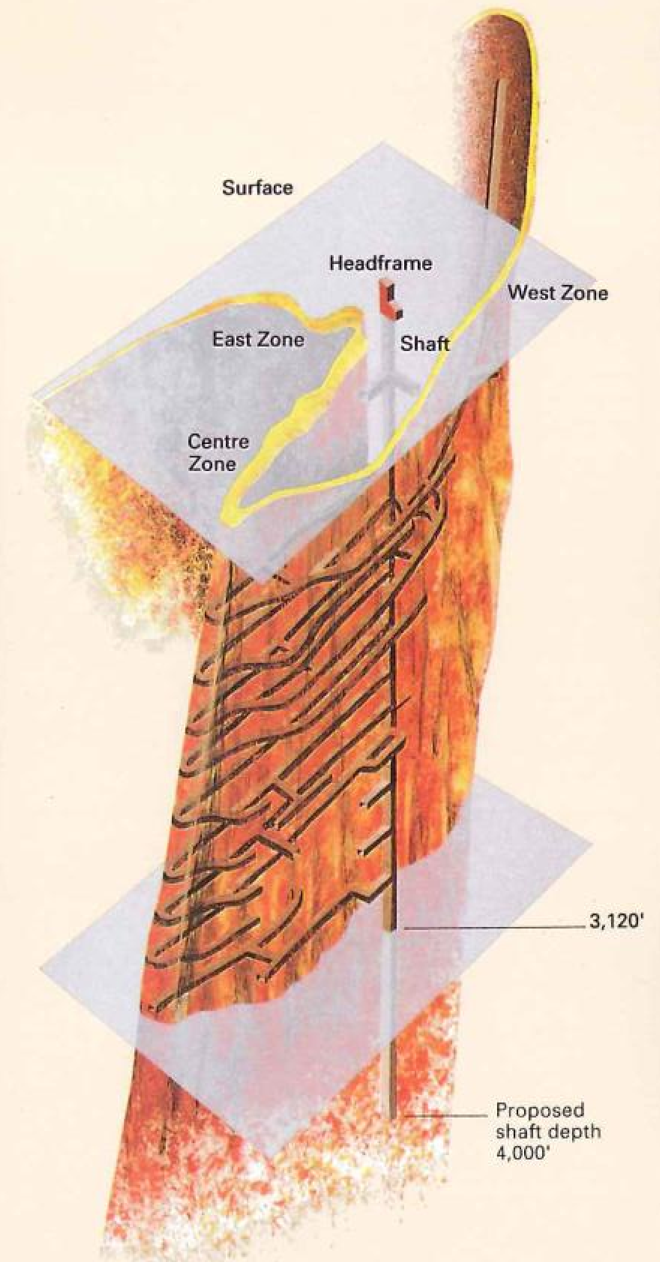
▲ *A track mounted mucking machine.*

▶ *The Lupin Orebody is Accessed by a Shaft & Decline.*

▼ *Open Pit and Haul Road, Pine Point.*

providing a drive-in entrance, or **adit**. Sometimes an underground shaft, called a **winze**, is constructed. Adits and winzes also lead to a network of underground tunnels which reach out into the ore body.

Miners fall into two categories, depending on their job. **Development miners** do all the preproduction mining that is necessary to prepare the orebody for



Mine rescue

Few industries take safety on the job as seriously as the mining industry does.

"Mine operators and workers are aware that underground can be a potentially hostile environment because conditions continuously change on a daily basis" says Greg Majeran, Safety Training Coordinator at Nerco Con Mine in Yellowknife.

"All mines must continually train employees to address workplace concerns, hazards, safety programs and awareness, as well as to prepare for emergency procedures and provide appropriate protective equipment."

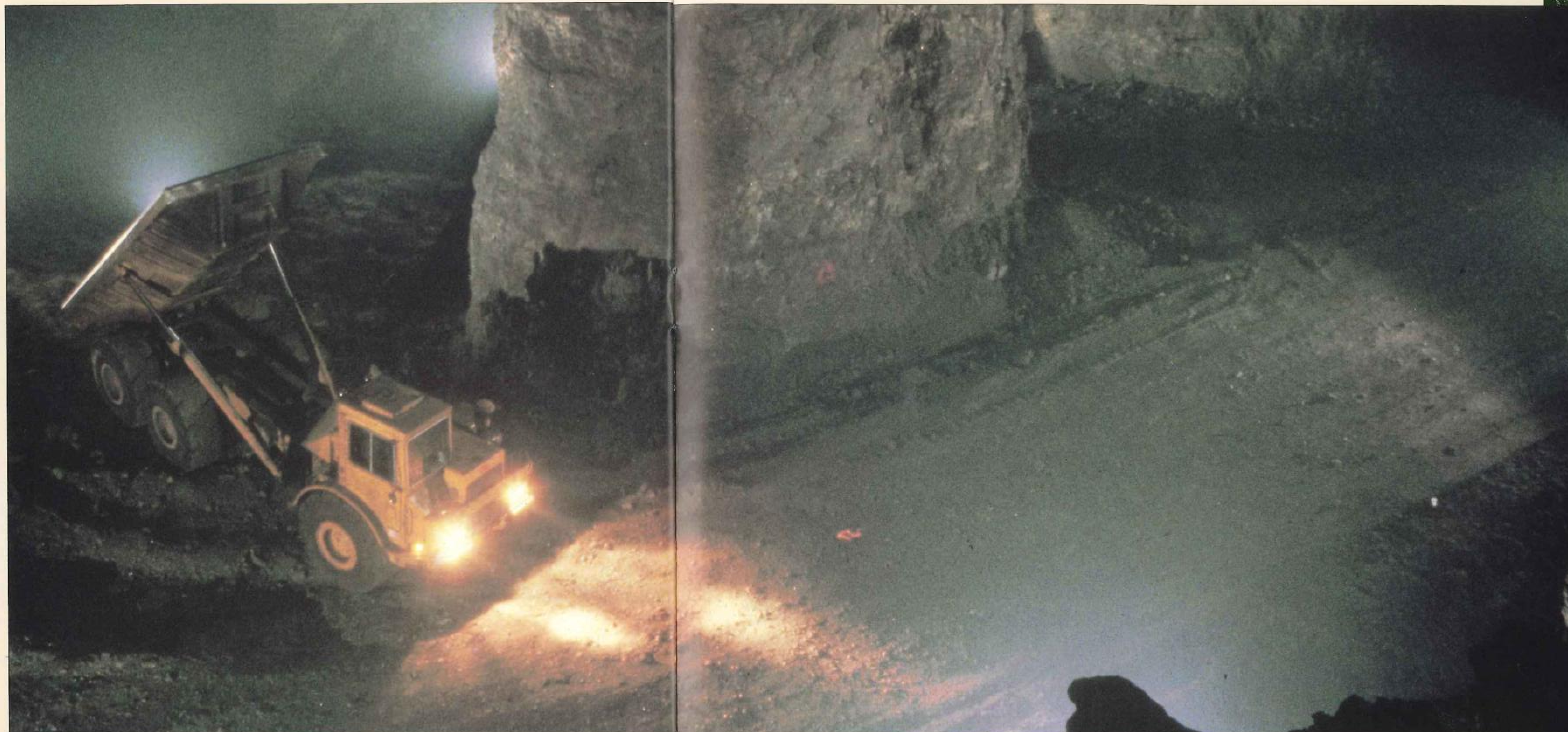
The key to any mine's emergency preparedness or response is a well trained Mine Rescue organization that can respond quickly and effectively in an emergency.

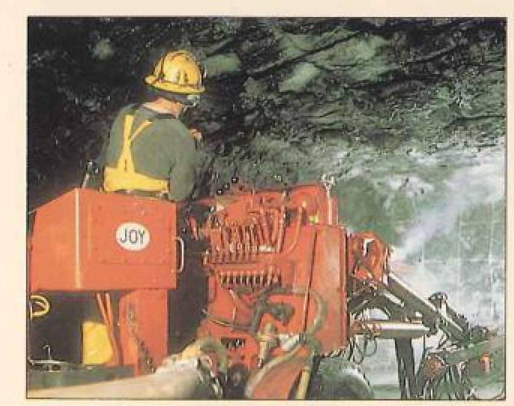
The team (or teams, depending on the size of the operation) are carefully chosen from volunteers. Being members of a mine's rescue teams brings workers a tremendous source of pride. Team members are trained in First Aid, fire fighting, breathing apparatus, and in rescue and life saving skills - training that prepares them for nearly any emergency.

In June each year, rescue teams from across the N.W.T. get the chance to show just how good they are at the annual N.W.T. Mine Rescue Competition held in Yellowknife. About half of the competition involves simulated emergency situations, some of which are based on real situations that have happened in the past.

In the past, choosing a Territorial champion team has been difficult for the judges. The performances have been very close, and show the high level of expertise all the teams display.

Mine Rescue Teams provide expertise which all mine workers can take comfort in.





▲ **An Underground Truck at Nanisivik Mine.**

▶ **A Drill Jumbo Drilling Hole Pattern on Working Face.**

mining. This is largely waste rock mining of raises, drifts and crosscuts. **Stope miners**, on the other hand, mine the ore itself from working areas called **stopes**.

To mine rock, miners drill a pattern of holes into the rock. These holes are loaded with explosives which, when detonated, blow the rock out into the empty stope. Track-mounted or rubber-tired equipment is then used to haul the broken rock away.

Broadly speaking, there are two ways to mine an ore-body, depending on its width. For narrow ore bodies, the miners use hand operated **jack-leg** and **stoper** drills, while in wider ore bodies, wider self-propelled, rubber-tired **jumbos**, or tracked longhole drills are used. In some narrow ore bodies, electric trains called **trams** haul the ore away, while in wider ore bodies, rubber-tired loaders called **scoops**, or **LHD**'s (for load-haul-dump) are more commonly used.

Exploration is also conducted underground. Diamond drilling from locations both underground and on surface continues throughout the life of the mine. Geologists log and sample the drill core, and plot their findings on underground maps of the mine. This outlines more thoroughly the shape, size and grade of the orebody, well before the miners are sent in. Underground exploration is essential, for if no new ore beyond that already known can be found, then the mine's days are numbered.

Ventilation is very important in an underground mine, as both men and equipment need air to work safely. Large fans and compressors on surface send millions of cubic metres of air underground. Ventilation engineers ensure that air flows freely and smoothly through the interconnecting levels, shafts, raises, and stopes.

After Crushing, Grinding Mills Reduce the Ore to Flour Size.

Various milling processes

The Colomac Mine uses a combination of gravity and carbon-in-pulp (CIP) leaching processes to recover its gold. A shaking table removes the coarser, free gold by gravity separation. However, to capture the finer gold, it must be leached twice with cyanide to dissolve the gold, and precipitated twice, first using charcoal, and then steel wool. The steel wool with the gold particles sticking to it is then fed into a gas-fired furnace for smelting.

At the Giant Mine, similar CIP technology is being used to recover gold from tailings. In addition to treating fresh ore, old tailings are being reprocessed to recover gold left behind in earlier years.

Recovering the metals: milling

Ore is a mixture of valuable minerals and waste rock, called **gangue** which must be separated and concentrated in a plant called a **concentrator** or **mill**.

The first step in the treatment of ore is to reduce its size. In the mine itself, explosives first break the ore into large pieces. From an underground crusher, or from trucks hauling from an open pit, these pieces are brought to the mill. Here, they are **crushed** to a smaller, more manageable size.

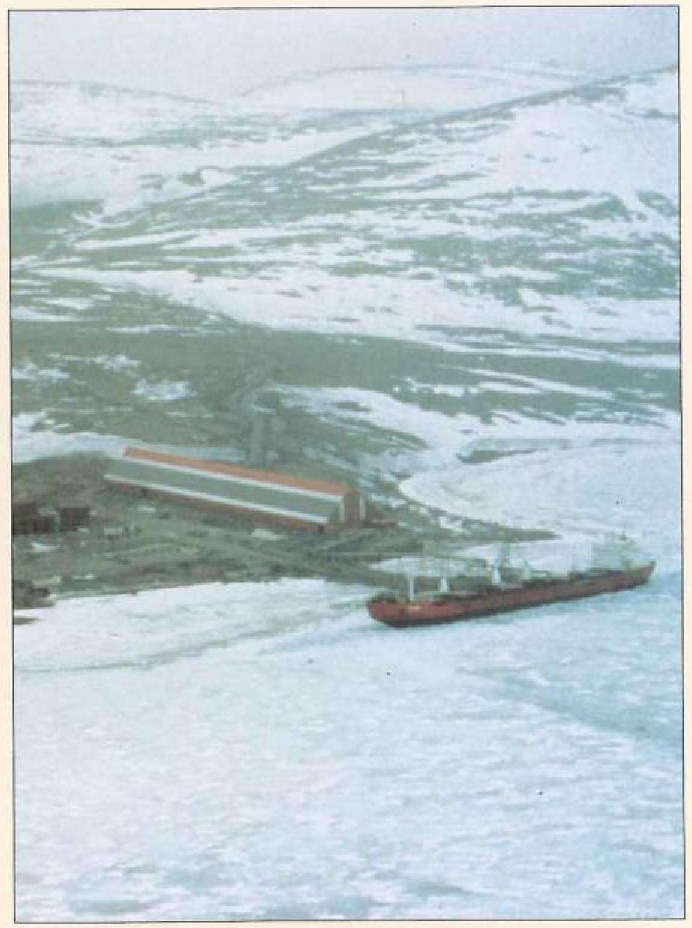
Conveyor belts carry the crushed ore to huge rotating steel drums, called grinding mills, where it is mixed with water. Grinding breaks the smaller ore mineral grains free from the waste rock, and reduces the ore to a mixture of powdered ore minerals, gangue minerals, and water. By adding water, transporting the finely ground rock flour through the mill becomes much easier and cheaper, as pipes and pumps can be used.

There are four types of grinding mills commonly used, named after the grinding medium they use to accelerate the crushing. **Ball mills** are half-filled with iron balls, while **rod mills** contain long steel rods. **Autogenous mills** are so named because they rely only on the grinding action of the constantly-falling ore itself. The fourth type, the **semi-autogenous** or SAG mill, is an autogenous mill containing balls.

Which types of mill a mine will use depends on the characteristics of the ore.

The powdered rock flour and water mixture which emerges from the grinding mills is treated by one or more processes including leaching, gravity separation, and flotation ... again depending on what minerals the ore contains.

The cheapest method for recovering gold and silver is to separate the precious metals from the gangue by making use of their density differences. If the ore is too complex for this **gravity separation** process, then chemicals are used that **dissolve** only the ore minerals, in large **leaching** tanks. Once the precious metals are dissolved in the solution (making it **pregnant**), the undissolved gangue minerals are easily removed. The **pregnant solution** can then be treated with other chemicals that cause the precious metals to **precipitate**, or come out of the solution. They can then be separated from the solution, using filters.



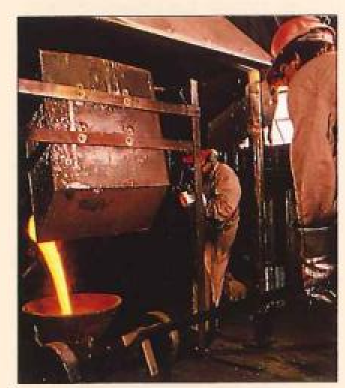
▲ ***Cargo Carrier, M.V. Arctic, Loading Ore at Nanisivik.***

Pouring gold bricks is the final, and perhaps most satisfying step. Here, at last, the results of all that work can be seen. The precipitate containing the gold is sent to the smelting furnace where it is heated to over 1,000 degrees Celsius. When the precipitate melts, the heavier molten gold and silver separates from the impurities, which are poured off first as waste, or **slag**. Then, finally, the molten gold is poured into brick-shaped moulds. The gold bars may weigh 30 kilograms each, and be worth half a million dollars! These are flown south to go through a final refining process from which they emerge as 99.999 per cent pure gold. The slag is broken up and remelted with the next pour, along with sweepings from the floor ... and the workers' coveralls ... to make sure no gold is lost.

▲ ***Cargo Carrier, M.V. Arctic, off-loading in Europe.***

"Ore is a mixture of valuable minerals and waste rock, called gangue which must be separated and concentrated in a plant called a concentrator or mill."

▲ ***A Shaking Table Uses Gravity to Separate the Gold. The Operator is collecting the gold grains at the end of the Table.***



▲ ***Pouring a Gold Brick at Nerco Con Mine.***

Recovering base metals such as copper, lead, zinc, and nickel, is quite different than the leaching process used for gold. The ground ore is fed into large tanks known as **flotation cells**, filled with a soapy chemical solution which is whipped into a froth by air blowing through it. Ore minerals stick to the bubbles and are carried to the top of the tank where a continuously-skimming blade collects the ore-laden froth. Waste rock is left behind. The wet ore minerals are separated from the solution using filters, and then dried in preparation for shipment to a smelter.

When Pine Point Mine was still in operation, a train took the concentrate to the smelter at Trail, B.C. At Polaris and Nanisivik, lead and zinc concentrates must be stored in huge sheds, each the size of a couple of football fields, until Arctic waters are open for shipping. The concentrates then go to European smelters, where the lead, zinc and sulphur are separated and the metals purified for resale.

Base metal smelters are very expensive processing facilities that require a very large amount of energy and a large amount of concentrate. None exist, nor will likely be built in the near future, in the N.W.T.

Gold concentrate, on the other hand, is produced in much smaller quantities than base metals concentrate. Thus, it can be smelted at the mine itself.

Wherever possible, chemical solutions are recycled, to be used several times, before being pumped into disposal areas, along with the pulverized waste rock which has been extracted. Waste material is known as **tailings**, and the storage areas - **tailings ponds** - are carefully designed to prevent any materials from escaping and polluting nearby rivers or lakes.

▲ ***The Finished Product - Gold Bars!***

Leading edge technology at Nerco Con!

Nerco Con Mine has constructed a pressure oxidation circuit at the Con Mine. The addition of pressure oxidation to the mill circuit required the construction of an autoclave vessel and structure to house it, as well as an oxygen plant, at a total cost of nearly $20 million. While pressure oxidation technology is expensive, it is the most environmentally benign, best available technology for treating arsenic-bearing ores.

The pressure oxidation circuit is a first for the North. While autoclaves have been used for several years to treat gold ores in the United States, there are only two autoclaves being used by the mining industry in Canada, one at the Campbell Red Lake Mine in Ontario, and now this new plant at the Con Mine.

The City of Yellowknife has benefitted from the addition of the autoclave. First, from the construction of the required facilities and second, from the subsequent employment of at least 20 new workers.

Environmental protection is a priority

Mining barely scratches the surface

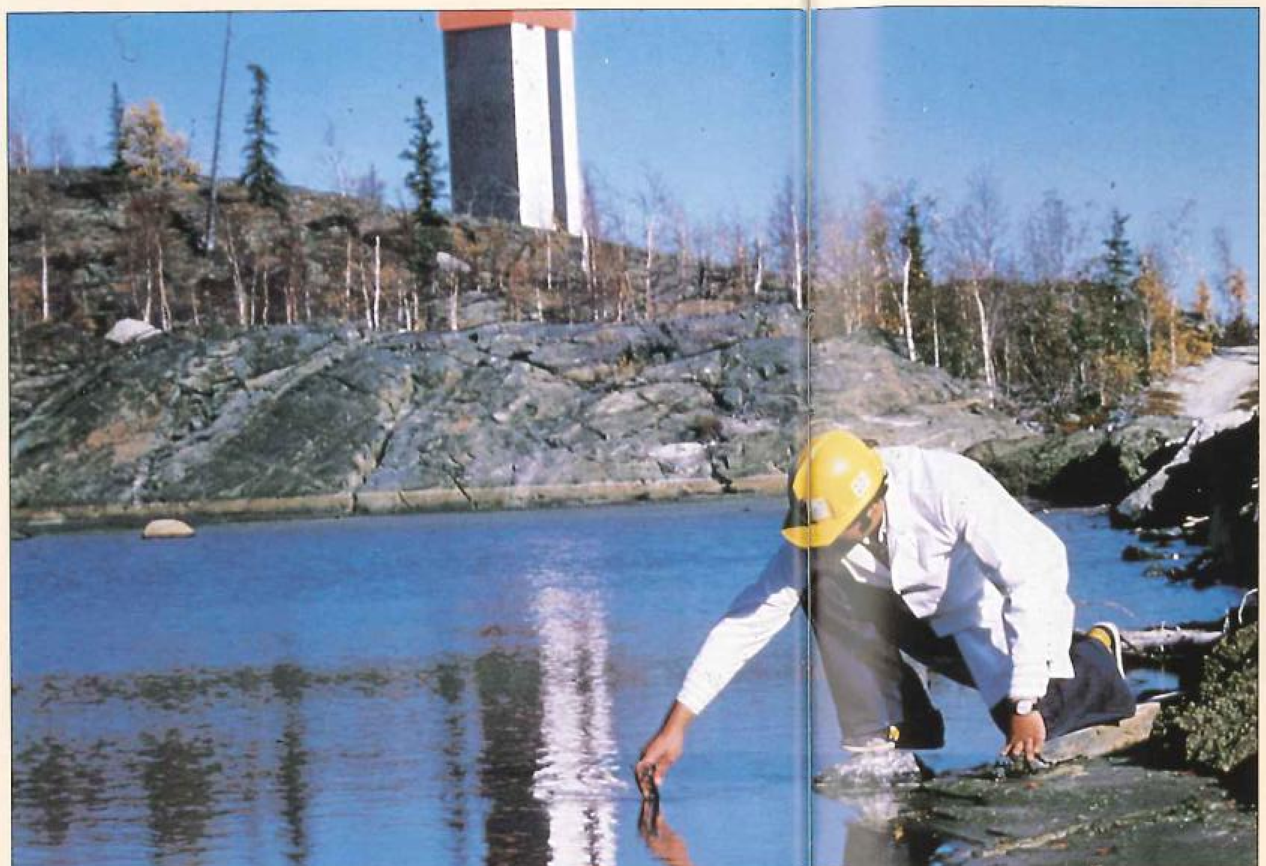
Most people are very surprised to discover that mining occupies very little land area in the North. The total area of all the mining operations, including those mines no longer operating, is less than 12,000 hectares. That is less than 0.003% (three thousandth of one per cent) of the total area of the Northwest Territories! To better appreciate how much this really is, the area of the City of Yellowknife is greater than the area of all the mines, at 13,000 hectares. The area of the N.W.T. highway system is four times greater, at 50,000 hectares.

As you can see, the impact of mining in the North is very, very small, indeed.

Not many people outside the mining industry are aware of the exhaustive process which is involved in constructing a mine and bringing it into production in the N.W.T. today.

In many ways, finding an ore body which can be economically developed, doing the exploration work which is needed, arranging the financing, and constructing the mine itself are the EASY tasks - despite the risks, hard work and frustration involved in each phase of that work.

Meeting stringent environmental protection requirements before mining is allowed to begin is only half the story. Throughout the whole life of the mine its operations will be continuously monitored to ensure that emissions of waste materials are kept within safe limits. And when the mining operation ceases, the mine must ensure it leaves behind a properly-reclaimed site which will not become an environmental hazard in the future.



The approval process is a tough one. In the N.W.T., mining comes under three federal acts, the Northern Inland Waters Act, the Fisheries Act, and the Territorial Lands Act. Through the permitting process, all interested parties are provided the opportunity to participate.

A detailed evaluation of projected environmental effects must be carried out and documented for submission to the N.W.T. Water Board. In addition, baseline studies to document, amongst other things, fisheries resources, wildlife, water quality, vegetation and stream and lake sediments are mandatory. These will help identify any significant wildlife or fisheries resources, and rare, threatened, or endangered plants or animals that could be affected by mine development.

A surveillance network program is incorporated into the water license, and prescribes where and when water samples are to be collected over the project area. These samples will be analyzed for a variety of parameters by an independent lab, or an approved on-site laboratory. These analyses will reveal any potential environmental problems.

Results, with a full report, are submitted monthly to the N.W.T. Water Board.

Emergency Response Plans must be drafted, that identify specific operating and response procedures to mitigate environmental impacts. Potential impacts could include such things as fuel, wastes, and chemical spills, and would also spell out safe practices for their handling and management.

To add to all of this, an abandonment and restoration plan must be submitted for approval. This plan will identify procedures for ensuring site stability and minimizing long-term environmental impact. The plan will address the removal of all buildings and equipment from the site, and the decommissioning of the tailings containment area to ensure future protection.

Exploration, with its minimal impact, is also subject to strict environmental regulation. In the Keewatin, for example, caribou and their calving grounds are carefully protected. Permits are required for any mining or exploration activity within certain areas during calving season. All work must stop if calving animals or cows with newborn calves appear. The ban includes such activities as blasting, low-level flying and the use of snowmobiles or all-terrain vehicles.

Mining is not the only industry to be hit by unsuspected problems in the areas of pollution and contamination, but it is one industry which has faced up to the challenge. Mining decided early to take a pro-active stance and to work with government to find answers, rather than waiting for public pressure and legislation.

Most mining companies have official environmental policies today. Member companies of the N.W.T. Chamber of Mines, as a first step towards achieving the goal of sustainable development in the North, support the Environmental Policy formulated by the Mining Association of Canada. They pledge to conduct their operations "in compliance with all applicable legislation providing for the protection of the environment, employees and the public." Where no legislation now exists, cost-effective management practices will be implemented "to advance environmental protection and to minimize environmental risks."

Environmental protection has added to the cost of Northern mining, but it pays benefits, too ... to the N.W.T., its people and the mining companies themselves.

▲ ***Muskoxen forage in safety around the Lupin Mine.***

◀ ***Water Sampling at Nerco Con Mine.***

ECHO BAY MINES

Environmental Policy

Echo Bay Mines is committed to good stewardship in the protection of the environment in the conduct of its business. More specifically, we are committed to:

- Carrying out sound project planning and operational management to minimize environmental impact in the course of exploration, mining and processing of mineral resources.
- Maintaining an active, self-monitoring program to ensure compliance with law and government regulations and with Echo Bay standards.
- After the completion of a project or operation, returning the disturbed area to a reasonable and acceptable condition, in accordance with applicable government regulations and permits.
- In the absence of legislation, applying practices to advance environmental protection and minimize environmental impact.
- Being responsive to requests for information and commentary by government in the formulation of laws and regulations of the mining industry in the environmental area.
- Supporting industry associations which promote good environmental practices and advance environmental protection in the mining field.
- Communicating this policy in writing and by deeds to all Echo Bay employees.

Mining is the North's second-largest employer

▲ *Tailing line maintenance, Colomac Mine.*

As an industry, mining is the N.W.T.'s second-largest employer. Only government creates more jobs. Of the 2,000 people who work in the mining industry in the N.W.T. today, not all are miners, not by a long shot. They represent some 37 trades and a whole range of professions, and at a highly-mechanized mine like Lupin, 60 per cent of them work above-ground.

Mining offers top wages in the North. The average wage for the whole mining industry is more than $45,000 per year. A top miner may earn over $100,000 a year.

A partial list of trades employed in the mines includes carpenter, diesel mechanic, draughtsman, electrician, heavy duty mechanic, hoistman, industrial mechanic, instrument mechanic, machinist, millwright, mine mechanic, pipefitter, plumber, power engineer, stationary engineer, steam engineer, warehouseman and welder.

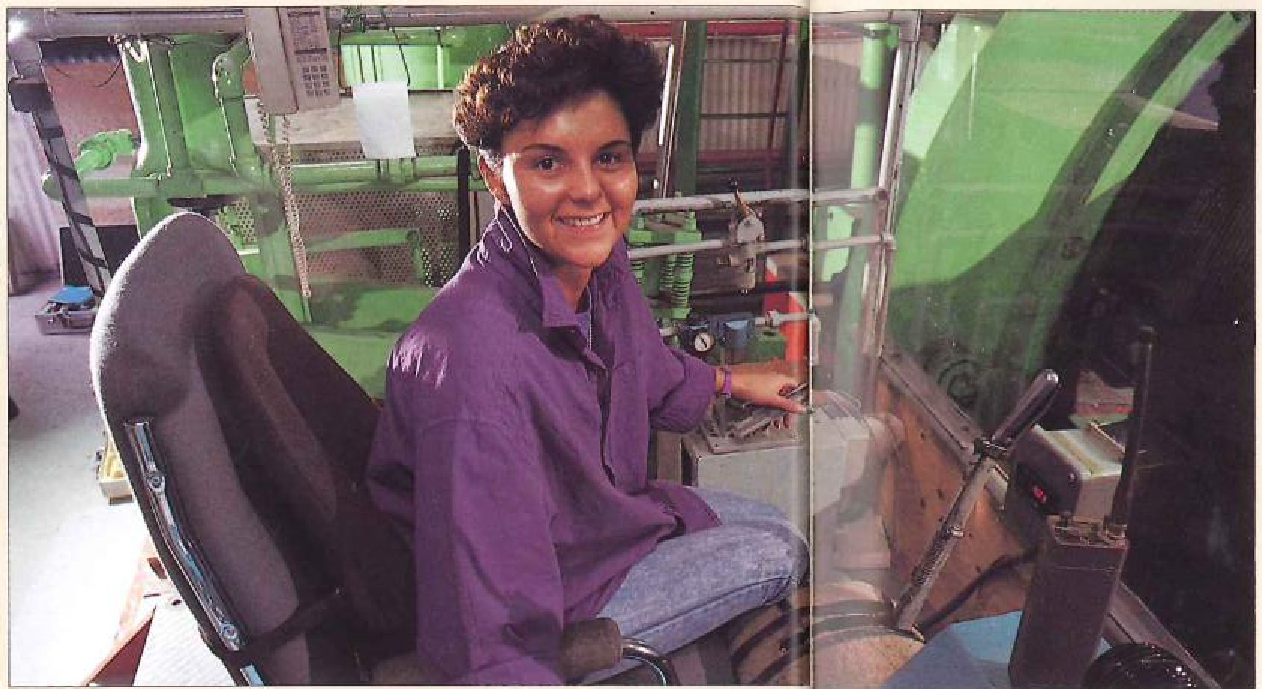
You need a full administrative staff to operate a mine, including managers, secretaries, computer operators, safety and security staff, and clerks. At remote sites, nurses, cooks, housekeepers, transportation specialists, and even weather observers are required.

Then there are the professional people, most of them engineers, geologists or accountants. They're the people who make a mine from a discovery and then ensure the mining operation remains profitable. They determine the most cost-efficient way of reaching the ore body, how to mine it economically and efficiently, and how to process the ore and recover the maximum mineral content at the lowest cost.

Those are the people who actually work on the minesite.

Mining exploration creates hundreds more jobs. You need prospectors, labourers, geologists, geophysicists, geochemists, drillers, assayers, surveyors, claim-stakers, road-builders, blasters and expediters, pilots and cooks to explore for minerals.

Mining provides employment for many other support services, including local businesses ranging from the grocery store to the fuel company. When a mine orders its annual fuel supply it usually does so in terms of millions of litres, and its food and other supplies by the tonne.



▲ *Hoist Operator, Nerco-Con Mine.*

Where prices are competitive, mining buys locally. That can be a shot in the arm for Northern businesses.

There weren't many women at work in the mines 20 years ago, and the few present worked as cooks, laundresses, housekeepers or office staff. On many a minesite, the cook was the only woman.

Today there can be more women than men in exploration camps, working as geologists, geologists' assistants or technicians as well as in the kitchen.

On the minesite, you'll find women working at almost every occupation, from underground miner to lab technician to heavy equipment operator, mechanic, carpenter or hoistman (that name hasn't vanished, yet, though "hoist operator" is becoming more common.) Today, a woman is just as likely to be the president of the company.

Four of the Nerco Con mine's 15 hoist operators are women ... and Con has found women better suited temperamentally to that demanding work than many men.

Many of the people in the N.W.T.'s mines have come North from the provinces, and many work at fly-in, fly-out operations, maintaining their homes in the south and working rotating shifts. But more and more Northerners are finding employment in the mines today, many a native Northerner among them.

When it came to hiring, northern mines were always quick enough to hire Dene and Inuit as stakers, woodcutters, caretakers or handymen. The bush or barren lands held few terrors for people who lived off the land; they were obviously better for that kind of work than southerners.

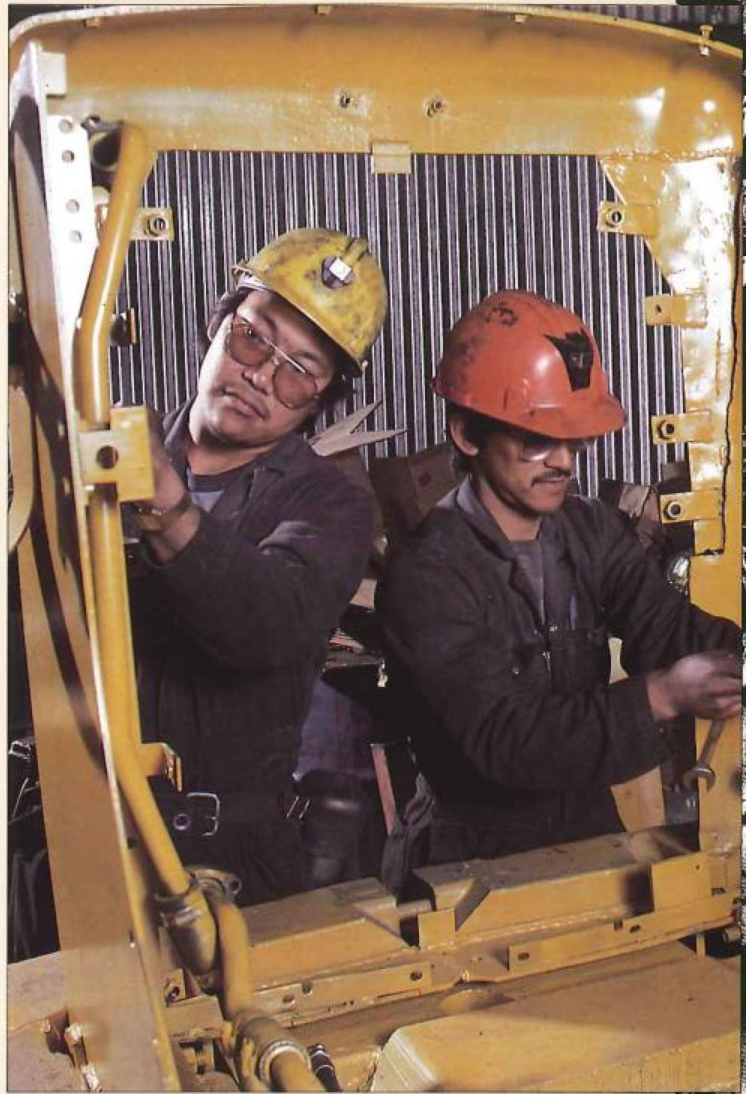
However, for the more skilled jobs such as miners, millwrights, engineers and other technical staff, it was necessary to hire skilled workers from the south, rather than hire local people - most of whom had only a few years of schooling.

There were sporadic efforts to change that situation, but not much of an organized approach. When North Rankin Nickel Mines opened at Rankin Inlet in 1957, for example, the federal government thought the project would be ideal for creating jobs for Inuit who'd been moved into Rankin from outlying communities and camps.

It apparently crossed no one's mind that not all Inuit ... any more than the average person on the street in southern Canada ... would jump at the chance of becoming a miner.

The federal government tried again when Nanisivik opened, with the federal government as a partner. This time, the government was more cautious. It established a series of training and employment goals aimed at creating a work force which would be 60 per cent native.

Though Nanisivik's native employment never reached 60 per cent, native employment has not been a failure, either; it has averaged 20 to 30 per cent Northern workers since it went into production and has produced a surprising number of qualified native journeymen through its apprentice system. Over the years it has employed nearly every able Inuk from nearby Arctic Bay. As well, practically every powerhouse operator in the eastern Arctic is a Nanisivik graduate.



▲ *Heavy Equipment Maintenance, Nanisivik Mine.*

Nanisivik's prize graduate is Joshua Kango of Arctic Bay. He worked at Nanisivik for seven years as a heavy equipment operator, then used the money he'd saved to buy a small canteen in Arctic Bay.

Today Joshua and his wife, Natsiq Alainga, own Arctic Bay's only hotel and coffee shop, a general store, a taxi business and tourist operation. He's local agent for First Air, holds the Territorial fuel distribution franchise, handles busing of Nanisivik employees who live in Arctic Bay, and has a snowmobile dealership.

Did you know that?

For every mine worker in Canada, there are at least four other employees dependent on him for their livelihood. This translates to many more benefits than are seen by merely looking at mine employment figures!

Better transportation, more jobs!

Mining could be providing jobs for many more Northerners and making a much greater contribution to the N.W.T. economy today if improved transportation infrastructure was available.

For instance, several large lead-zinc-copper deposits were discovered some years ago within 300 kilometres of Coronation Gulf. With the construction of roads to the coast, and the availability of more ice-breaking freighters like the MV Arctic, these deposits could finally become economic to mine.

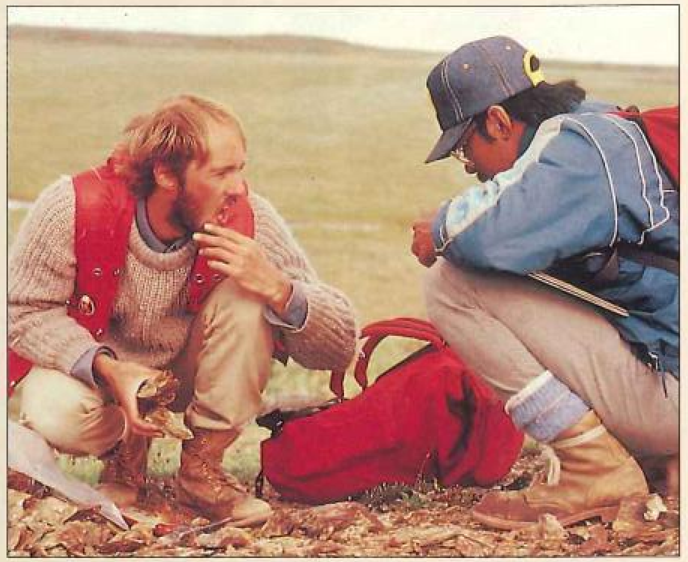
The benefits to the North would be huge!

"Fly-in" operations

"Fly-in, fly-out", or commuter mining operations are generally the rule for newer mining operations in the modern North. Miners and other staff work shifts ranging from two weeks "in" and two weeks "out" to nine weeks in and three weeks out. The mines accept responsibility for flying their workers in and out, to both northern and southern homes.

In the early days of N.W.T. mining, companies built whole townsites to accommodate not only their workers but their families, as well.

They had to, if they hoped to hire the skilled people they needed. The now defunct Port Radium, on Great Bear Lake, and Nanisivik are typical of those operations. *See opposite page*



▲ ***Gov't geologists mapping in the barrens.***

Other mines, like Cominco's Polaris lead/zinc mine or Echo Bay's Lupin gold mine, take real pride in their success in hiring good northern employees.

Part of that success is the result of continuing government pressure to "hire North." Northerners' own realization that education is the route to follow to qualify for well-paid, skilled jobs is another factor.

A more important factor, perhaps, has been the Northern mining industry's recognition of the value of a stable N.W.T. work force, and its active support of training programs, such as the N.W.T. apprenticeship program, educational upgrading and mining training through Arctic College.

Fly-in, fly-out mining has proven a boon, too, to many a native Northerner reluctant to give up the comparative freedom of life on the land for the structured hours of the wage economy. Rotating shifts allow native mine employees to enjoy the best of both worlds: the good wages and working conditions of mining and, in their time off, the opportunity to return to the traditional lifestyle and to retain those skills.

When Cominco opened its Polaris Mine on Little Cornwallis Island, it was prepared for heavy turnover among its Inuit workers. What it never expected was that it would be producing a steady stream of Northern journeymen through apprenticeship training which takes three to four years to complete ... or that Dene and Metis people from the Yellowknife area would become some of its most reliable long-term employees.

Jimmy Beaulieu, a Dene from Yellowknife, is typical of the native journeymen Polaris has produced. Jimmy, whose two brothers work with him at Polaris, is already a qualified heavy equipment operator. Now, he's completing his apprenticeship as a heavy equipment mechanic.

Lupin Mine hires over 30 workers from Coppermine, including tradesmen, mill workers, miners and heavy equipment operators. John Ivarluk of Coppermine, lead hand on the night surface crew, has been at Lupin since construction of the mine began in 1979. Lupin employs Dene and Metis and non-native workers from Yellowknife, Rae-Edzo and Dettah, as well.

Turnover among Lupin's Inuit employees is almost negligible, says personnel manager Doug Willy. As a result of its success with the Coppermine employees, Echo Bay Mines recently began hiring and training workers from Cambridge Bay.

When Neptune Resources Corporation decided to go ahead with its open-pit Colomac gold mine north of Yellowknife, it took one more step forward in the area of hiring and training Northerners for mining jobs. In a novel move, they made an agreement with local Dene to hire 25 per cent of its employees from among native residents in the mine area. With PCL Constructors Northern, their prime construction contractor, they hired construction workers, wherever possible, from the North. In so doing, they tried to identify Dene workers who, though lacking in formal education, showed an ability and willingness to learn on the job. PCL made a point of hiring supervisors who had experience in working with native people, and provided cross-cultural training for those who hadn't.

Neptune set up a native employment office and hired a Dene employment officer to visit local Dene communities from which it hoped to recruit much of its labour force. PCL put those recruits in the sort of construction jobs ... welding, pipefitting, plumbing, electrical, carpentry ... which would teach them skills useful later, during mining.

As each trade completed its phase of the construction work, PCL moved the best of its native workers into other trades whose work was continuing. When construction was finished, in early 1990, the mine had a group of native Northerners with practical skills for mine jobs, and the potential, with educational upgrading, to become trade apprentices.

Some of those people - particularly young people who'd grown up on the trapline with their parents - had only a Grade 4 or 5 education. Colomac gave them the chance to change their whole lives for the better.

There were about as many native employees on Northern mine payrolls as there were women, 20 years ago. It's a far different story today.

▲ ***Mill maintenance.***

▲ ***Remote Controlled Scoop Tram, Nerco-Con Mine.***

Crew change at Lupin Mine

But even the richest ore body runs out in time.

Unless the mining community finds a new existence as a tourism or transportation centre or government headquarters (as Yellowknife has) that's it. The mine closes and its people move away.

Pine Point went into production in 1964. In its heyday, it was the richest lead/zinc mine in Canada, rich enough to merit the building of a railroad from the Peace River country to haul its ore south to the smelters.

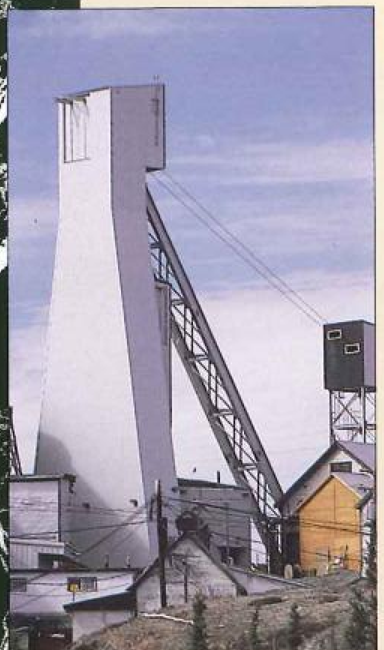
By 1981, Pine Point was a thriving community of 1,763. Today, the town is no more.

If a mine provides a townsite for workers' families, government has to provide schools, hospitals, police and social services - in the full knowledge those needs will cease to exist when the mine does.

Government is eager to avoid the heavy extra costs required. Commuter mining, with accommodation for workers only, is the apparent solution.

However, commuter operations have created a new problem. With many of the workers flying to their homes in the south, the North loses substantial revenues from both income tax and personal spending.

While more and more Northerners are realizing the opportunities which are available to them in mining, the bulk of educated and trained mine workers still come from the South. To recapture these lost revenues, some new attraction to encourage living in the North will have to be found. The most logical is to provide education, training and jobs for northern residents - people who prefer living in the North over the south.



▲ *Nerco-Con Mine*

Mines operating in the N.W.T.

Six mines were in full production in the Northwest Territories at the start of 1992.

Mineral production in the N.W.T. in 1991 included:

Gold	16,562	kilograms
Silver	19,000	kilograms
Lead	31,403	tonnes
Zinc	223,024	tonnes

In 1991, the total value of mineral production exceeded $500 million. This was down sharply from the nearly $1 billion in 1989, and is due to low metal prices and the shut-down of Pine Point Mine.

Gold

Four of the N.W.T.'s six producing mines are gold mines. They are:

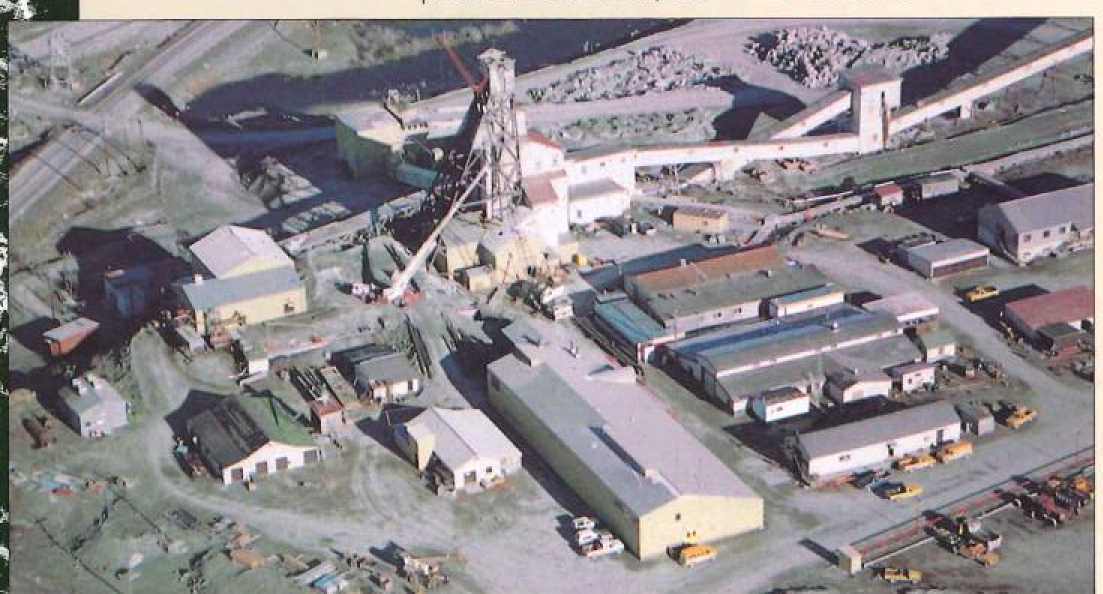
Con Mine

The Nerco Con Mine in Yellowknife produced its first gold in 1938 ... and set an annual production record of 123,092 ounces in 1991, 53 years later! Grandfather of all active Northern mines, Con has produced continuously since 1938 except for a two-year shutdown in 1943, due to the war. First built and operated by Consolidated Mining and Smelting Company Ltd. (now Cominco), the Con Mine was sold to Nerco Inc. in 1986.

Its 6100 level is more than 1.5 kilometres deep and its workings extend under Great Slave Lake and the City of Yellowknife. Mining is by cut-and-fill, shrinkage, and long-hole stoping methods, and access is via two external shafts and two winzes. The Nerco Con mine processes 1,200 tons of ore per day and recovers an average of 2,800 ounces of gold per week at a feed grade of 0.35 ounces per ton.

Recently, the mine completed the construction of Canada's second high-tech, environmentally-sensitive, autoclave unit for treating arsenic-bearing, refractory ore as well as to treat wastes remaining from earlier mining.

The Con Mine provides employment for nearly 400 people.



▼ *Giant Mine*

Giant Mine

The Giant Mine, now owned by Royal Oak Mines, Inc., is located in Yellowknife. It poured its first gold brick in 1948 ... and its 10,000th brick in 1986, becoming one of a few gold mines in the world to attain that level of production.

Giant is an underground operation, although several open pits were mined recently. Mining is by cut-and-fill, shrinkage, and open stoping. The refractory, arsenic-bearing ore must be treated by roasting. Annual production exceeds 375,000 tons at 0.32 ounces/ton (9.9 g/t).

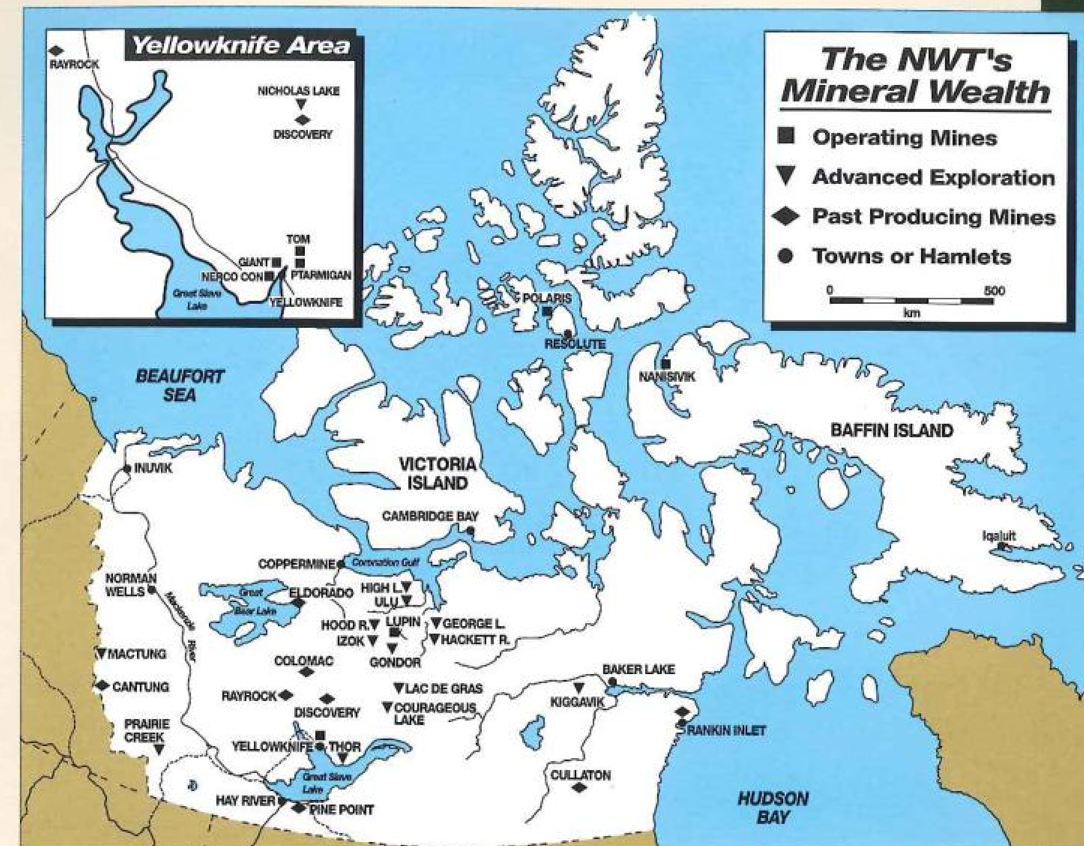
Giant has a work force of about 350.

Lupin Mine

Echo Bay Mines' Lupin Mine is located on the shores of Contwoyto Lake, 90 kilometres south of the Arctic Circle and 400 kilometres northeast of Yellowknife, in the midst of the Barren Lands. Lupin is the world's most northerly gold mine, outside the Soviet Union.

The commuter operation went into production in 1982, and in 1991 the mine set a production record of 216,877 ounces gold. Mining is by mechanized, longhole open stoping. Its 2,000 ton/day mill produces an average of 200,000 ounces of gold per year.

About 12 per cent of its 430 employees are Northerners, including Inuit crews from Coppermine and Cambridge Bay, and Dene and Metis from the Yellowknife area.

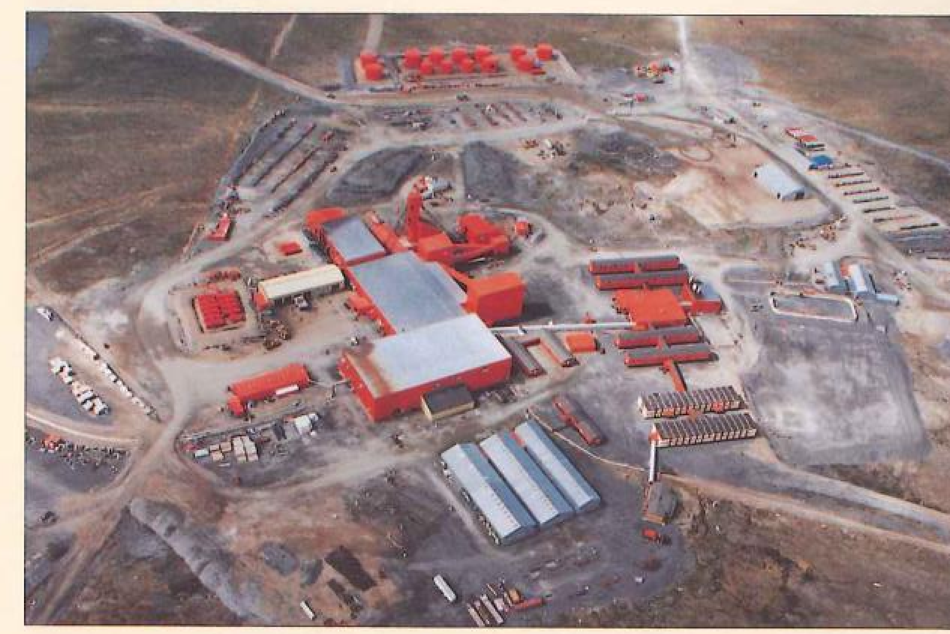


Ptarmigan/Tom Mines

Treminco's Ptarmigan and Tom Mines are located 15 kilometres east of Yellowknife. In 1985, Treminco drove a decline on the Tom property to develop gold reserves for small scale mining. In 1987, they purchased the neighbouring Ptarmigan Mine, originally mined briefly during the Second World War. Production was initially trucked to the Giant Mine mill for processing. In 1989, Treminco opened its own 200 ton/day mill. In 1990, Treminco drove a decline to access the "C" vein, located between the Ptarmigan and Tom veins. Additional work has was carried out on the Tom vein in 1991. Since 1985, Treminco has mined and processed approximately 250,000 tons at an average grade of 0.350 oz/ton from the three veins. The mines currently employ 32 persons, although employment levels have been as high as 60 employees.

Lead/Zinc

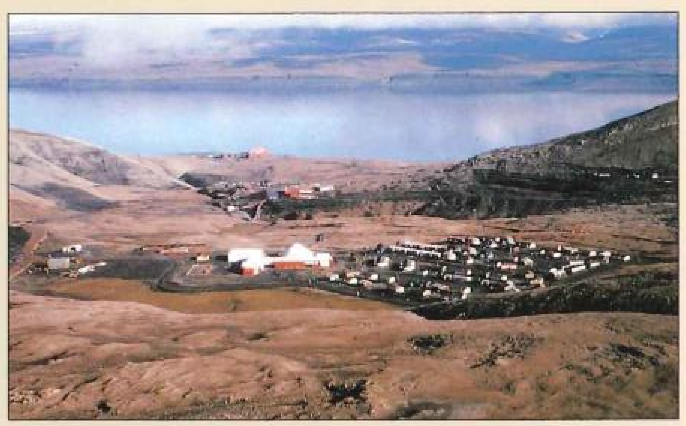
Our two lead/zinc mines are the Polaris Mine, on Little Cornwallis Island, 1,600 kilometres northeast of Yellowknife, and Nanisivik Mine, on the northern tip of Baffin Island.



▲ *Lupin Mine*

Nanisivik Mine

Nanisivik Mine has been producing since 1976. It processes about 700,000 tonnes of ore annually. Mining is by room and pillar, trackless, and mechanized cut-and-fill methods, with access through an adit. The mill can process 2,000 tonnes of ore per day, and produces zinc and lead concentrates which are stock-



▲ **Polaris Mine**

◀ **Nanisivik Mine**

piled on-site for shipment to European smelters and refineries during the summer.

In 1991, 98,200 tonnes of zinc concentrate, and 700 tonnes of lead concentrate containing 18,500 kg of silver were produced. Despite its remote location, Nanisivik Mine is one of the most efficient zinc producers in the western world.

Nanisivik has a work force of about 220 people, of whom 20 to 30 per cent are Inuit. The majority of the workers live in the community of Nanisivik, or commute from nearby High Arctic communities.

Polaris Mine

Cominco Ltd. conducted exploration in the high Arctic for 21 years before bringing the Polaris Mine into production late in 1981. This state-of-the-art operation, Canada's most northerly mine, processes over 1,000,000 tonnes of ore per year. The mill produces over 180,000 tonnes of zinc and over 34,000 tonnes of lead concentrate annually, which are stockpiled for shipment to European smelters during the brief summer shipping season. In 1991, ten shipments of lead and zinc concentrate were made to Europe between June 25, the earliest ever, and October 27 for a total of 252,000 tonnes shipped.

The mining method is mechanized, longhole, sub-level, open stoping, and the access to the workings is by a ramp. Since the mine workings are in permafrost, they must be kept frozen year-round. In summer, air must be refrigerated before it is pumped underground.

The mine's work force averages 250 employees, who work a nine-weeks-in, three-weeks-out rotation schedule; the mine flies employees to and from airports closest to the employees' homes. Seasonal variation of native workers varies from 10-18 per cent.

Minerals are very important to us

▲ **Minerals make up most of our everyday utensils.**

Many of the things we need to live, and most of those that make life more comfortable, depend directly or indirectly on minerals taken from the earth. Food and water supply, shelter, clothing, health aids, transportation and communication, a wide variety of products used at home, at play and at work, all depend on the mineral industry.

To grow most of our food we need fertilisers made from minerals. Fertilizers also help the growth of plants such as cotton and linen which are used to make much of our clothing.

In the North, where many of us hunt for food, we need guns and bullets made from metals. To transport food to our tables we need trains, airplanes, trucks, boats, and snowmobiles - all made from such metals as aluminum, steel, copper, and zinc.

To cook our food, we need metal pots and pans, knives and forks.

We watch television sets which are made from cables, wires, and electronic components, all made from metals or minerals. The rockets, and the satellites they carry into space for telephone and television service, are made from metals.

Water is pumped through copper pipes, by brass pumps, and drains through copper pipes into steel sewage tanks. The wiring in our homes and office buildings is copper or aluminum, the walls are gypsum. Steel beams are made from iron, carbon, and chromium, and the lumber may have been treated with chemicals made from minerals. Our homes sit on gravel or concrete foundations, that are built from materials taken from the ground.

We need metal rigs, drill pipes and assorted equipment to drill the oil wells to get gas for our metal snowmobiles, boats, cars, and trucks, and coal, oil or uranium to provide us with electricity. Metals make the moulds needed to produce the plastics which are so common today. Glass in our windows, and the ceramics in our sinks, toilets and bathtubs are all produced from minerals. Lead and zinc are used in batteries that are so necessary to power our vehicles, radios, and portable stereos.

We need mining!

Each year, every North American requires 40,000 pounds of new minerals. At this level of consumption, the average newborn infant will need a lifetime supply of:

795 pounds of lead, primarily for automotive batteries, solder and electronic components;

757 pounds of zinc, as an alloy with copper to make brass, as protective coatings on steel and as chemical compounds in rubber and paints;

1,500 pounds of copper for use mostly in electrical motors, generators, communications equipment and wiring;

3,593 pounds of aluminum for various uses, from beverage cans to folding lawn chairs to aircraft;

32,700 pounds of pig iron for kitchen utensils, automobiles, ships and large buildings;

26,550 pounds of clay, for making bricks, paper, paint, glass, and pottery;

28,213 pounds of salt for cooking, plastics, highway de-icing, and detergents;

1,238,101 pounds of stone, sand, gravel and cement, for building roads, homes, schools, offices and factories.

To reduce mining activity, as some people think should be done, we as citizens, must first reduce our wants and needs.

If it can't be grown, it has to be mined!

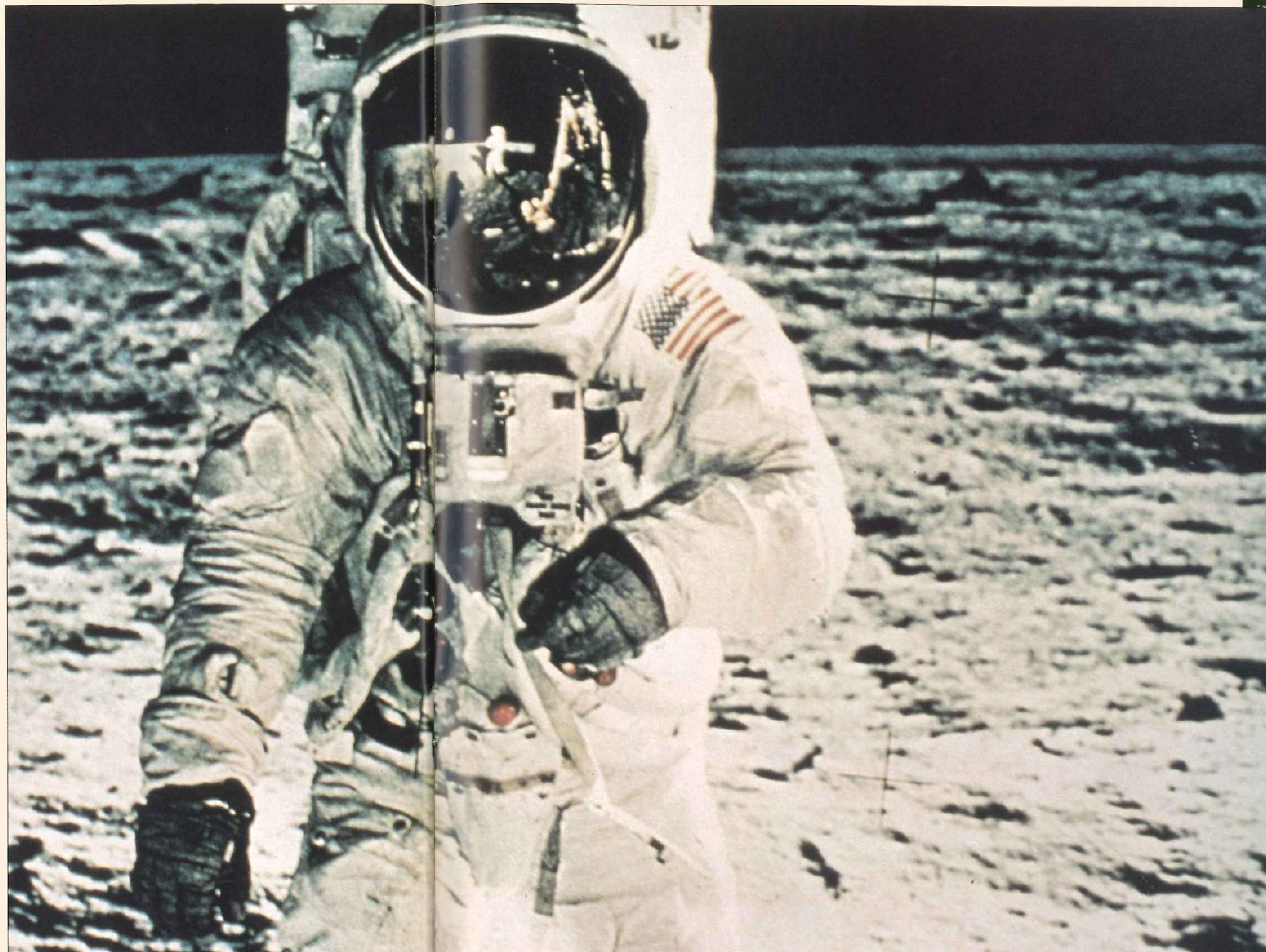
Few people realize that if it cannot be grown on our farms, taken from the sea or the forest (or the barren lands), it must be mined.

The future

The potential for growth in the northern mining industry is very great. As the least amount of geological mapping and research has been done in the N.W.T., mapping has now become a priority. As our geological knowledge improves, we can expect that more and more valuable mineral deposits will be discovered.

Canada will need the mineral riches of the North, and the mining industry is busily pursuing ways of tapping those riches economically ... confident it can find the answers.

The challenge for the mining industry of the 1990's will be to add to the strong tradition of innovation shown in the past, especially in the areas of environmental protection and northern training and benefits. It is a challenge the mining industry is fully confident it can meet successfully.



A thin film of gold covering his visor protects the astronaut from solar radiation.

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N.W.T. Chamber of Mines

MINERAL INITIATIVES

1991–1996 CANADA–NWT ECONOMIC DEVELOPMENT AGREEMENT

Industry and Government - Working Together to Build a Strong Future