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GEOLOGY

After abuse, Inuit group closes off ancient rock belt

The nearly 4-billion-year-old rocks offer a look into Earth's earliest years

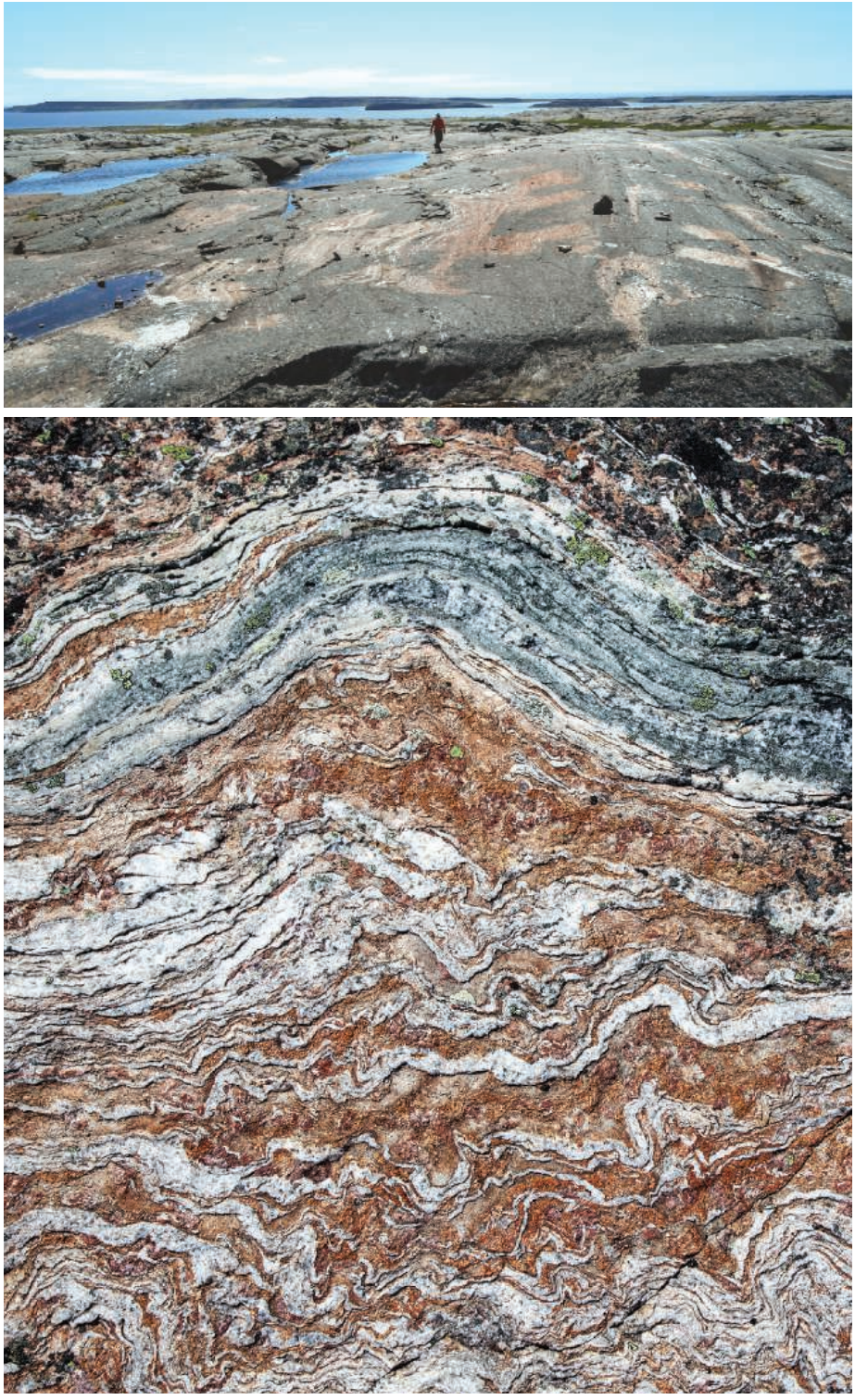
By **Rachel Berkowitz**

For nearly 2 decades, geologist Jonathan O'Neil of the University of Ottawa has sampled and studied what he believes are the oldest rocks on the planet, in the northernmost reaches of Canada's Quebec province. Estimated to be about 3.8 billion years old—and perhaps much older—the rocks lie on tribal Inukjuak lands near Hudson Bay, and O'Neil relied on support from the Inuit locals to study them. But following several incidents of abuse by a few other scientists, the tribe has said "no more" to all samplers.

"Other geologists who came to do research took large amounts of rock and scarred and damaged the land," explains Tommy Palliser, a member of the Inuit community and president of the Pituvik Landholding Corporation (PLC), which manages the land for the tribe. Excavations at the outcrops exposed near the shore of the Hudson Bay have left the land with "jagged edges" and looking "not pristine," he says. Moreover, another board member of PLC found rock collected from the site for sale on the internet for upward of $10,000. "We were pretty disgusted with this," Palliser says. As a result, the Pituvik decided last year to close the area to extractions entirely.

O'Neil understands the Pituvik's decision, noting that in 2017 he saw evidence of sampling that was "not very considerate … almost unethical" and a traditional inukshuk stone structure, used as a navigational marker by the Inuit, that had been vandalized. But he and others mourn what may be lost to science. Geologists are frustrated by the vanishingly small amounts of material that have survived since Earth's formation 4.56 billion years ago, says Aaron Cavosie, a geologist at Curtin University who studies ancient minerals. For now, the Acasta Gneiss in northwestern Canada holds the age record at 4.03 billion years old, based on easy-to-date zircon crystals embedded in its grains.

But the Hudson Bay rocks, part of the Nuvvuagittuq Greenstone Belt, are not far behind. Gold-standard dating techniques on zircon-rich samples from the Nuvvuagittuq have repeatedly confirmed a 2002 date of at least 3.75 billion years old. And based on an unusual isotope signature in their composition, O'Neil believes the rocks at Nuvvuagittuq are older. He says he has the material



The layered rocks (bottom) of the Nuvvuagittuq Greenstone Belt (top) may preserve traces of early life and primordial magnetic fields that scientists hoped to study.

PHOTOS: (TOP TO BOTTOM) JONATHAN O'NEIL; DAVID HUTT/ALAMY

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needed to make that argument, but also that he hoped to revisit specific areas to study early traces of life such as microscopic structures and mineralized chemical byproducts, which he will now not be able to do.

Other scientists were also drawn to the unusual formations. PLC handled permits and arranged logistics in the 521-square-kilometer region surrounding the community of Inukjuak. Inuit leaders guided permitted scientists, who collected anywhere from a single grapefruit-size sample to several hundred kilograms of rocks. "Sometimes I would bring people myself, by canoe," Palliser says. He recalls the beauty of the rocks, which Pituvik Elders describe as *Qupuartuuq*: rock with different shades of colors. "When you look at it, you can really see the swirls of blacks and whites and grays," Palliser says.

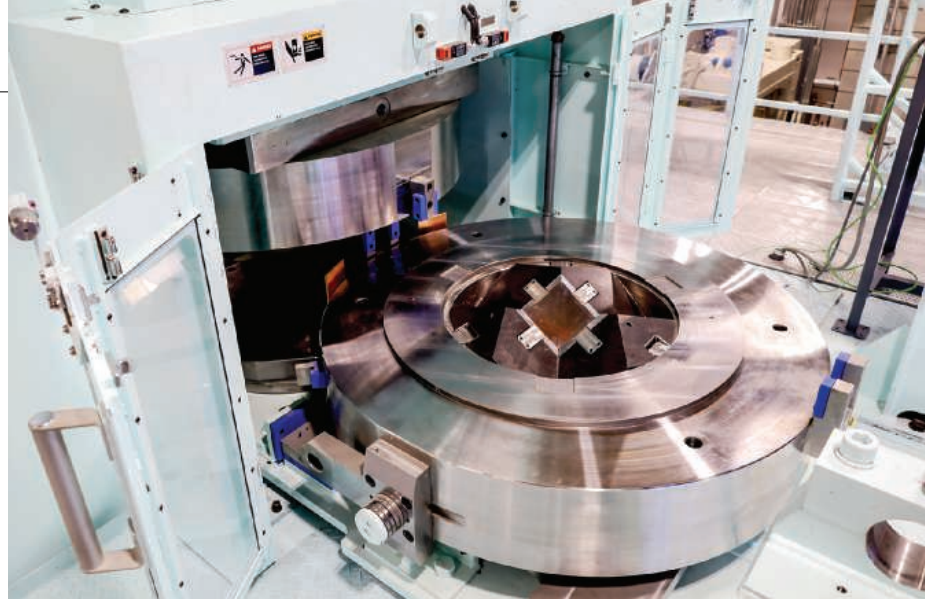
But in 2016, he recalls, a group branding itself as "museum curators" brought excavating equipment to Inukjuak, ferrying it to the site in a large boat. "When we realized they were taking such large amounts of rock we were astonished," he says. PLC limited samples eventually down to softball size before the COVID-19 pandemic shut down the site. But when site visits resumed and when Palliser and others saw some of the extractors trying to profit off these rocks "without our knowledge and consent," they'd had enough. The Pituvik pulled the plug.

Losing access will deprive scientists of the chance to study some of Earth's earliest years. Claire Nichols, a geologist at the University of Oxford who studies early Earth's magnetic field, found records of ancient magnetism in Greenland rocks that were part of an ancient ocean's crust. "We were excited to see if the same was true for Nuvvuagittuq," she says, given it was also part of an ancient ocean. Her request to visit the rock belt last year and collect samples was denied, but she understands why. "There have been many issues with bad sampling practice" in her field of paleomagnetism, she says.

The incident may have a silver lining. PLC is now collaborating with scientists to fund and set up a provincial park that would protect the Nuvvuagittuq rocks. "There would be no more taking of material. You come and see firsthand the geology and the rocks themselves," Palliser says. The Inuit community would remain stewards of the land, and that's as it should be, O'Neil says. "For most people this may be a remote area in the Canadian North, but this is home for the Inuit people and has been for hundreds of years." ■

Rachel Berkowitz is a freelance journalist based in Eastsound, Washington, and Burnaby, Canada.

PHOTO: CORE CONSTRUCTION



A massive press at Arizona State University will subject rocks to deep-Earth pressures and temperatures.

EARTH SCIENCE

New complexity emerges in Earth's 'boring' middle region

Planetary CT scans and lab experiments reveal layering and intricate flows in the mantle

By **Paul Voosen**

Earth's middle depths are dull, or so geophysicists thought. The crust is fractured and convulsed by plate tectonics; in the core, churning liquid iron generates the planet's magnetic field. In between is the mantle, 2900 kilometers of hot, pressurized rock, convecting feebly like a superslow lava lamp. Studies of earthquake waves that probe the middle mantle showed little structure other than plumes of hot rock rising all the way through its thickness and the remnants of surface plates, called slabs, that have slid from the surface to its depths.

New work is changing that picture. A mysterious new mantle layer has emerged, and the mantle's flow patterns appear more complex than was thought. They are hectic, variable, jumbled, with some reaching the mantle's surface and some stalling below, rather like the erratic churning in a pot of potatoes that has just reached a boil. For a long time, much of the mantle was thought "boring," says Dan Shim, a mineralogist at Arizona State University (ASU). "But now we're starting to see some complexity there."

Geophysicists use the shifting speeds of earthquake waves as they pass through the mantle to create a sort of planetary CT scan, a coarse reconstruction of Earth's interior. A decade ago, a breakthrough paper in *Nature* made a definitive case that plumes of superhot rock can rise all the way from the mantle's base to the crust, fueling hot spots such as Hawaii. But that paper, and others since, also revealed a puzzle: Although some hot spots made it all the way through, many plumes—along with sinking slabs—also stalled and flattened at various points. "It all started by observing these flat slabs and flat plumes," says Claudia Adam, a geophysicist at Kansas State University.

One sticking point appeared at a depth of 660 kilometers. It made geophysical sense: Seismic waves uniformly change speed at this depth, where ringwoodite, a form of olivine—the upper mantle's predominant mineral—breaks down under immense pressure into two other minerals. But researchers were puzzled by another stagnation, seen at a depth of 1000 kilometers, where there is no known transition in mantle minerals and no detected change in the speed of earthquakes.

In work presented late last year at an American Geophysical Union meeting, however, geophysicist Keely O'Farrell at the University of Kentucky and Yuping Wang, a former graduate student, glimpsed a change in mantle properties at 1050 kilometers' depth. The change marks the start of what they've dubbed the middle mantle transition zone (MMTZ).

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