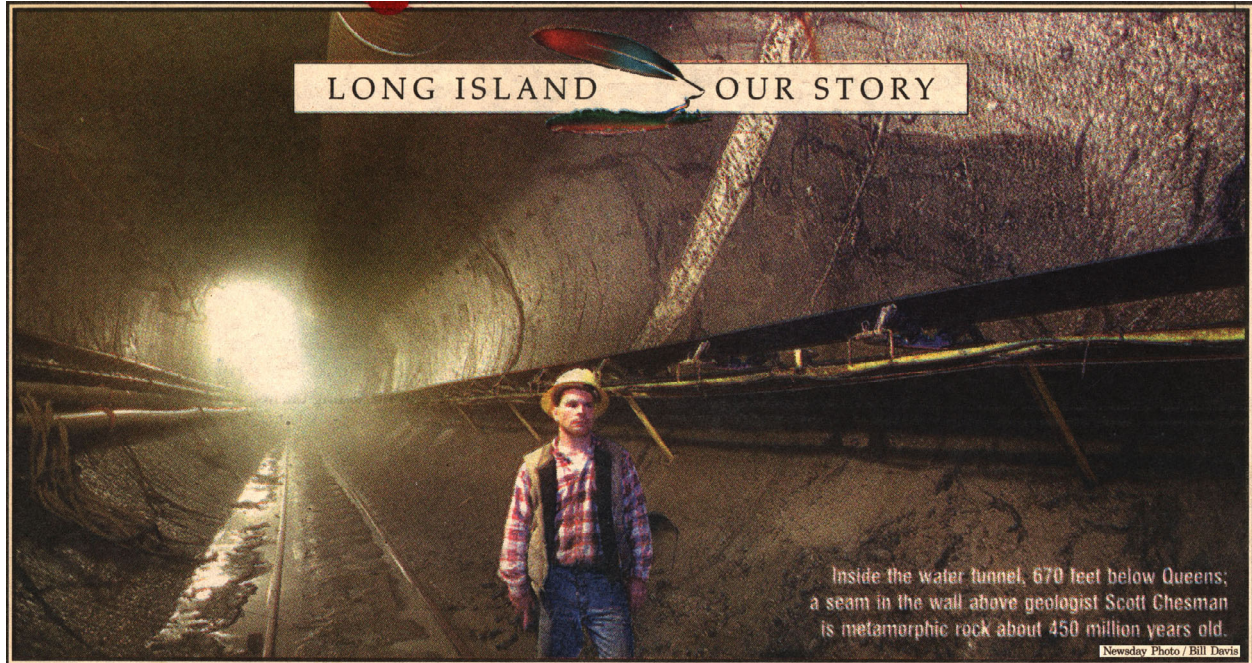


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LONG ISLAND

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A new water tunnel offers rock-hard and ages-old clues about the formation of Long Island
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In the Belly Of the Earth

Forged by the fiery collision of a now-vanished continent and a string of volcanic islands, the oldest pieces of Long Island are a mystery whose secrets lie buried beneath hundreds of feet of sand and soil. But there are clues, and some of the most intriguing are being revealed, inch by laborious inch, as a locomotive-sized machine drills a water tunnel through some of

the hardest rock on Earth, 670 feet below Queens.

Much of the bedrock exposed by the drilling is 450 million years old. And while the primary purpose of the project is to bring more water to New York City, the incidental geology is fascinating in its own right. The long-hidden rock is the sturdy pedestal upon which eroding mountains and bulldozing glaciers later sculpted Long Island's familiar features, and it is the only real

evidence of the Island's earliest history.

As revealed by the tunnel excavations, the ancient rock is anything but colorless. Even in the dim light of the construction lamps, the tunnel's sloping walls are a striking tableau of rippling stripes as delicate as spider webs and slashing faults as jarring as lightning bolts. Granite slabs speckled with garnet lie beside sheared-off chunks of blackish-green ocean crust and hardened

lava from long-dead volcanoes.

``It's really extraordinary. It's the closest thing to a religious experience you can get in geology," said Charles Merguerian, a professor of structural geology at Hofstra University.

The epiphanies are few for bedrock experts on Long Island because here, unlike many other parts of the world, the only visible bedrock is a

few small outcroppings at the northwestern edge of Queens in Long Island City. From there, the bedrock's upper boundary slopes steadily downward to the east and south. By the time that slope reaches central Suffolk County, the bedrock is more than 1,500 feet below the surface.

No one knows whether the bedrock in Queens is similar to the unmapped rock beneath Nassau and Suffolk counties. "It's very possible that there may be a totally exotic piece of real estate down there under eastern Long Island that we don't even know about, possibly an old piece of Africa," Merguerian said, explaining that local bedrock could have originated in a different continent and been joined to North America after an ancient continental collision. "We have absolutely no clue."

Much of the sparse evidence that does exist has come from New York City's effort to build a third water tunnel to bring drinking water down from upstate reservoirs. The Queens leg of the tunnel is the latest in a series of digs that began in 1970 and will continue until the tunnel is finished in 2015.

On an afternoon when a driving rain had curbed activity at the surface, a crew of tunnel workers -- or sandhogs, as they call themselves -- was making steady progress near the bottom of an entry shaft in Maspeth that is more than twice as deep as the Statue of Liberty is tall.

Monitoring the crew's progress in guiding the 640-ton boring machine was Scott Chesman, a former sandhog who is a geologist at the city Department of Environmental Protection.

His prime mission is to see how the ever-changing composition of the rock affects the progress of the \$13 million machine. But Chesman is also mapping, analyzing and even videotaping the types of rock the machine encounters in hopes of shedding new light on the origin of Long Island's basement. He has only one chance to get it right, since the tunnel's exposed walls will later be covered with concrete. And the task is tricky because newer rock -- a mere 360 million years old -- has filled in crevices and faults in the older bedrock.

"It's rock psychology, you can see all the trauma that the rock's been through," said Chesman, pointing at an intricate pattern of older granite and younger volcanic rock.

The tunnel walls in Queens are streaked with major fault lines, and many of those cracks are packed so tight with groundwater that when struck by the drilling machine they gush water at a torrential rate -- as much as 1,300 gallons a minute -- that requires a fast grouting job by the sandhogs.

The many faults along the tunnel walls are powerful evidence that our region is in an earthquake zone. Large quakes were recorded in the New York City area in 1737 and 1884, and others are sure to follow, according to Merguerian. In fact, he said, the long gap between earthquakes means that the next one, when it comes, may be a big one.

Another key discovery in the tunnels has bolstered the leading theory about how at least some of Long Island's bedrock was formed.

A half-billion years ago, geologists believe, the continent that would later become North America was rotated in a different direction. The land that would become the east coast of the United States was facing south, just below the equator, near an offshore arc of islands.

When that island chain smashed into the coast about 450 million years ago, the oceanic rocks were pushed 10 miles deep into the Earth. There, temperatures as high as 1,300 degrees transformed the rock to its super-hard form.

Later cataclysms brought the bedrock to its present position near the surface, and added new wrinkles. For instance, additional local bedrock was formed 360 million years ago when a collision on the other side of the volcano arc created what would become New England, and still more was formed about 280 million years ago in the great collision with what became Africa that pushed up the Appalachian Mountains and formed the super-continent of Pangaea. North America and Africa have been drifting apart ever since Pangaea began breaking up about 200 million years ago.

Merguerian and other experts believe it is the first of those collisions that created most of Long Island's bedrock, and the tunnel excavations support that theory by revealing new evidence of a massive fault zone -- called Cameron's Line -- that stretches from central Massachusetts to Brooklyn and is thought to mark the impact zone of that first ancient collision 450 million years ago.

"You can actually see the characteristics of Cameron's Line in the subsurface geology," Merguerian said, referring to the fault lines.

"It's right there on the tunnel walls."

Many secrets of the bedrock are still untold. But a skyscraper's length below the streets of Maspeth, inside the tunnel whose walls are covered with swirls and swoops of pressure-cooked rock, it is at least possible to begin to imagine the awesome power of the continental collisions that formed the solid foundation upon which Long Island was built.

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