



# INCO DISCOVERY



# THE METEOR IMPACT THEORY

The exact origin of the rock structure in the Sudbury region is not known, however, a popular theory states that at one time, perhaps hundreds of millions of years ago, a tremendous meteor came crashing into the area creating a crater approximately 64 kilometres long and 28 kilometres wide.

The impact in the Pre-Cambrian rock, some of the most ancient in the earth's crust, 1,500 to 2,500 million years old,

caused it to crack allowing molten rock from the earth's fiery core to ooze into the new formation.

The Sudbury Basin remains the world's largest single source of nickel sulphide ore. Known deposits will allow for continuous mining well into the next century and continuing exploration is expected to find reserves which will extend that forecast.

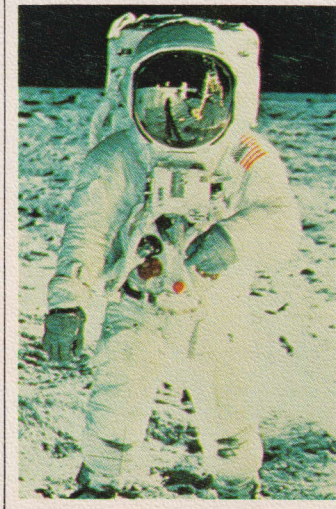
**1** Each shaft in the Creighton complex has a purpose:

7 - shaft is used for lifting the ore to the surface.

3 - shaft was developed to extract the rich ore from the original mine site.

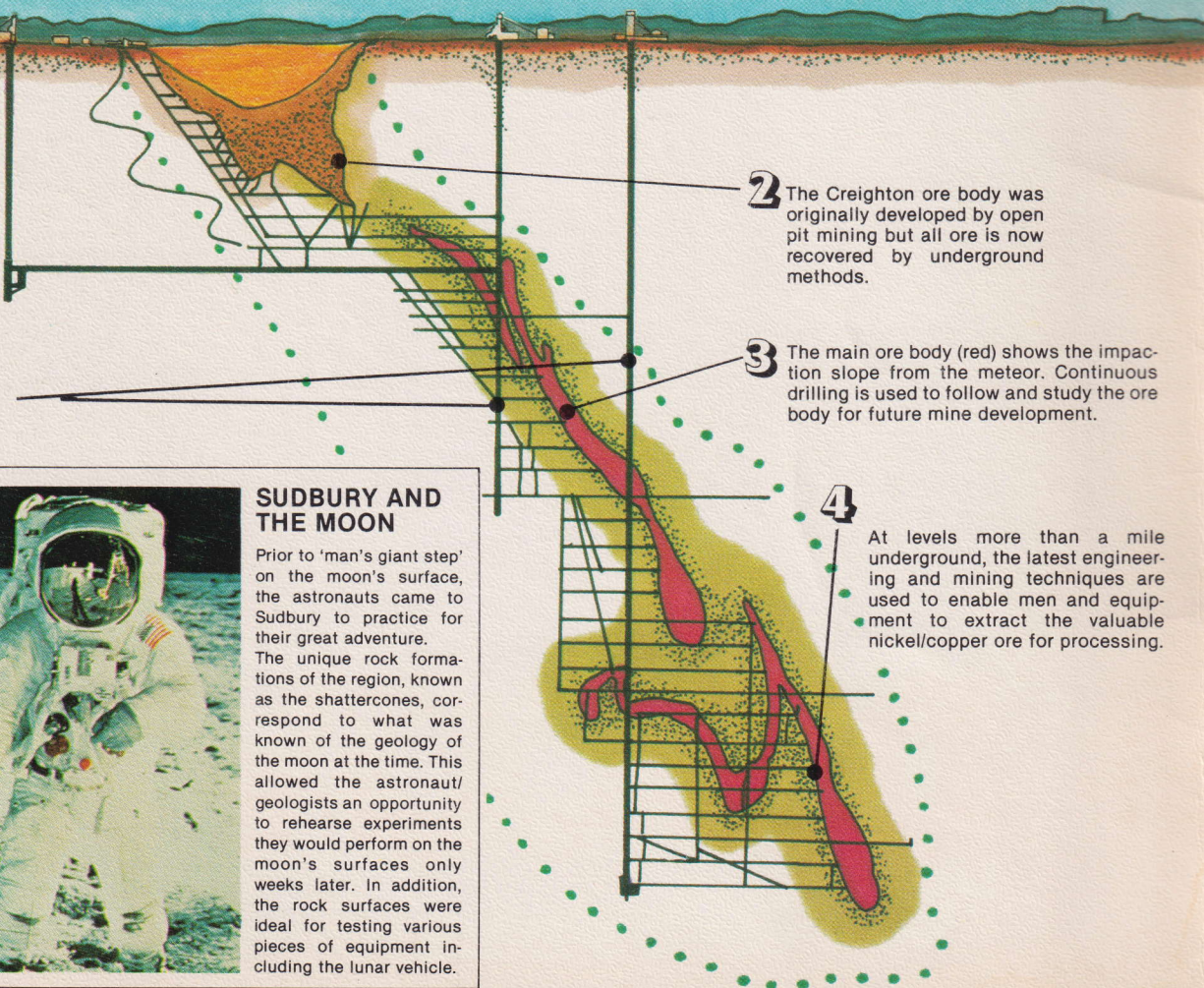
5 & 6 - shafts were sunk to reach the continuing ore body down to about 5,000 ft.

9 - shaft, at more than 7,000 ft., is the deepest continuous shaft in the Western World.



## SUDBURY AND THE MOON

Prior to 'man's giant step' on the moon's surface, the astronauts came to Sudbury to practice for their great adventure. The unique rock formations of the region, known as the shattercones, correspond to what was known of the geology of the moon at the time. This allowed the astronaut/geologists an opportunity to rehearse experiments they would perform on the moon's surfaces only weeks later. In addition, the rock surfaces were ideal for testing various pieces of equipment including the lunar vehicle.





# Welcome to...

## INCO METALS COMPANY

Whether you tour Inco in person or through the pages of this booklet, we hope you will find the experience interesting and rewarding.

Mining is truly a Canadian national resource industry with more than 300 operating mines in this country employing more than 7 percent of all working Canadians.

Canadian mines extract more than 60 different commodities although the Inco operations primarily recover nickel, copper, iron and some precious metals such as gold, silver, platinum group metals, as well as palladium.

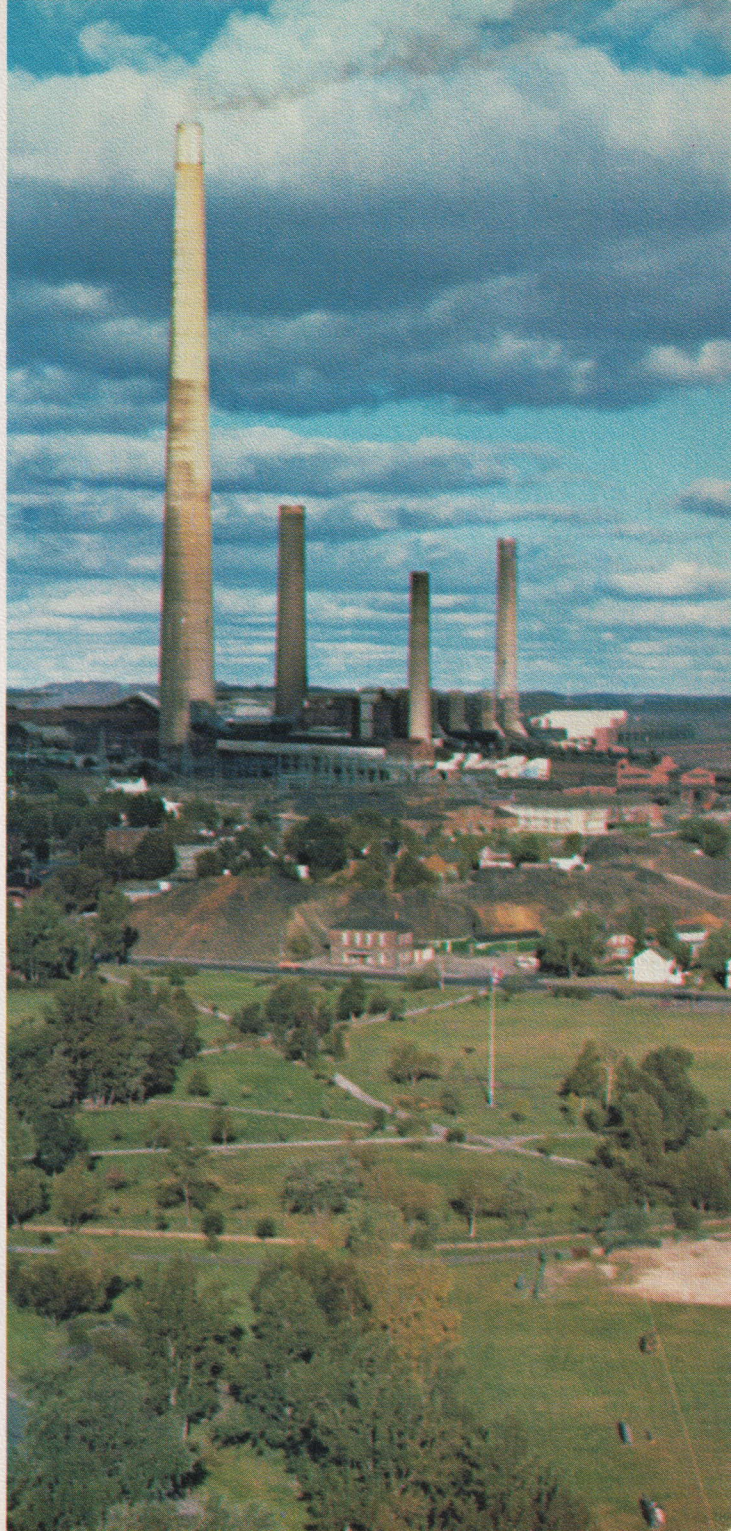
Because Inco tours (and this booklet) cannot cover everything involved in so vast an operation, you will be introduced to only the basics of mining, milling, smelting and refining. . . the essential metals recovery processes.

We only wish we had the opportunity to show you our specialized underground operations, or our electric power generating stations on the Spanish river, or Inco's extensive air and water purification systems and laboratories.

What you will discover though, is a big company doing a big job. Extracting small amounts of metal from rocks formed as much as 2,500 million years ago . . . from a mile-and-a-half below the earth's surface. This requires large numbers of people, machinery and investment.

For the company to remain competitive in world metal markets, we must operate efficiently.

Welcome to Inco. Look . . . listen . . . ask questions. We hope that when you are finished you will have a better understanding of our company and a greater appreciation of the Canadian mining industry.





# INCO and the Environment

Although much has been made of emissions into the atmosphere from the Inco smelter complex, only one side of the story has really been told.

First, Inco Metals is committed to reducing environmental pollution in all forms. The company has spent many millions of dollars to develop some of the finest equipment for air and water quality control available today. In addition, large numbers of highly skilled employees in research, monitoring and pollution control operations watch over the flow of air and water through the Inco complex 24 hours a day...every day.

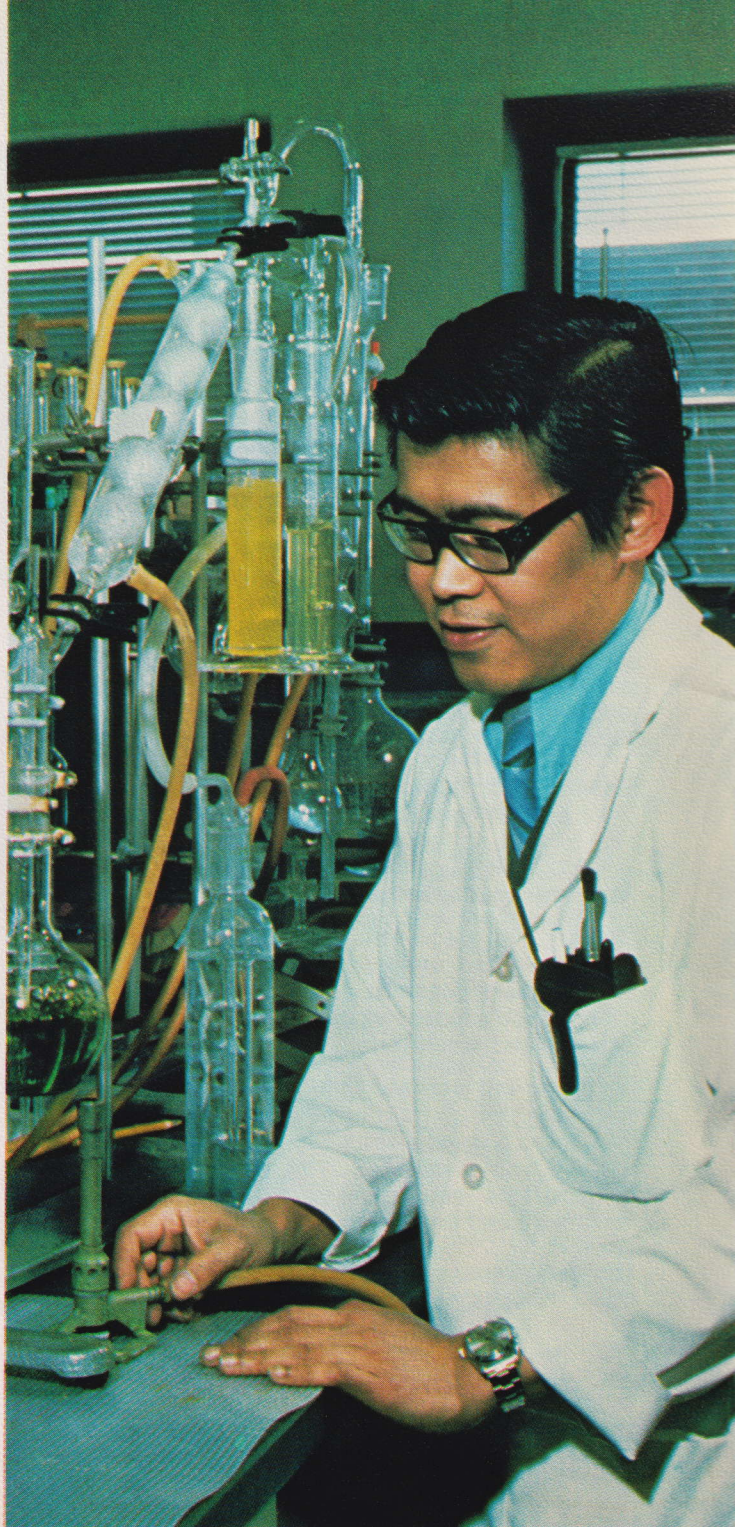
Our most pressing and serious concern, sulphur dioxide emissions, is a direct result of the large quantity of sulphur contained in the Sudbury ore body. This high sulphur content, combined with the vast scale of the Inco operations, creates a large and difficult problem...a problem that we have faced up to but still have not completely solved although we have succeeded in reducing the emissions by about 55 percent since the 1960's.

But Inco emissions today, even at present levels are only a small part of the problem...about 2 percent of the total sulphur dioxide emissions in Canada and the United States.

Inco scientists have discovered two new processes which are under development and which, if successful, may gain even more impressive reductions in emissions.

The problem of emissions in any form is complex from a social, scientific, governmental or industrial point of view.

At Inco we continue to strive to control emissions to the greatest possible extent while maintaining production of the metals so crucial to modern technology.





# A Short History of Mining in Sudbury

Like so many other instances in history, the rich nickel/copper deposits of the Sudbury basin were discovered quite by accident.

Railroad crews working in the region in 1883 had to blast and level huge rock formations for the bed of the railway which would, a few years later, join Canada together as a nation with a ribbon of steel.

They discovered that the rock contained rich deposits of nickel, copper and other minerals and before long the Sudbury basin swarmed with prospectors. In those days of limited metallurgical technology, the nickel portion of the deposits was considered a nuisance. In fact, the word nickel comes from the German word Kupfer-nickel which means 'copper of the

devil'! Not surprisingly, those early miners were far more interested in the copper and precious metals available in the ore.

Only after scientists discovered the properties of nickel in combination with other metals to resist heat and

corrosion while adding tremendous strength did the real significance of the Sudbury ore reserves become important.

The first mining rights in the region were granted by the government to Thomas Murray in return for the princely sum of one dollar an acre. Inco's Murray mine was a continuation of that early effort.

By 1902, several smaller mining companies in the region were joined to form The International Nickel Company. The real importance of nickel was just being realized. At the same time, new processes were being developed for the separation of the nickel from other materials found in the ore.

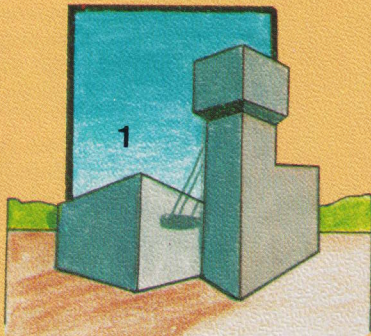
Today, the Ontario Division of Inco Metals forms the largest mining, milling, smelting and refining complex in the non-communist world. In addition to the Sudbury complex, there are refining operations in Port Colborne as well as mining and milling facilities and Shebandowan in Northwestern Ontario.





1

The headframe identifies a mine location. It houses the machinery to carry men and equipment down to the working levels.



1

5

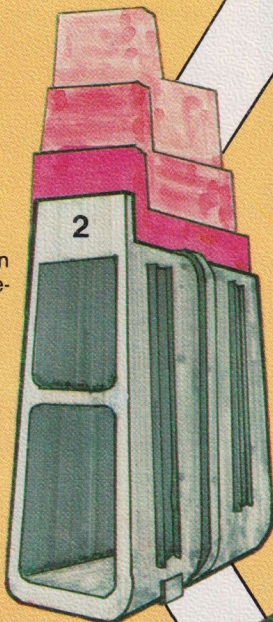


5

Before it is hauled to the surface in 'skips', the ore is broken into smaller chunks in an underground crusher.

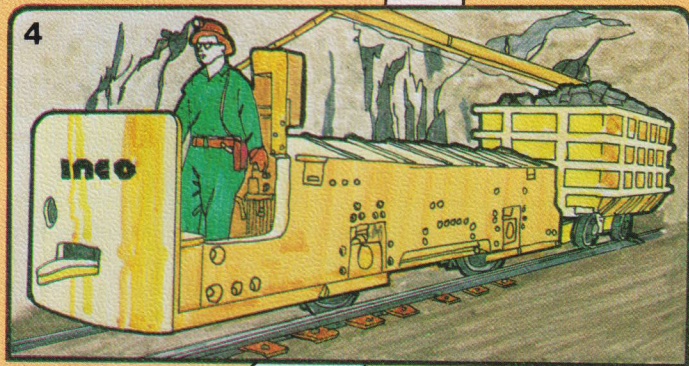
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Miners descend in 'cages', or double-decker elevators.



2

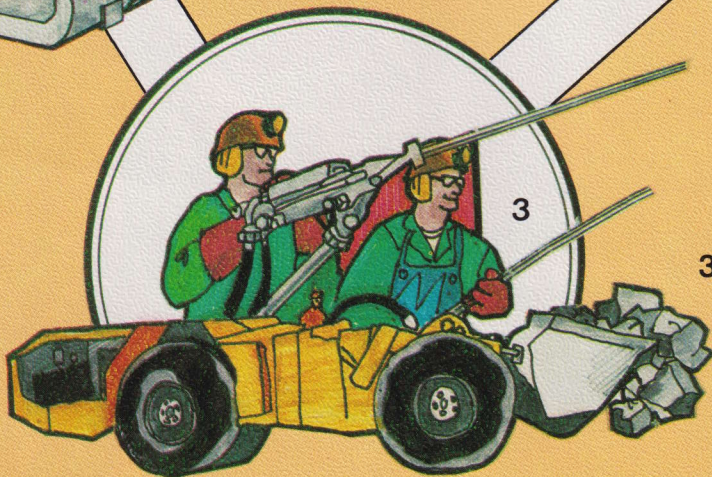
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4

Underground trains carry the ore through tunnels to the crusher.

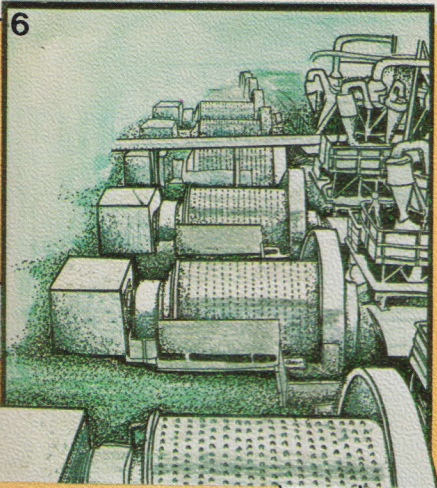
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3

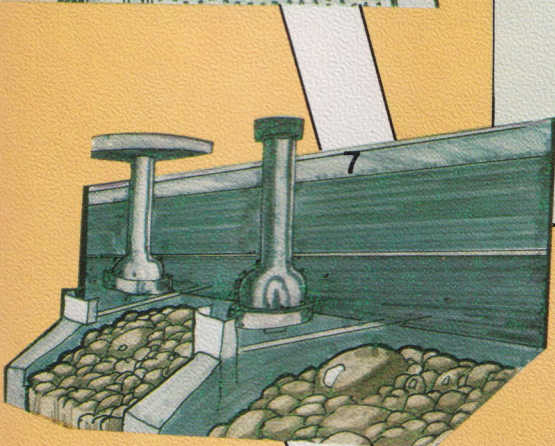
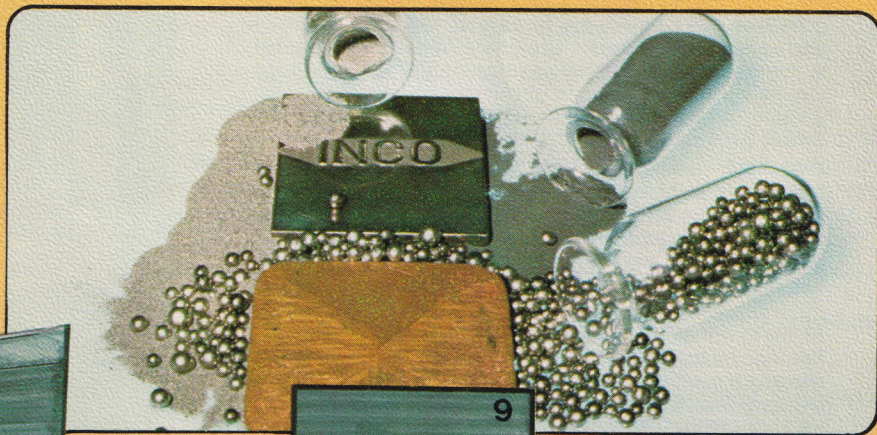
By drilling and blasting, miners break the copper and nickel-rich ore into chunks called 'muck'. Load-Haul-Dump vehicles move the muck to loading stations.



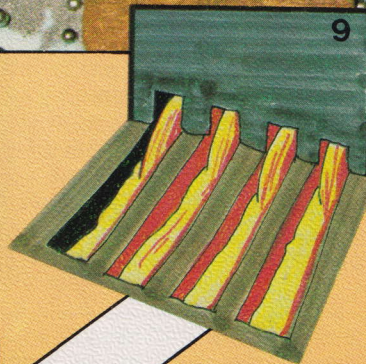


**6**  
On the surface, the ore goes by train to a mill where it is further crushed and ground to a fine powder.

# FROM MINE TO MARKET



**7**  
Iron, nickel and copper-rich concentrates are separated in a combination of froth flotation and magnetic techniques.



**9**  
In the nickel and copper refineries, the smelter products are further purified to form high-quality, finished products. Gold, silver and other platinum group metals are also recovered as by-products at this stage.

**8**  
In the smelter, the copper and nickel concentrates are desulphurized and then separated from the useless rock and iron constituents by a series of high temperature operations.



Finished metal products are shipped to other Inco plants, or customers around the world, in many forms. Nickel products may be pellets or powder while copper is produced as cathodes or horizontal wire bars.



# The Winning of Nickel

Some of the ore in the Sudbury Basin was close to the surface and was recovered by open pit operations.

After the extraction of the surface deposits, the mining operation had to move underground following the path of the ore body through the surrounding rock. Tremendous engineering and other technical problems were overcome to extract the ore efficiently and safely. Today, Inco's Creighton Mine is the deepest in the Western Hemisphere at more than 7,000 feet. Inco engineers pioneered much of the world's technology for working at extreme depths in the earth's surface.

There are now special techniques and machinery to move men, supplies and equipment down to those levels while hoisting hundreds of thousands of tons of ore to the surface. Special machinery was developed to force cool, fresh air down to the working levels and then to exhaust waste air and machinery gases.

At most mines you will see a headframe building containing huge pulleys and cables operating special elevators used to deliver men and materials down to the working levels. Other elevators called 'skips' hoist as much as 20 tons of ore to the surface at one time.

Underground the miners work in teams. Blasting holes are drilled into the mine face then the ore-bearing rock is blasted into large chunks called 'muck'. The muck is transported by ore train through a tunnel to an underground crusher where it is broken down into smaller, more manageable pieces. Once hoisted to the surface in the skips, the ore is taken to the mill in long ore trains.

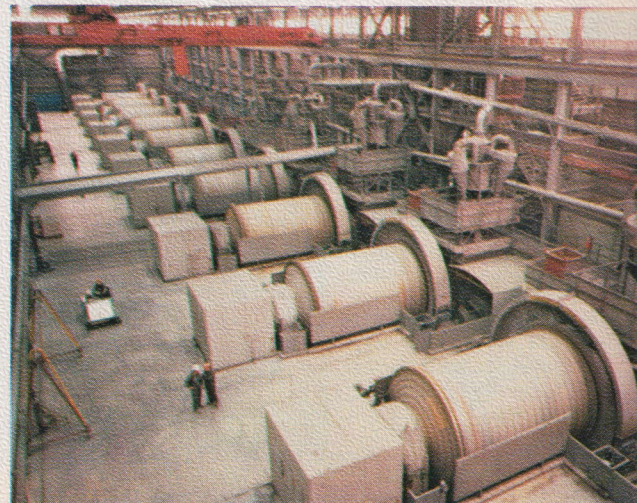


## MILLING

The purpose of milling is to reduce the ore-bearing rock from pieces of about 6 inches to about 1/100th of an inch. Other milling processes extract iron from the nickel/copper concentrate after which, the remaining rock, known as tailings, is pumped to a disposal area or used as backfill in mining.

Inco's Clarabelle Mill is one of the most modern automated plants of its kind. The grinding stage consists of rod and ball mills followed by a magnetic separation stage for the removal of iron. Separate nickel and copper concentrates are then extracted in a foamy bath in the flotation stage.

The Clarabelle complex can process up to 35,000 tons of ore in 24 hours.







## SMELTING

From the mills, nickel concentrate is roasted to burn off a portion of the sulphur. The remaining material is then smelted at high temperatures to partially eliminate unwanted impurities in the molten slag, while recovering nickel and other valuable metals in "matte" form. The matte is then converted so impurities can be skimmed off as slag and transported to the slag dump. The matte is then poured into 25 ton ingots and allowed to cool slowly followed by crushing and grinding in preparation for refining.

Copper concentrate from the mills is flash smelted by burning some of its sulphur and iron with oxygen in the flash furnace to produce matte and slag. The slag is removed to the slag dump and the matte is put through a converter to remove most of the sulphur and other impurities. The resulting semi-refined product, called "blister copper", is then directed to the Copper Refinery for further refining.



\*Inco Trademark

## REFINING

To further remove impurities from the nickel product, the matte is passed through one of two processes depending on the finished form of the metal required. In the first, Matte Processing, a flotation process similar to that used in the Clarabelle Mill, removes the final traces of copper as copper sulphides which are returned to the smelter. The remaining nickel is then roasted in a fluid bed process from which some of the resulting metal leaves Sudbury as nickel oxide for further processing in Port Colborne. The rest of the metal may be shipped to customers as a product called Sinter 75\* or further processed to produce Inco's high-purity product called INCOMET\*.

In the Copper Cliff Nickel Refinery, one of the world's most modern plants of its kind, the remaining matte material undergoes a different process resulting in three finished products: 99.99 percent pure nickel pellets, nickel powder and ferro-nickel powder containing some iron.

In the meantime, the blister copper is being refined in the Copper Cliff Copper Refinery by first smelting in an anode furnace followed by electrorefining. This consists of electrochemically dissolving copper from impure anodes and selectively plating the dissolved copper in pure form onto copper cathodes. The finished, high-purity ORC\* copper product is cast into shapes according to customer requirements.

In another part of the Copper Cliff Copper Refinery, the residues from the copper process are further treated to separate small, but significant, quantities of precious metals such as gold, silver platinum group metals selenium and tellurium.



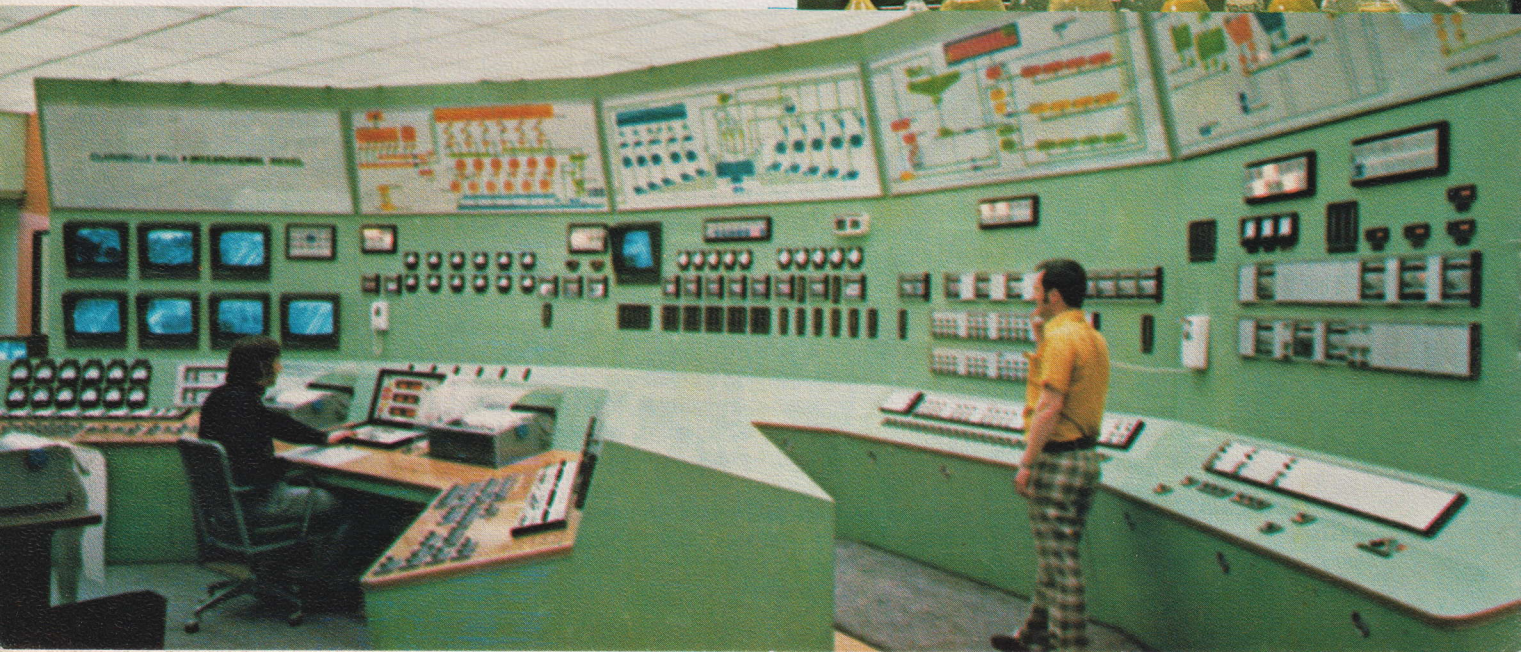
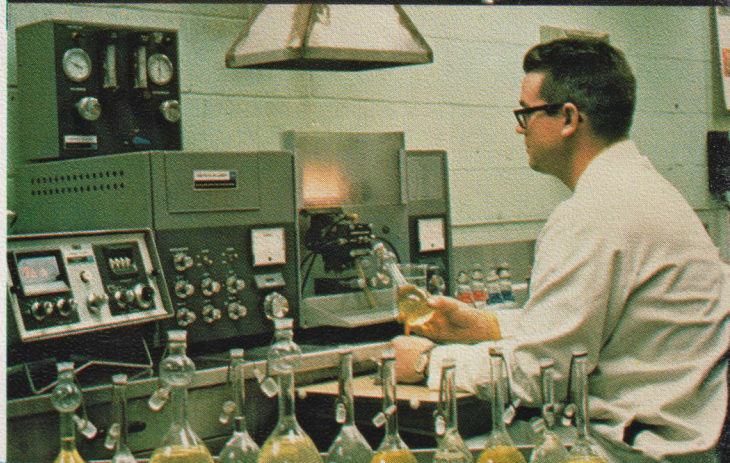
# INCO People

Operating the Inco mines, mills, smelter and refineries is a tremendous job which wouldn't be possible without the dedication of the thousands of people whose collective efforts are required for the production of Inco products.

From the miners who recover the ore from deep within the earth to the mill, smelter and refinery operators who purify it, none could work a day without vast quantities of equipment and machinery. Keeping the process running efficiently requires a small army of skilled technicians and mechanics, scientists and managers.

In other, less obvious Inco departments, men and women apply their skills in environmental control, health science, research and development, safety, planning, employee relations, public affairs, data processing and managing the vast quantity of resources required by an operation of this scale.

It is the foresight, dedication and perseverance of Inco people which has built the company from a small open-pit mine to the massive complex which we operate today.





# METALS FOR THE WORLD

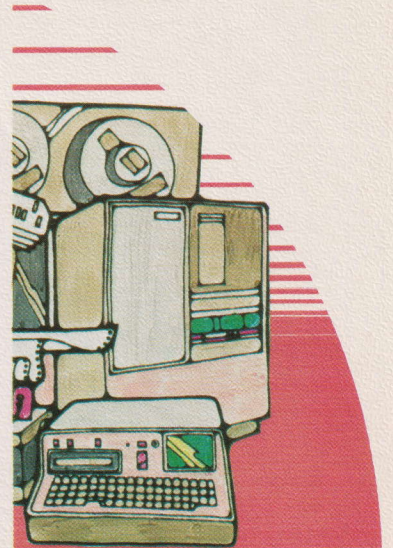
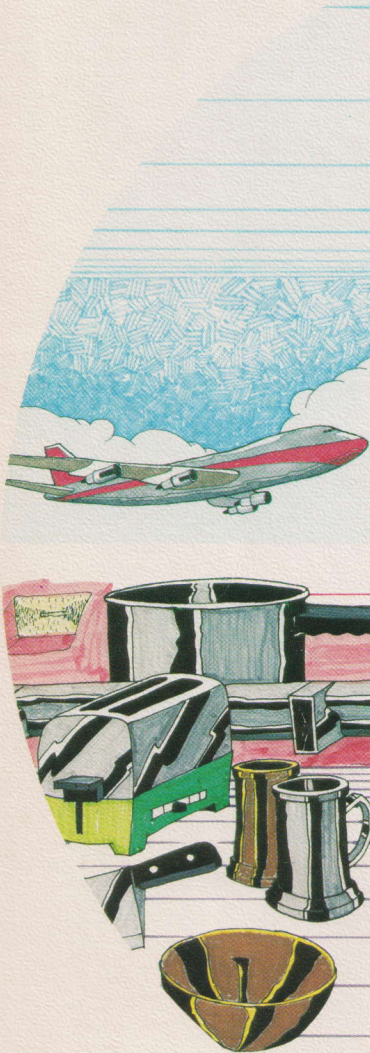
## Nickel and copper.

What a role these two metals have played in the story of modern development! Without nickel and its strength, corrosion-resistance, heat resistance and many other properties, such things as the jumbo-jet, space travel and deep-sea exploration might have been impossible. So may have the instruments used in modern surgery and dentistry. The more we learn about nickel, the more we find wonderful new uses for this once-unwanted metal.

Copper, too, plays a role in our daily lives that touches every one of us. From the telephone, television, radio and computer to window casings and cookware, copper, with its own special properties, is also critical to our modern way of life.

As technology continues to move the world society forward, the demand for nickel and copper continues to increase. At Inco, our challenge is to meet those needs while searching for new, better and more efficient means to recover metals for tomorrow.

And because we are not alone in our field, we must do our job competitively; producing and selling in world markets against other companies and other countries for the benefit of all Canadians.



INCO METALS COMPANY



# Nickel and Copper



## The Progress Metals

Few other substances have been so important in man's development or as critical to his future as nickel and copper.

From the earliest telephone and automobile to modern surgery and space travel, nickel and copper have played vital roles in the progress of man.

Today, hardly a moment passes that our lives aren't touched by one or both of these critical metals...in transportation and communication, in the kitchen and the operating room, in the sky and under the ocean, copper and nickel represent unseen technology keeping us alive and healthy, in touch and in command.

Tomorrow, as we stand on the edge of the universe, when we find new forms of vital energy, as we learn to conquer sickness and disease...when we learn these things, nickel and copper will continue to support man and his endeavours as we find and develop new technology.

In INCO's laboratories, as well as those of its customers, scientists are searching for tomorrow today.

**NICKEL AND COPPER  
THE PROGRESS METALS**

Brought to the world by the people of INCO in Sudbury.

# INCO METALS COMPANY