The Diamond with a story

RioTinto

Diavik

DIAMONDS
MINED IN CANADA

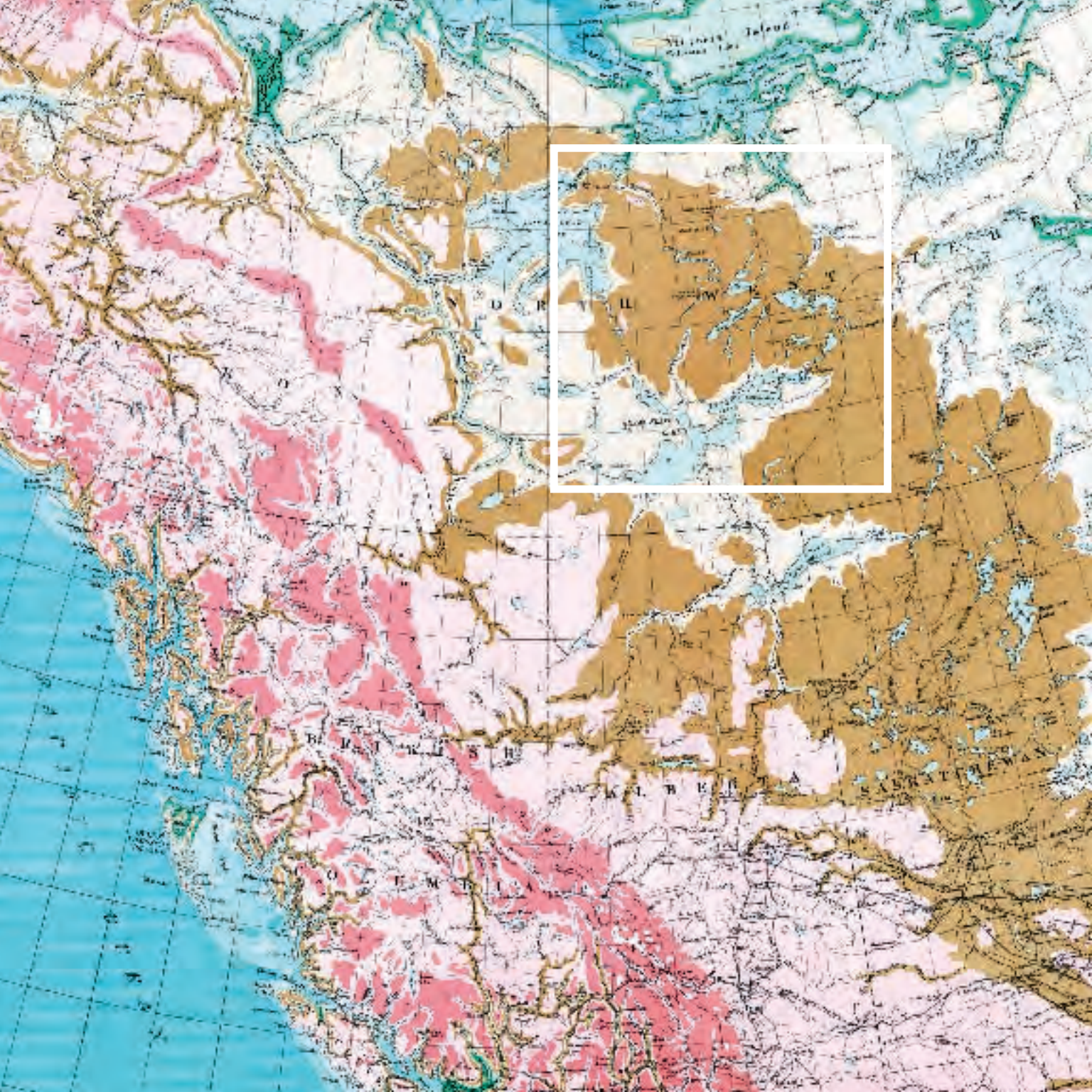
Rio Tinto Diamonds N.V. • Antwerp, Belgium

The Diavik Diamond Mine

Formed deep underground more than a billion years ago by the mysterious forces of nature, the Diavik diamond was thrust closer to the earth's surface by powerful volcanic eruptions, bringing these brilliant gems within our reach.

In 1991, after years of exploration, first traces of these diamonds were discovered in the remote and treeless Barren Lands of Canada's Northwest Territories. Twelve years later, global mining company Rio Tinto opened the Diavik Diamond Mine, now recognized as one of the premier diamond mines in the world—not just for its stunning natural stones, but for its innovative engineering, environmentally sustainable mining practices, and collaborative work with indigenous communities.

From above, this hole appears otherworldly, as if it were on a distant planet. But it is actually part of the Diavik Diamond Mine, two diamond-rich kimberlite pipes, the "roots" of small volcanoes—extending about eighty-five stories downward. The pipes sit under the waters of a large lake called Lac de Gras. Hidden beneath this dirt and rock and ice—in some of the richest pipes in the world—are precious, sharply edged white diamonds. Finding them is a magnificent task: Each ton of ore pulled from the hole yields just 3.9 carats.



A Sense of Place

Their sparkle has mesmerized the world for generations. The first diamond deposits were discovered in India as early as the eighth century B.C. By the eighteenth century A.D., they were found in Brazil, and by the mid-nineteenth century, in South Africa. Those three countries remained the dominant sources for centuries. Then in the 1950s, deposits were found in Russia, and in Australia in the 1970s. The early 1990s brought us to perhaps the most promising diamond frontier: Canada's Northwest Territories.

CELEBRATING THE SOURCE

Diamonds have traditionally been sorted by size, color, and clarity, not by country of origin, meaning customers cannot determine from where a particular stone hails. But Rio Tinto diamonds are different: Each has a traceable history, a story to be told and cherished along with the stone, whether it's from the Diavik Diamond Mine in Canada, the Argyle Mine in Australia, or the Murowa Mine in Zimbabwe.

The territory in the white box (opposite page) is where Fipke and Blusson concentrated their search, north of the Great Slave Lake and the city of Yellowknife. That area is basically flat, having been razed by glaciers, but is rife with lakes, ponds, streams, and muskegs.

Stewart Blusson

Charles Fipke

MODERN-DAY EXPLORERS

In the late seventies, Charles Fipke, a rugged prospector, and Stewart Blusson, an equally adventurous geologist and helicopter pilot, ventured out into the Canadian North in search of diamonds. They used the geology of the land as their guide, relying on, among other things, billions-of-years-old Precambrian rock called Archean. The premise was that since Archeans were the clue to every other diamond-rich spot on earth, the same should hold true in northern Canada. In 1991, after almost fifteen years of perseverance, they discovered that premise was right.

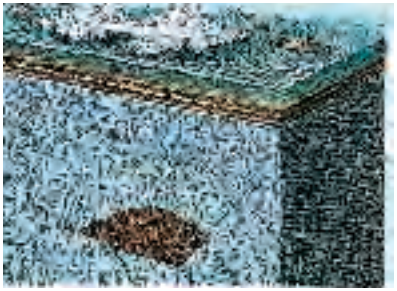
Kimberlite: Searching for the Right Clues

Most diamonds are found in kimberlite, but not all kimberlite contains diamonds. Worldwide, there are roughly 5,000 known kimberlite deposits, but only one percent are considered to be worth mining. For centuries, miners panned rivers and stream-beds, hoping to find diamonds. These gems were actually far from their original home, due to millions of years of erosion. Not until the 1800s did geologists discover kimberlite to be the diamond's source.

Kimberlite, a dark, carbon-dioxide-rich rock, provides geologists a glimpse of what lies beneath. Embedded in it are a variety of heavy minerals called indicators, which include distinctive olivine, garnets, and chrome diopside. Explorers use these minerals as "breadcrumbs" of sorts, following the indicator trail with the hopes of locating diamond-laden kimberlite pipes.

Within the pipes are bits of surface history uprooted by volcanic explosions. This piece of redwood uncovered at the Diavik Mine is a reminder of a warmer climate that once enveloped this now icy land.

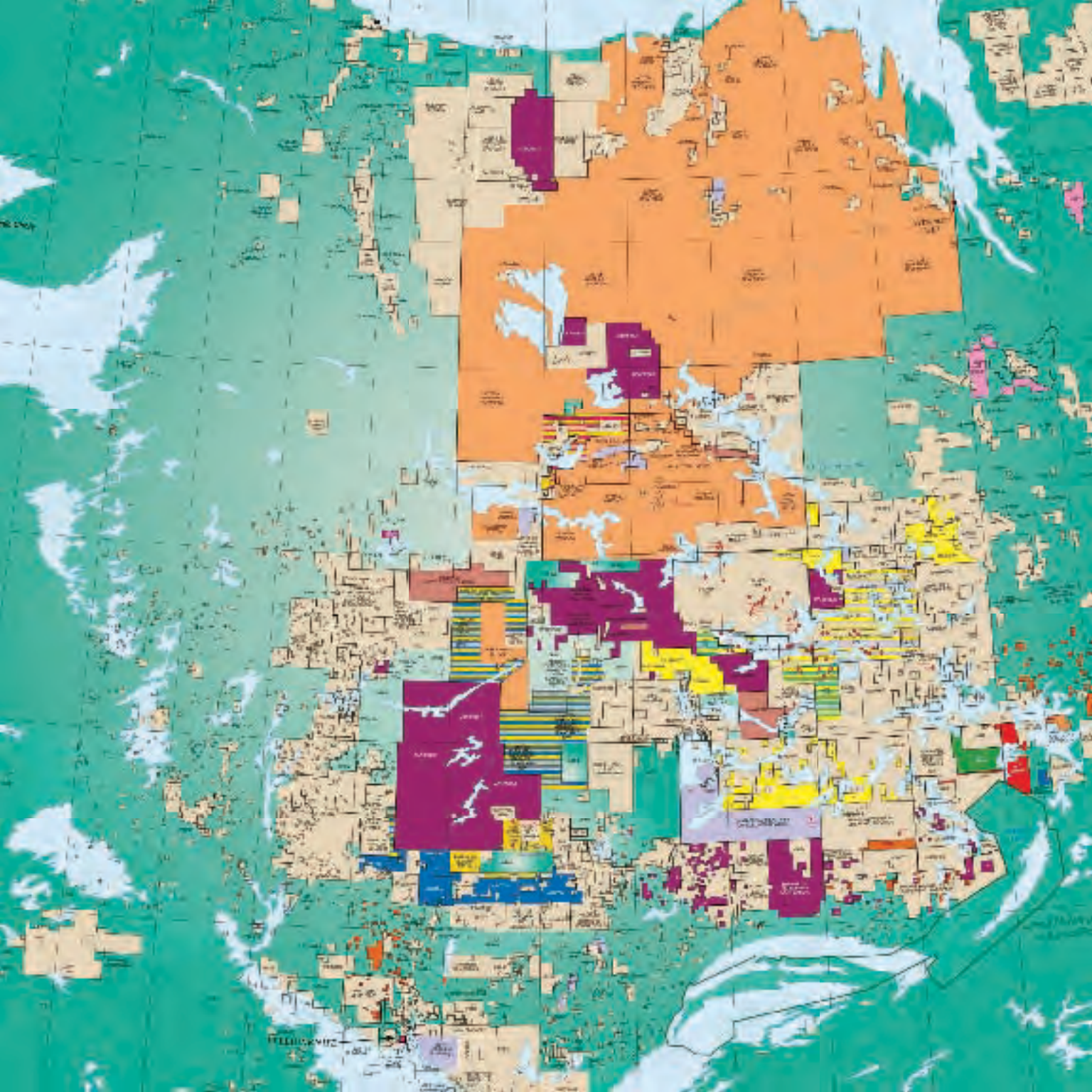
About one billion years ago—long before the existence of life on earth as we know it—diamonds formed far beneath the surface, under the very special conditions of high pressure and relatively low temperatures. Seventy-five to 100 miles above those diamonds was a surface covered with ocean, as the continents had not yet formed.



There the diamonds sat for millions and millions of years, until they were thrust toward the surface by molten kimberlite a mere 55 million years ago. Rock and ash were blasted into the air in an explosive cloud, engulfing parts of a redwood forest. The debris collapsed back into the ground and, once cooled, formed a conical "pipe."

Over the millions of intervening years, the remaining redwoods and the volcano tops were scraped away by erosion—the most recent of which was due to receding glaciers transporting bits of kimberlite miles away. The challenge for explorers was to trace those dislocated pieces (the indicators) back to the source.

Mt. St. Helens, May, 1980



The Great Staking Rush of 1991

When word spread of Fipke and Blusson's discovery, there was a massive scramble by prospectors to claim mineral rights to their own piece of land, sparking the largest staking rush in world history. The task required more than markings on a map. It had to be done the old-fashioned way – in person, with wooden stakes. Helicopter pilots would fly out in often freezing weather, sometimes just feet from the ground. Each stake had to be hammered by hand into the frozen snow and ice. Companies both big and small vied for land, not knowing exactly which plots contained diamonds and which did not.

ONE MAN'S GOOD FORTUNE

Gren Thomas, founder of Aber Resources (now Harry Winston Diamond Mines Ltd. partial owner of the Diavik Diamond Mine), recruited other small companies to pool their money and go in together. In one frenzied, auspicious helicopter staking mission, Aber took the 50,000 acres under Lac De Gras that would eventually become the Diavik Mine. But at that point, no one realized just how precious that claim was.

The area up for grabs was massive: 50 million acres. The various colors shown in this map (opposite page) represent the claims of hundreds of prospectors. All of the claims are fashioned from 1,500-square-foot blocks, each of which had to be staked by hand. A wooden stake with a hand-marked metal tag (above) may be small, but it has grand implications. Helicopters with global positioning satellite systems (top) were the modus operandi during exploration.

Exploring the Land

Eira Thomas and her team (top left) used kimberlite core samples to determine if the rock below was diamondiferous. A computer model (top right) maps the A154 pipe from the many core samples taken. A core sample sparkles with indicator minerals (above).

Staking the land was the priority—the strategy was to claim whatever you could, as fast as you could. Then it was time for the hard work, to actually search for the diamonds on the land that had been claimed. Fipke and Blusson were the first ones in. Then Aber brought in its team to search the neighboring plots it had staked on Lac de Gras, just south of Fipke's land.

A BRILLIANT DISCOVERY

Eira Thomas, daughter of Aber founder Gren Thomas, had just graduated from the University of Toronto with a geology degree when she began working with her father. By early 1994, she was Aber's chief geologist on the Diavik exploration project at Lac de Gras. She and her team, made up of Aber and Rio Tinto geologists, eventually found the kimberlite they were searching for. As they continued to drill beneath Lac de Gras, even under treacherous spring melting conditions, they unearthed a diamond just shy of two carats—so rare in a sample that it suggested phenomenal potential. Eira slept with the precious sample under her pillow until she could get it to her father in Vancouver.

It turns out, Eira's team had discovered arguably the highest-grade diamond pipe in the world—what would soon become the A154 pipe at the Diavik Mine.

Today, a camp east of the Diavik Diamond Mine
is used as an outpost for ongoing exploration.


Yellowknife

The Northern Hub

The city of Yellowknife is the center of activity in the Northwest Territories.
It is a mere 512 kilometers south of the Arctic Circle, surrounded by wilderness and renowned for its outdoor recreation, aboriginal culture, midnight sun, and aurora borealis (aka northern lights).
It is the capital of the Northwest Territories, and home to about 20,000 people, a large part of the population of the entire region.
In the vast and sparsely populated North, Yellowknife is the center for not just mining but also transportation, communication, recreation, commerce, tourism, health care, and government.

A Rich Mining History

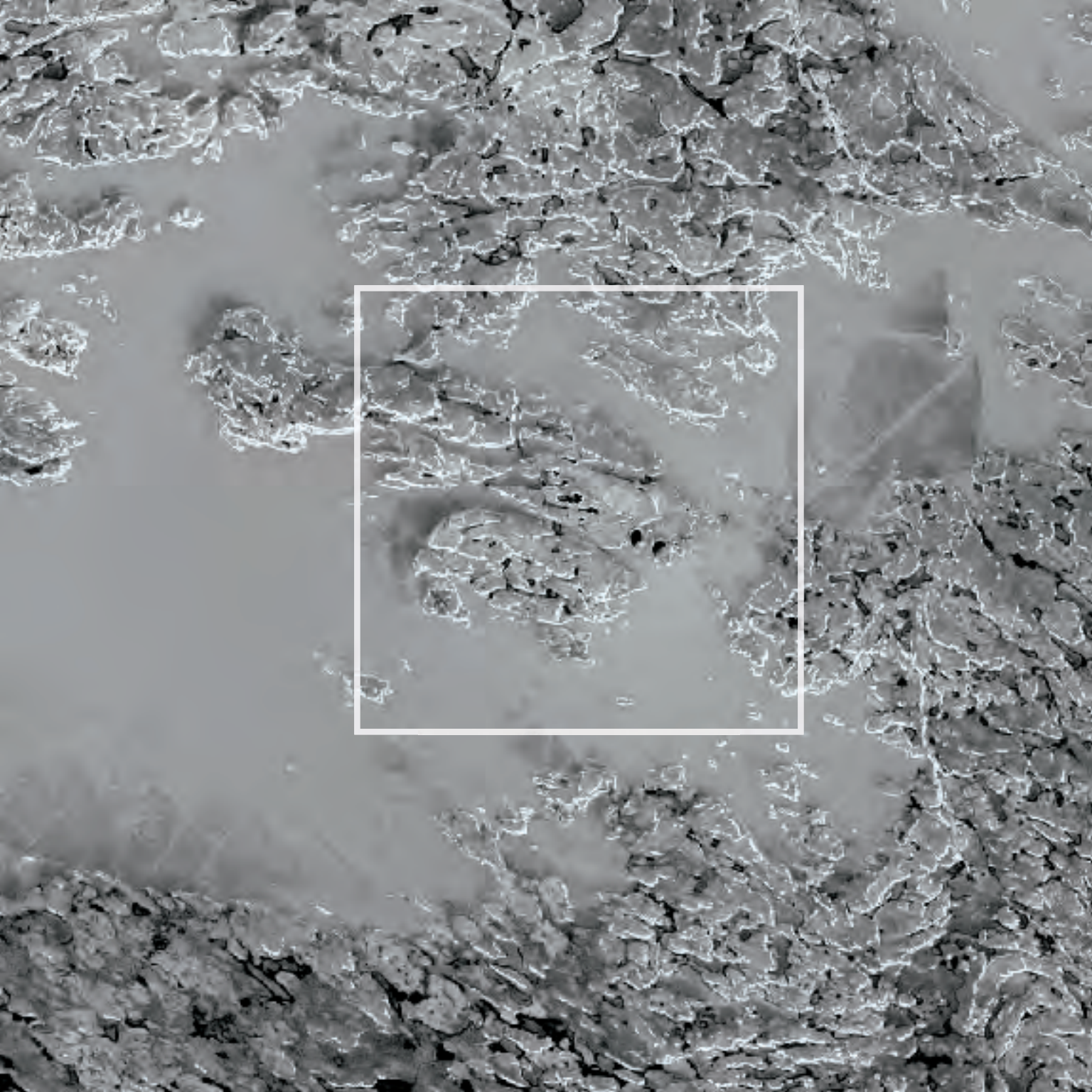
The remnants of past industries are evident in Yellowknife.
An abandoned gold mine (above); a fur trader's cabin on the shore of Lac de Gras (top).
Because the ground in Yellowknife is solid granite and cannot be dug into,
these houses in Yellowknife's Old Town (opposite page) are built perched atop the
jagged edges of a hill.

Named after the Yellowknives Dene, indigenous peoples who moved into the area in the early 1800s, Yellowknife has a storied past. The town was originally inhabited by the Dogrib people, who call it Somba K'e, meaning "money place," and has long been a part of the fur trade.

Hints of gold were found at Yellowknife in 1896, but the area was remote and, at the time, virtually impossible to reach. It took the discovery of pitchblende (the principal source of uranium and radium) in 1930—hundreds of miles north of Yellowknife—to bring a transportation infrastructure to the area. Significant amounts of gold were discovered in Yellowknife Bay in 1934, and by 1936, Yellowknife was a boomtown. With its mining-supported infrastructure, it was granted the status of capital of the Northwest Territories in 1967.

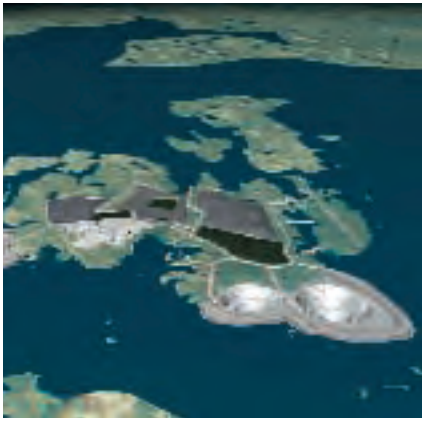
After more than a half-century of operation, Yellowknife's gold mines would, as all mines one day do, close down, severely affecting the North's economy. But as the gold ore diminished, the North's diamond mines moved into production. And by 2003, mining employment was back to historic highs. But to avoid a repeat of gold's boom-bust cycle, Diavik took a sustainable approach. Working with its neighbors, most of whom are Aboriginal communities, Diavik committed to protecting the land, water, and wildlife, and to providing training, employment, and business benefits locally.

the diamond capital of North America

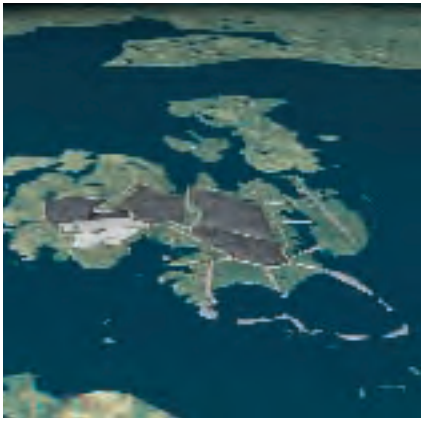


This is a land of snow-covered islands and lakes that remain frozen nine or ten months of the year. The challenge for Diavik was to understand the patterns of the land and develop a plan for a mine that would be sustainable over a period of time, leaving the environment with the least ecological impact possible. Local leaders were consulted from the beginning, even before the mine was built, and Diavik representatives frequently met with these community elders to update them on all aspects of the mine. The biggest concern was making sure the integrity of the land and water remained intact and that caribou, which migrate through the Lac de Gras area twice yearly, were protected.

A Plan with a Purpose



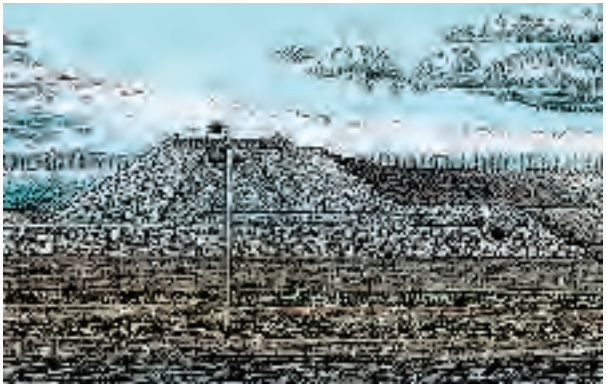
Full operation



When the mine closes

The perspective on the left (above) shows the mine in full operation, just off the coast of East Island, which sits in the middle of Lac de Gras. Four kimberlite pipes are at the site (the fourth pipe, however, is not shown). The perspective on the right depicts what the mine will look like after its closure, when the waters of Lac de Gras are once again let in, transforming the mined areas into fish habitat.

Borrowing the Lake Water



This diagram of the dike (above) shows how the lake is being contained. The 2.4-mile structure under construction (below). The dike in early spring (opposite page), before the snow has begun to melt.

In this effort to preserve the environment, Diavik was faced with a puzzle: Mining underneath a body of water requires that the waters be temporarily moved aside. How could it be done—and in such a way that it would be safe for the lake? The answer was to engineer and construct a dike, one unlike any that had been built before (see left).

First, the loose lake-bottom sediment had to be dredged so the structure could be put on a solid foundation—all the while protecting the rest of the lake with a floating curtain. Workers then placed a rock-fill embankment, set a watertight concrete wall, and put in equipment to ensure the permafrost would stay frozen. A water collection system was installed inside the dike to collect the inevitable, albeit small leakage.

The goal was also to set up a system that would use as little water as possible from the lake itself for the day-to-day mining operations, instead recycling water by moving it around according to its quality and to the needs at any given location. In 2004, this system recycled 1.7 million cubic meters, meeting two-thirds of the mine's water requirements.


keeping the waters of Lac de Gras at bay

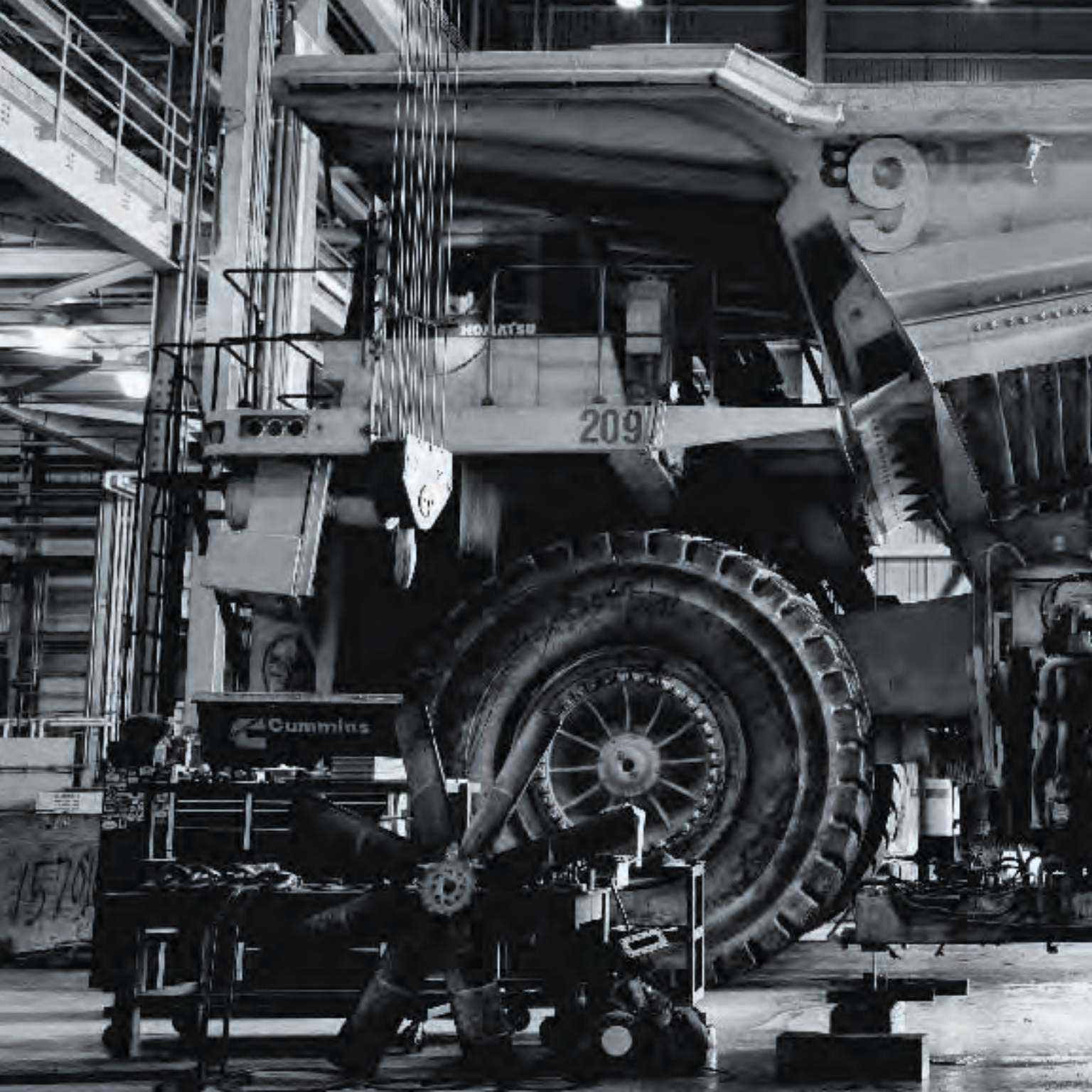
at Diavik, wildlife has the right of way

In the same way Diavik created a plan to preserve the land and water, it had a plan for protecting the area's wildlife. Before the water was pumped from behind the dike, more than 5,000 fish were removed, returning them to the lake or giving them to local communities. And to ensure that the fish continue to thrive here, parts of the dike will become ideal aquatic habitats after the mine has closed.

Other wildlife that has long prospered in the North is of concern as well. Caribou are an essential part of the aboriginal life and sustenance, and are fiercely protected, as are the area's eighty-four bird species and sixteen mammal species: grizzly bears, wolves, foxes, and wolverines, among others. Portions of the Bathurst caribou pass through the Lac de Gras region during their spring and fall migrations, on their way to and from the tundra and the Northern forests. To leave their path unobstructed, waste-rock piles will be contoured so the animals can easily pass over them as they make their annual journey.

Respecting the Wild

In winter, caribou migrate south into the tree line, where it's warmer; in spring, they make their way back to the tundra. Caribou signs are posted on all mine haul roads to warn drivers; and employees are trained extensively on how best to proceed around the animals.


KOMATSU
209
Cummins

Fueling the mine

Diavik's eleven large haul trucks account for just a fraction of the mining operation's fuel needs. Diesel storage tanks provide fuel for these and other mobile equipment, as well as for diesel power generators and for heating.

Because the mine is remote and fuel is difficult to transport across the ice, conservation is paramount. The heat produced by the diesel generators is recycled to warm some of the plant buildings. In fact, recycling increases the efficiency of the diesel generators, from 40 percent to over 70 percent. Unfortunately, this doesn't create enough heat to supply the camp and other buildings, so a boiler plant provides additional energy at peak demand—during a cold winter, for example.

Getting There: The Road to Diavik

Ice can be a blessing and a curse in these frigid Barren Lands. With no year-round road access, the lifeline to this remote mine is a seasonal ice road. It was built decades ago to resupply the region's other mines, well before diamonds were discovered in the area. It's just pure luck that Diavik's diamond-rich pipes were located so close to the road.

The ice road is open in the coldest months for about ten weeks, from late January through early April, when it is frozen enough to withstand the weight of trucks transporting materials, machinery, and fuel. Travel time from Yellowknife to Diavik can be as long as nineteen hours for heavy loads, with speeds carefully con-trolled to protect the ice. If a truck travels too quickly, it will create waves underneath that have the potential to break the ice at the shoreline.

From late April through early January—
when the road is not viable—materials are brought in by aircraft (above),
which is more costly but necessary nonetheless.

Work Together, Grow Together

The health of the neighboring communities is crucial to a sustainable mining operation. Diavik has made a commitment to the people of the North—to provide training, employment, and business opportunities where there have been few economic prospects in the past. Northerners and aboriginal Northerners are encouraged to not just take these jobs, but to also establish their own businesses that can contract services to Diavik, as well as to other mines in the region.

And the effort is succeeding. Seventy percent of Diavik's workers are Northerners, over half of which are aboriginal Northerners, surpassing the mine's projection. And because of a commitment to support local businesses, Diavik purchases more than 70 percent of goods and services locally.

In addition to jobs, the mine improves quality of life in the region. The ice arena Diavik helped to build in Yellowknife in November 2004, for example, affords both children and adults the opportunity to partake in the region's beloved ice sports.

Hundreds of aboriginals, raised in nearby communities, now have jobs as miners. Many of them come from families that once made a living trapping fur, an industry that is no longer lucrative here. But the diamond-mining industry brings new opportunities to the area.


The Pit

Diavik will be a combination of open-pit and underground mining.
For open-pit mining, explosives are used to blast the hard granite ore, creating step-like terraced walls which support roads that spiral safely down to the lowest point. The loosened granite and darker kimberlite are hauled off in a fleet of trucks, up the ramping pathways, twenty-four hours a day. When the pit eventually becomes too deep for open-pit mining, an underground tunnel—bored at a safe enough angle that vehicles can traverse it—will reach deeper into the pipes.

The pit is small by mining standards and contains two fertile kimberlite pipes (the two dark spots opposite). Each is carefully monitored by geologists for diamond content as every layer is exposed.


755

The Miners

Today's miners may not be as you imagine them. They are geologists, blasters, haulers, truck drivers, mechanics, geotechnicians, welders, and human resource managers. They're women and men, apprentices and veterans. They're Northerners and aboriginals. Contracted workers and consultants. Some come weekly from Yellowknife (four days on, three off), while others travel from across Canada for rotations that can last weeks (typically two on, two off).

Processing the rock

Washing, Shaking, Crushing, Swirling

The processing plant is where the diamonds bid farewell to the kimberlite that has traveled with them for eons. Gravity, water, and X-ray technology, not chemicals, are used to separate the diamonds from the ore.

This plant, like all of Diavik, was constructed with sustainability in mind. It stands eleven stories high with crisscrossing, steeply angled conveyors—a design that reduces the footprint of the structure, thus minimizing the impact on its surroundings. To function, it requires enormous amounts of energy and water, much of which is recycled many times over.

To extract the diamonds, the large kimber-lite rocks are carefully broken down into smaller and smaller pieces as they travel through the machinery. Water and iron sand are added to the crushed rock to create a slurry, which is then spun around in a centrifugal machine to separate out the heavier diamonds and indicator rock. Finally, the concentrate of crushed stones passes by an X-ray, where each diamond is identified and then blown off the conveyor belt with a blast of air. The garnets and other indicators are left behind.

Big kimberlite rocks are crushed and rinsed (opposite page)—again and again—until they are small enough to be swirled and divided. The leftover bits of kimberlite and colorful garnets (above) are not valuable in a traditional sense, but they are what led geologists to the diamonds in the first place.

The Shape of Things

The Diavik diamond in the rough is a beautiful crystalline form, recognized by experts as an especially white diamond, lustrous and filled with a brilliant fire. Composed of microscopic carbon atoms, diamonds are full of angles and parallel surfaces that grow geometrically. Rough stones have an array of surface textures–from being wonderfully smooth to having triangular trigons with delicate patterns of arrowheads in formation, looking like the first freeze on Lac de Gras.

Common diamond crystals found in Diavik's pipes are the octahedron and maccle. The octahedron (above) is eight-sided, with a form whose points would fit perfectly inside a pure cube. Sharp-edged octahedrons are ideal for slicing in two, just above the midpoint; the result is one large and one small polished diamond. They are often polished into square shapes such as the Princess cut, but those that are slightly rounded are polished into round brilliant cut stones.

The maccle (top), also known as a twinned crystal, develops when two or more distinct crystals become connected, taking on a triangular profile. Maccles typically are ideal for cutting into a shallow single diamond in fancy shapes like hearts and trilliants.


Venture
Work in Progress Vault

Grading, Splitting, and Sorting

After processing, diamonds are shipped to the Diavik product splitting facility in Yellowknife, where they are cleaned, sorted by size and grade, and divided between the joint venture partners (Harry Winston receives 40 percent; Rio Tinto, 60 percent). Every parcel packaged in Yellowknife is inspected and weighed by Canadian officials before it embarks on the journey to Antwerp, the diamond capital of the world.

At the Rio Tinto diamonds' sales and marketing offices in Antwerp, highly skilled sorters batch the diamonds according to size, color, purity and potential value. Sales brokers then direct the varied diamond rough to customers, called “diamantaires,” for cutting and polishing in diamond-cutting centers around the world: Antwerp, New York, Tel Aviv, and India, as well as back to Canada, where new diamond-cutting and polishing plants have been established.

Rough diamonds are first sorted at the mine by size and color (left). Once in Antwerp (top), the diamonds are sorted yet again by size, color, and potential value, by assessing their shape: If they are deemed “makeables,” their form is of a high enough quality that they can be polished as is, no cutting needed; if “sawables,” they would be best cut into two stones; and if "clivage," they would be cut into multiple pieces. Rio Tinto diamonds are sorted and packed in boxes clearly marked with the country and mine of origin (above).

The Diamantaire

In Northern aboriginal culture, every part of a caribou that has been hunted is put to use. The same is true of diamonds: All find a place, whether it be in an engagement ring or a piece of machinery. Each Rio Tinto Diamonds customer, recognized as a diamantaire, has been selected for his or her ability to evaluate, process, cut, polish, and sell meticulously assembled assortments of diamonds to the appropriate markets.

The work of the diamantaire is a time-honored profession steeped in history. It requires skills and knowledge that have been passed across generations of family businesses. Just as an architect understands every element of his building, the diamantaire is expert at reading a diamond's natural grain and imperfections, and planning how to capture the greatest amount of carats and the most brilliant cut.

Deciding how best to cut a diamond is an art form that today involves a combination of instinct and high technology. Traditional loupes, microscopes, scanning technology, and 3-D software are used in combination with hand-written notations (above). This 56-carat Diavik stone (opposite page) will be cut into several pieces of varying shapes and sizes.
Oftentimes, diamantaires collaborate on the largest stones, taking months to strategize and plan.
A diamantaire (top) uses a loupe to observe the diamond's grain and inclusions (natural imperfections).

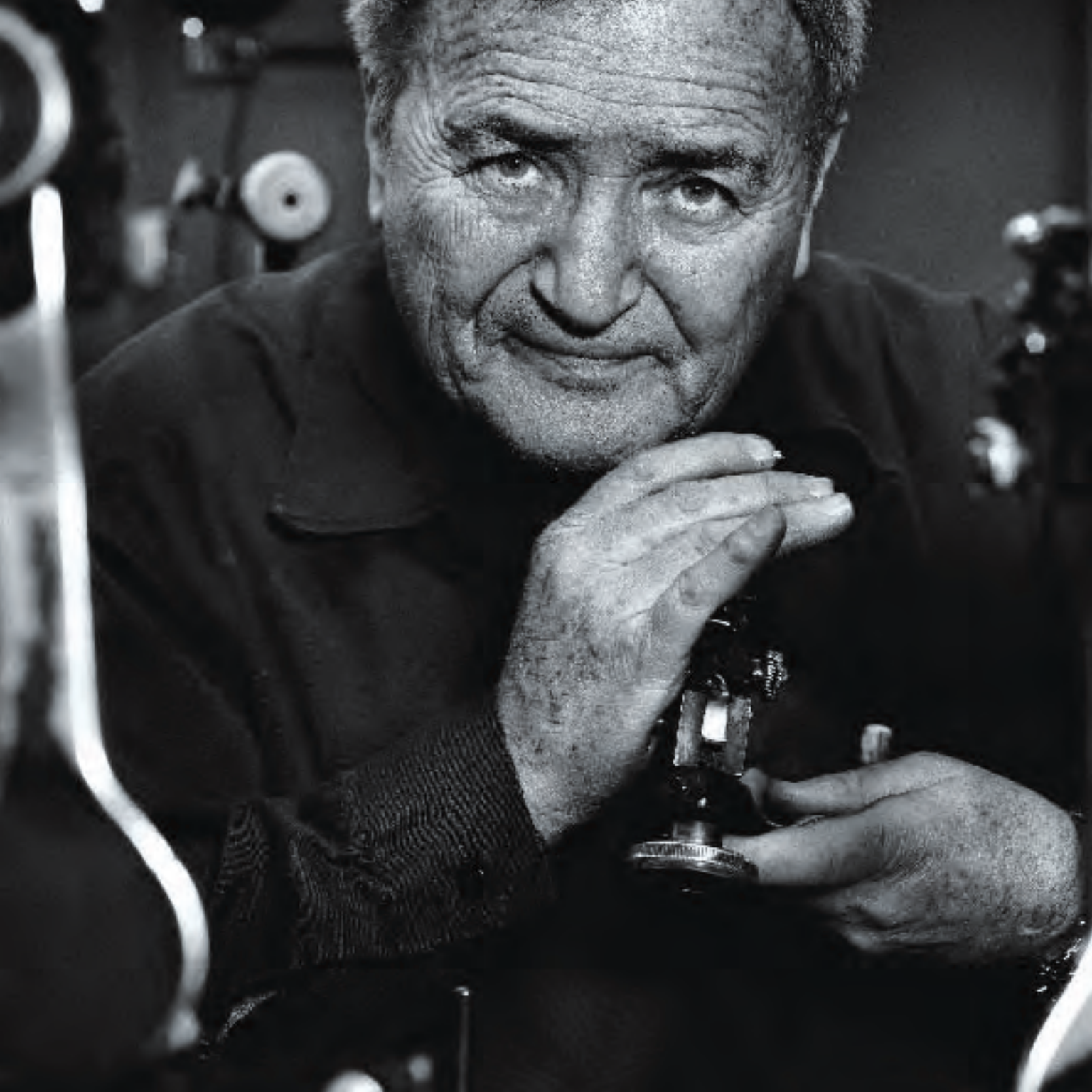
Cutting and polishing

Just as we can equate the diamantaire with an architect, master cutters and polishers are like the fine woodworkers or stone masons who implement an architect's vision. Using the diamantaire's markings, they give form to the rough diamond, using traditional handcraft complemented by state-of-the-art tools.

Based upon the marked instructions, each "sawable" stone is sectioned, or sawn into two or more parts. Next, the diamond is given its shape, known as bruting—a process in which two diamonds spin against each other to create the basic round mass. Then it is polished to produce the facets, a technique called crossworking. To elicit maximum fire and vibrancy, each facet is then brillianteered, or polished, to a flawlessly smooth finish.

Each of these disciplines involves lengthy training and apprenticeship. The stakes are high. For example, a diamond can explosively shatter into pieces if the saw or polishing wheel encounters a difficult or unexpected knot.

Technology is rapidly changing the techniques used to cut the stones. Now the most prevalent tools are high-speed razor-thin blades (above left) and lasers. But at one time, the job was done by cleavers, with a swift anxiety-filled thwack. Diamonds are polished using a spinning wheel oil-rubbed with diamond dust (above right). Master cutters (opposite page), who sit close by the diamantaires, take care of the large, most valuable stones in cities such as New York, Antwerp, Tel Aviv, and Mumbai (Bombay). Smaller diamonds are increasingly sent to cost-efficient cutting centers in India, China, Armenia, and South Africa.



A Diamond's Gift

Diavik diamonds typically make excellent polished gems due to the range of top white colors and consistent shapes. Formed naturally under the luminous northern lights, some say they have been infused with the mystery and brilliance of that light. After their long trip, they find a perfect new home in a stunning bracelet or necklace or ring, but they will carry the legacy of their Northern roots with them forever.

Endless innovations in cuts and shapes maximize the appeal of each diamond. Radiant, pear, marquise, baguette, emerald, rose, Swiss, square—each offers something special, an intoxicating twinkle that attracts the eye and captures the heart.

DIAVIK DIAMOND MINE: AWARDS & RECOGNITION

2009 Diavik Diamond Mines Inc. selected one of Canada's top 100 employers
2009 Diavik team wins Northwest Territories and North American western regional mine rescue competitions
2009 Spending with local companies surpasses Cdn $3 billion
2008 John T. Ryan regional safety trophy for select mines in western Canada
2008 Diamond production surpasses 50 million carats
2007 Mining Association of Canada recognition for community outreach, processed kimberlite management, and crisis management planning
2007 Arctic Energy Alliance Energy Efficiency Award
2007 Renewed Progressive Aboriginal Relations (PAR) program Gold level of achievement from the Canadian Council for Aboriginal Business
2006 Surpassed $1 billion in business spending with Aboriginal companies
2006 Environmental Management System ISO 14001: 2004 Certification
2005 Conference Board of Canada Award for Excellence in Workplace Literacy
2005 John T. Ryan Regional safety trophy for Select Mines in Western Canada
2005 Association of Professional Engineers, Geologists, and Geophysicists of the Northwest Territories and Nunavut Civic Award
2005 Environmental Management System ISO 14001:1996 Certification
2005 Product Splitting Facility ISO 9001:2000 Certification
2005 Prospectors and Developers Association of Canada E3 Environmental Excellence in Exploration Award
2005 Progressive Aboriginal Relations (PAR) program Gold level of achievement from the Canadian Council for Aboriginal Business
2004 John T. Ryan Regional safety trophy for Select Mines in Western Canada
2003 Workers' Compensation Board of NWT and Nunavut Mine Rescue Competition Surface Mine Rescue Award
2003 Canadian Council of Professional Engineers National Award for Engineering Achievement
2003 Association of Professional Engineers, Geologists and Geophysicists of the N.W.T. Professional Award of Merit
2003 Start Technology and Business Vertical Market Solutions Award
2002 Nunavut Mining Company of the Year
2000 Northern Manufacturers' Award

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Staking Map: c. 1992
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A-154 Pipe 3d Model:
Diavik Diamond Mine (DDMI)

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