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Not My Fault: What is Greenland? A key geographic area for many reasons

Lori Dengler for the Times-Standard

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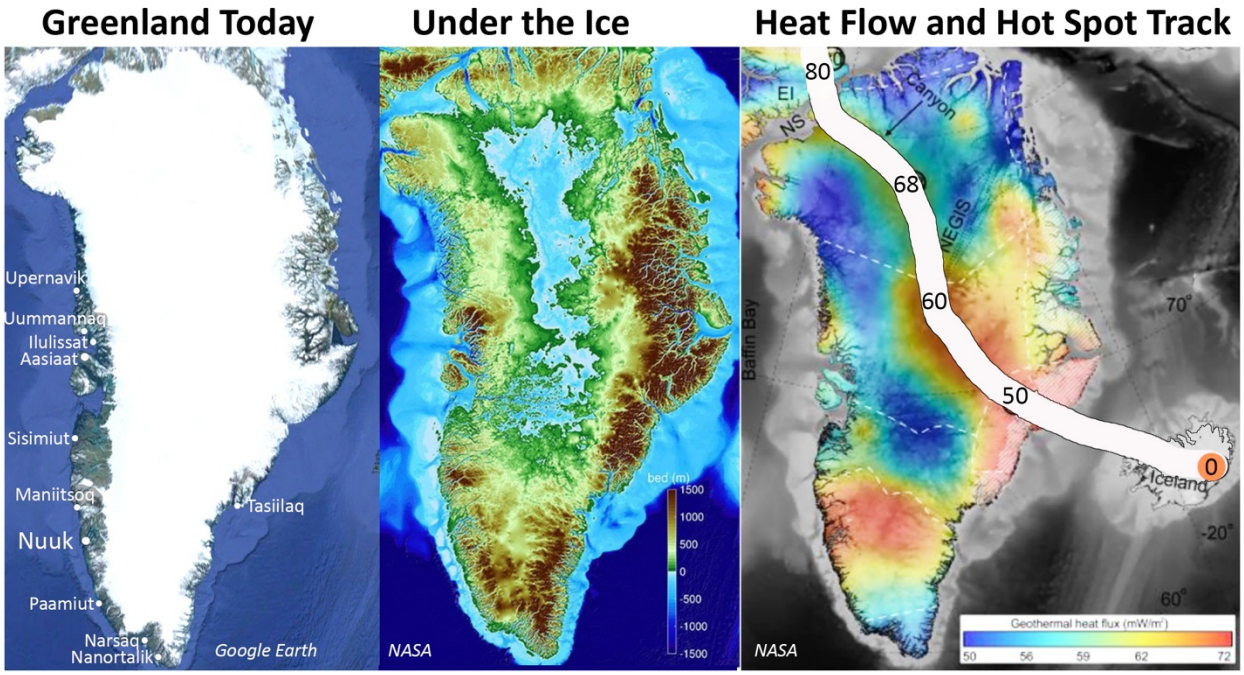

Three views show Greenland: On the left is a Google Earth image with locations of Nuuk, the largest city, and selected towns and villages. Center shows the inferred topography beneath the ice. Right is the measured heat flow and hot spot track; numbers give age in millions of years of former hot spot locations.

What thoughts come to mind when I say Greenland? In the far north, glaciers, probably not high on most people's lists of vacation spots, and too much in the news recently. Greenland has the potential to tip the global political framework that has been in place since the end of World War II. It's worth taking a moment to learn more about this unusual place.

Greenland is the world's largest island. At over 800,000 square miles, it is nearly three times larger than number two, New Guinea, and almost 25% larger than Alaska. On most maps, Greenland looks enormous. That's just a distortion caused by representing a sphere on a flat surface. Look at a globe or more modern map projections and Greenland isn't even a third the size of Australia.

Geographically Greenland an island, but geologically it's part of North America, moving in conjunction with the rest of North American plate. There's been some distortion over the ages. Roughly 80 million years ago some spreading began with the opening of the Labrador Sea that

separates Greenland from Canada, but there are no plate boundaries separating Greenland from North America and the two have moved in lock step ever since.

Greenland poses problems for geologists. Over 80% of the surface is covered with an icecap that averages nearly a mile in thickness and reaches close to two miles in the central part of the island. Even the areas free of ice are difficult to access. Laura Levy is a colleague of mine in the Humboldt Geology Department and spent a number of years studying glacial retreat in Greenland. She is in awe of the spectacular landscape and grimaces recalling the logistical nightmare of doing field work there.

Reconstructing Greenland's under all that ice and how it got that way requires more than direct sampling. Scientists use ice-penetrating radar, magnetics, gravity, and other remote sensing techniques to estimate topography and rock characteristics and tie that data into the more exposed geology of surrounding regions. I was surprised by what glacier stripping reveals, a vast interior "lake" where the land surface has been depressed below sea level by the tremendous weight of the ice cap.

Greenland contains some of the oldest rocks on the planet. It's part of the Canadian Shield, the ancient core of the North American continent composed of igneous and metamorphic rocks formed in Precambrian times over 1.5 billion years ago. The Isua Greenstone Belt near the capital Nuuk in the southwestern part of the island is between 3.6 and 3.9 billion years in age. These rocks were some of the very first to permanently form on the earth's surface. Created long before any fossil remains, they also contain some of the earliest signs of life in small carbon traces produced by micro-organisms.

By 1.5 billion years ago, long before any part of California existed, Greenland was essentially complete. Since then, Greenland along with the rest of North America has moved and deformed. It has been a part of at least three supercontinents that formed and broke apart in the long-distant past. It has traveled from far more temperate climates to its current arctic location.

A remnant of that history is exposed in the East Greenland orogen, a mountain belt that bears striking similarities to both the Appalachians in the eastern U.S. and the Caledonian mountains of the British Isles and Scandinavia. Continuity of rock types/fossil assemblages and magnetic markers have allowed geologists to reconstruct the world in early Paleozoic times, reconnecting mountain ranges that are now widely separated.

These mountains were created by the collision of ancient continents, the same process that built the Himalayan mountains. The Indian subcontinent began colliding with Asia roughly 50 million years ago and continues that convergence today. Like the Himalayas, the ancient Appalachian and Caledonian chains formed over many millions of years, were monstrous in size, uplifting large plateaus and dominating the world's climate. This supercontinent would later connect with the Gondwana, the southern supercontinent, to form Pangaea.

All supercontinents eventually break apart, driven by the massive heat trapped beneath thick continental crust. The fissures began to form in Pangaea about 200 million years ago. First a few cracks, then an elongated rift, not unlike Africa's rift valley today. As the crack widened, the

North American plate with Greenland firmly attached moved to the west, eventually forming the Atlantic ocean.

Greenland today is a remarkably passive land mass. Numerous earthquakes occur on the mid-Atlantic ridge 400 miles to the east and occasionally in Baffin Bay and the Labrador Sea to the west, but the modern interior is remarkable quake-free. This was likely not the case for the late Cretaceous and early Cenozoic eras, and it has nothing to do with plate boundaries.

Greenland encountered what we now call the Icelandic hot spot about 80 million years ago. At that time, the entire island was much further south, the capital Nuuk would sit at about the same latitude as today's location of Portland Oregon. A slow counterclockwise rotation of the North American plate sent Greenland on a northwest path. For forty million years, Greenland inched its way over the hotspot, cutting a swath over much of the island.

The direct impacts of the hotspot track can only be observed in the small ice-free spots where basaltic rocks are exposed. These rocks are far younger than the Precambrian basement of much of the island. A friend Karina Junge traveled to Greenland recently and told me "the reddish-brown rock and basalt columns surprised me as I was expecting only snow and ice everywhere." These aren't unlike the volcanic scars left by the Yellowstone hotspot as the North American plate slip over it.

The hotspot track beneath Greenland was recently exposed by a NASA remote sensing team from the thermal signature in the rock. Heat flux, the amount of heat exiting from the earth's interior, is distinctly higher across the central part of the island than at other locations and matches well with the exposed volcanic rocks where the hotspot likely entered and left.

About 56,000 people live in Greenland today, 89% with Inuit ancestry. Roughly 76,000 visit the island as tourists each year and the number is growing. But the reason for the current political interest has nothing to do with its tourism attractions. Greenland's ancient rock has some of the world's largest deposits of iron ore, uranium, zinc, graphite, tungsten, gold, rare earth elements, and other economically important materials. The magmatic processes that formed these rocks in the very early stages of crustal formation concentrated these elements. Other areas of the Canadian Shield have been exploited for centuries, but Greenland's resources are essentially untapped. Glacial retreat is rapidly exposing many more areas making the island a top candidate for resource extraction.

Glacial retreat has other potential impacts on the planet. In the last 30 years, NASA estimated 1.6% of the ice cover has disappeared. If the entire ice cap melted, sea level would rise 23 feet. The influx of fresh water has the potential to permanently change ocean currents and weaken the Gulf stream. This is no longer a distant hypothetical. A recent study by the University of New South Wales suggests 30% weakening of the Atlantic circulation as early as 2040 with major disruptions in climate and marine ecosystems.

Greenland is important for many reasons – take the time to learn more.

For a NASA animation of Greenland's tectonic past, visit
https://science.nasa.gov/resource/earth-greenlands-geologic-past/

Lori Dengler is an emeritus professor of geology at Cal Poly Humboldt, and an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times--Standard's. All Not My Fault columns are archived online at https://kamome.humboldt.edu/taxonomy/term/5 and may be reused for educational purposes. Leave a message at (707) 826-6019 or email Kamome@humboldt.edu for questions and comments about this column or to request copies of the preparedness magazine "Living on Shaky Ground."