



ARCTIC DREAMS

Narsaq could be the site of Greenland's first major mine.



As it pursues independence, Greenland seeks to develop its economy without ruining one of Earth's last pristine places.

BY JULIA ROSEN

The houses of Narsaq gleam in a cheerful riot of blues, reds and yellows. The crayon-coloured town spills across a hill that separates barren mountains from a fjord filled with icebergs. But up close, grimmer details come into focus; the paint on many homes is peeling, and few signs of life stir in the narrow streets.

Established as a trading post in 1830, Narsaq long served as a hub of Greenland's fishing industry — the backbone of its economy. But in the past few decades, modernization has moved much of the fishing offshore, and many jobs in Narsaq have disappeared. The town's 1,500 residents have been struggling to find a way forward.

The same could be said of Greenland at large. Part of the kingdom of Denmark since 1814, Greenland has transformed over the past century from a society based on subsistence hunting and fishing to one built around an industrial economy and a Nordic-style welfare system. But that rapid development has stalled, leaving communities such as Narsaq to grapple with economic stagnation and high rates of unemployment. At the same time, Greenland has sought to overcome its economic and political dependence on Denmark.

"I don't know any people — any country — who don't want self-determination, who don't want independence in the world," says Hjalmar Dahl, president of the Greenlandic branch of the Inuit Circumpolar Council. Some 80% of Greenland's population is Inuit.

Over the past 35 years, Greenland has gained increasing control over its internal affairs — it was granted self rule in 2009 — but it continues to receive Danish subsidies that account for roughly one-third of its gross domestic product (GDP). To gain true independence, it will have to generate almost US\$1 billion in additional revenues — all from a population of just 56,000 people on an island with only 150 kilometres of roads and an ice sheet about 3 times the size of Texas.

But Greenlandic leaders see promise in places like Narsaq. Geological studies of the rugged peaks outside town have identified valuable deposits of rare-earth metals, uranium and zinc; a major mine is approaching the final stages of obtaining a permit. These are just some of many such deposits that have attracted the attention of international mining companies, and which proponents say could usher in a new era of prosperity.

Researchers and some residents have challenged the idea that Greenland can mine its way to independence. A bitter debate has erupted over the social and environmental impacts that mining will have on one of the last pristine parts of the planet. Now, leaders are looking for opportunities — and investors — to expand other industries such as tourism and agriculture, as well as ways to optimize Greenland's vast fishing sector. The government must juggle these goals while contending with climate change, which threatens traditional ways of life and potentially bolsters new ones.

Whatever route Greenland chooses to follow, researchers say that it needs to start paving the way now. Even if the island forgoes full political independence, Danish subsidies will remain fixed at 2009 levels, adjusted for inflation, and the funds will not help to cover the rising costs of Greenland's ageing population or to sustain small towns like

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Narsaq. “It is a very urgent problem because Greenland already runs at a deficit,” says Minik Rosing, a geologist at the University of Copenhagen who is well known in Greenland for his work on the island’s future. Unless something changes, he says, “everything points toward the situation getting worse rather than better”.

RICH ROCKS

Narsaq’s name means ‘plain’ in Kalaallisut, the official language of Greenland, probably because the town occupies the flattest piece of land in sight. Mountains rise on all sides, their summits dulled by millions of years of glacial erosion. The inland ice sheet lurks just over the horizon, leaving only a thin ribbon of ice-free terrain. But what little exposed land there is happens to be rich in minerals (see ‘Mineral futures’). The crust here is ancient — up to 3.8 billion years old, in places — and has seen many cycles of volcanism and rifting. These brought metal-rich fluids close to the surface, where they formed deposits. The island also has substantial offshore oil and gas resources that could come into play if fuel prices rise or exploration costs drop.

Interest in the minerals has grown over the past decade, thanks to a confluence of forces. Greenland gained the right to manage and profit from its mineral deposits in 2009, just as the global appetite for many metals started rising. Politicians quickly pointed to mining as the best, and perhaps only, way to offset Danish subsidies and make statehood possible.

At the moment, many have their eye on the Kvanefjeld deposit near Narsaq, a contender to host Greenland’s first major mine. The resource there is “potentially huge”, says Kathryn Goodenough, a geologist with the British Geological Survey in Edinburgh. She works with EURARE, an initiative to develop Europe’s rare-earth potential that brings together researchers and mining companies such as Greenland Minerals and Energy (GME), the Australian company behind the Kvanefjeld project.

GME has been exploring here since 2007 and has studied core samples from hundreds of holes drilled into the nearby mountains over the years. “It’s like Swiss cheese up there,” says Ib Laursen, a company representative based in Narsaq. GME has estimated that the rocks above the town hold approximately 11 million tonnes of rare-earth oxides and that Kvanefjeld is one of the largest rare-earth deposits outside China.

Another company is seeking to develop the Kringlerne deposit across the fjord, which it calls a world-class reserve of rare earths and other metals.

Until mining starts, it is not clear whether these deposits will prove as extraordinary as the companies contend, says Rosing. But the geologist, who grew up on a reindeer farm outside the Greenlandic capital, Nuuk, is optimistic about the future of the island’s mining industry. “Greenland is exceptional, it is large,” he says. “I think with enough effort, there will be definitely something happening.”

Like many Narsaq residents, Mariane Paviassen desperately hopes that the mining boom doesn’t start at Kvanefjeld. She works for Air Greenland, greeting the handful of helicopter flights that touch down on Narsaq’s blustery landing pad. Her house, at the top of a narrow road on the far side of the town, is bright and inviting on a sunny day in September.

Some oppose the mine because it would bring an influx of foreign workers, but Paviassen is most worried about the uranium in the deposit, which GME plans to extract and sell along with the rare-earth elements. It’s what first brought Narsaq to the attention of scientists, including Niels Bohr, who visited in 1957 as part of Denmark’s investigations into atomic energy.

The country later banned all nuclear activity, including uranium mining, and Paviassen wishes that Greenland had upheld the tradition. “I think it is very dangerous stuff — the most dangerous stuff in the world,” she says. That’s why, in late 2014, she helped to found a citizens’ group called Urani Naamik, or No to Uranium.

GME’s current plans call for an open-pit mine on top of the plateau, about 10 kilometres from town. Paviassen’s group has highlighted the potential risks from uranium to human and environmental health, through water pollution and dust exposure. “My husband and my sons and my father — they like to go out and catch some food,” Paviassen says. But she wouldn’t eat it if mining began.

Others, including environmental organizations in Denmark, have cited the dangers of the radioactive thorium in the deposits, which currently has little commercial value, and of fluorine-containing minerals that can acidify water. Such concerns have fuelled a heated dispute over how to balance the economic benefits of exploiting Greenland’s natural resources with the environmental risks.

GME insists that Kvanefjeld can be mined safely. The company says that it is considering ways to contain the thorium, and that it will lock up fluorine by converting it into a marketable mineral. “That’s a part of the demand from the government — to use best practices,” Laursen says. Studies have found¹ that modern techniques for managing tailings can minimize the contamination risk, at least in the short term. The technical details of GME’s plans, however, won’t be revealed until the Environmental Impact Assessment report comes out later this year.

Economic forces may be the biggest barrier to Greenland’s mineral plans: the prices of rare earths and other metals have slumped after reaching all-time highs in 2011. “The simple reality is, it doesn’t look good,” says Tim Boersma, a fellow at the Brookings Institution in Washington DC, who co-authored a 2014 report² on Greenland’s mining potential.

Greenland would need about 24 major mines operating simultaneously to replace the Danish subsidy, according to a 2014 joint report³ by the University of Copenhagen and the University of Greenland in Nuuk that assessed how the island’s mineral resources might shape its future. Given what is known about the deposits, that would be a tall order even in good economic times, says Rosing, who chaired the committee that wrote the report. “The dream that mining could be a quick fix for the economy — that’s not going to happen,” he says.

POWER PLANS

As the results of the report have sunk in, talk of political independence has dwindled. Many Greenlanders realize that the process will take time, and Rosing says that some young people have started to question the benefits of completely severing ties with Denmark. In their view, he says, “a nation of 56,000 people is maybe not the best way of ensuring that individuals in Greenland can shape their own future”.

Disappointments in the mining sector have spurred discussion about diversifying the strategy for economic self-sufficiency. Rosing suggests that Greenland should devise other ways to profit from what makes it unique. He is exploring the possibility of marketing rock flour — the fine powder created by glacial erosion — as a source of nutrients and neutralizing agents for tropical soils. And he says that Greenland should court industries that would benefit from its cold climate, such as computer-server farms, which use enormous amounts of energy for cooling.

Greenland has begun harnessing its torrents of glacial melt water to produce renewable energy. The island has 5 hydropower plants, and government estimates suggest that it has enough untapped potential to produce 800,000 gigawatt hours of energy per year — more than the total used by the United Kingdom and France combined. The aluminium producer Alcoa, based in New York City, has considered building a smelter to capitalize on the cheap energy and, in 2010, Greenland’s national energy company launched a pilot project using hydropower to produce clean-burning hydrogen fuel.

For the moment, however, those options are largely prospects for the future. Today, about 40% of Greenland’s workers are employed by

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the public sector and 90% of its export economy revolves around fishing, particularly for northern shrimp (*Pandalus borealis*) and Greenland halibut (*Reinhardtius hippoglossoides*). Although catches remain good, west Greenland's shrimp stocks have declined over the past decade, perhaps influenced by climate change.

According to Helle Siegstad, director of fish and shellfish at the Greenland Institute of Natural Resources in Nuuk, the culprit could be Atlantic cod (*Gadus morhua*), a predator that could benefit from warming near Greenland and has started to reappear after being overfished. Another factor behind the shrimp's decline might be that climate change has caused a mismatch between their hatching time and the blooms of phytoplankton that they eat⁴.

But higher water temperatures have also lured new species north, such as Atlantic mackerel, Atlantic herring and even some bluefin tuna⁵, says Brian MacKenzie, a marine ecologist at the Technical University of Denmark in Kongens Lyngby. In recent years, temperatures off the coast of east Greenland have become warm enough for tuna, MacKenzie says. "It's basically a whole new habitat."

Siegstad says that the fishing fleet has been quick to pounce on these opportunities, and she is optimistic that changes in marine ecosystems will ultimately benefit Greenland's fishing industry. But even so, she worries about the island's overwhelming dependence on this variable, uncontrollable resource. "We are so sensitive," she says. "I hope we will have something else."

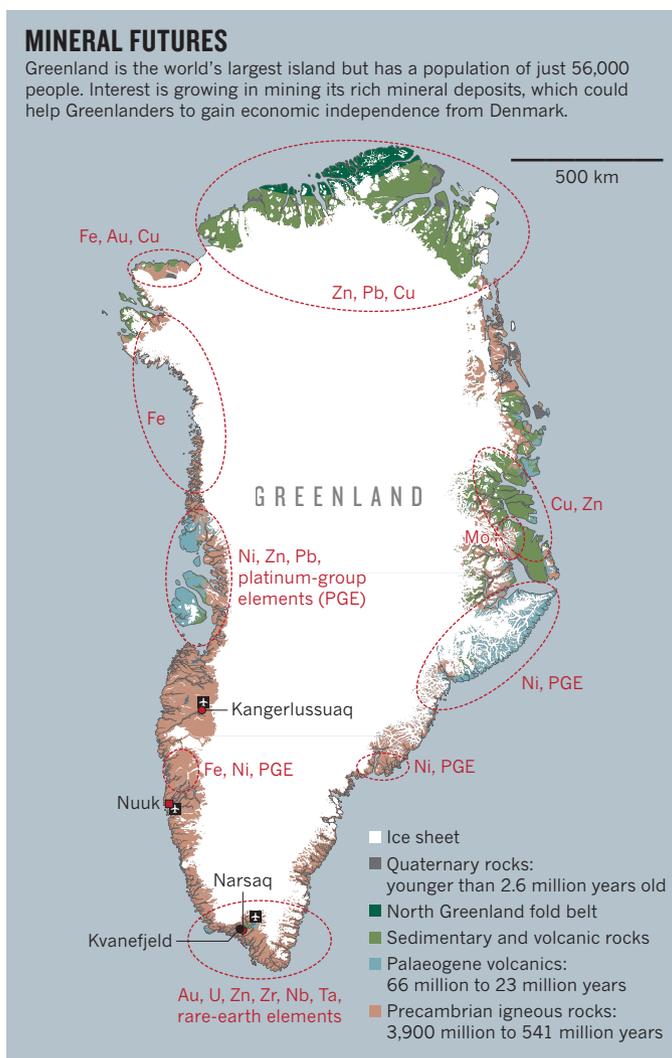
GROWTH INDUSTRY

Thirty minutes by boat from Narsaq, Kalista Poulsen and Agathe Devisme share 10 hectares of land with 300 head of sheep. Compared with the surrounding tundra, their grassy farm is lush. Purple wildflowers and *Angelica archangelica* — a popular medicinal herb — line their carefully manicured fields.

The couple is part of Greenland's budding agricultural industry — one of several small sectors of the economy that the island's leaders are trying to expand. Agriculture currently accounts for less than 1% of Greenland's GDP, but that figure could grow thanks to climate change, which has boosted temperatures in the south by almost 2°C over the past few decades. Modelling work⁶ by Jens Christensen and others at the Danish Meteorological Institute in Copenhagen suggests that if the world warms according to some of the most dramatic projections, the length of the growing season in southern Greenland will more than double.

But the climate is likely to become more variable, too. Already, a string of dry summers has forced farmers to import extra supplies of hay from abroad, supplementing the feed that they grow to get the animals through the long, brutal winter. This has left them wondering whether climate change will help or hurt them, says Devisme. "For the moment, it's more, kind of, disturbing."

To supplement their farming income, Devisme also runs a small bed



and breakfast, where visitors come to relax or to fish for Arctic char in the stream behind the fields. Many Greenlanders see the island's nascent tourism industry as a welcome alternative to exploitative activities such as the mining at Kvanefjeld, which Devisme says poses a threat to her businesses.

In 2013, the government counted roughly 35,000 visitors, who contributed around 3% of GDP. Greenland hopes to ramp up adventure tourism, such as hiking and kayaking, and boost cruise-ship traffic — a pattern that has succeeded in Iceland. The consulting firm Ramboll, based in Orestad, Denmark, has projected that the tourism industry could more than double by 2025, although this would require strong investment in infrastructure such as hotels and airports, as well as increased marketing and international cooperation.

But, if Greenland is to benefit from these industries, its people must have the skills to work in them. Developing the island's human capital may be the key to Greenland's success, according to a 2013 report⁷ by the Copenhagen Institute for Futures Studies.

Today, although many Greenlanders possess a wealth of informal knowledge, only 35% of students go beyond compulsory school, which they finish at age 15

or 16. The government aims to boost the number continuing with their training, and the plan starts with strengthening elementary education.

The residents of Narsaq are doing their part. Here, late on a Sunday afternoon, workers bustle around a fenced-off construction site in the centre of town. A crane swings overhead, hoisting wooden beams onto a tower of scaffolding, where crews are renovating the red-panelled school. It will soon boast a wall of windows, giving Narsaq's children a grand view of the mineral-rich mountains, the ice-choked fjord and their own small town — as it lurches forward into Greenland's uncertain future. ■

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