
The Metro Section

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At Ground Zero, Scenes From the Ice Age

Trade Center Excavation Uncovers a Landscape Carved by Glaciers



DAVID W. DUNLAP/THE NEW YORK TIMES

A Glimpse of New York City, 18,000 B.C.

Excavation at the World Trade Center site has uncovered, among other geologic features, a 40-foot glacial pothole. Page B4.

By DAVID W. DUNLAP

Those who say the World Trade Center site is changing at a glacial pace have no idea how right they are.

A fantastic landscape in Lower Manhattan — plummeting holes, steep cliffsides and soft billows of steel-gray bedrock, punctuated by thousands of beach-smooth cobblestones in a muted rainbow of reds and purples and greens — has basked in sunlight this summer for the first time in millennia.

This monumental carving was the work of glaciers, which made their last retreat from these parts about 20,000 years ago, leaving profound gouges in the earth and rocks from the Palisades, the Ramapo Mountains and an area of northern New Jersey known as the Newark Basin.

Plumbing these glacial features and souvenirs has been critical in preparing the foundation for Tower 4 of the new World Trade Center, being built by Silverstein Properties. The concrete footings from which its columns rise must rest on firm bedrock. Engineers need a clear understanding of the rock's contours.

"You want to make sure you're not perching something on a ledge," said Andrew Pontecorvo, a supervising structural engineer at Mueser Rutledge Consulting Engineers, which is working on the trade center project.

Engineers knew in advance that there were "discontinuities" in the bedrock at the southeast corner of the trade center site, where Tower 4 is situated. Some of these were revealed in the 1960s during the construction of the original slurry wall. (George J. Tamaro, who supervised that job for the Port Authority of New York and New Jersey, is a retired partner of Mueser Rutledge.)

And when parts of the slurry wall were rebuilt after 9/11, engineers found areas where the rock anchors that stabilize the wall would not hold, meaning there were voids in the bedrock.

Borings through the ground also showed large discrepancies in the elevation of the rock underneath. "It was extreme from the variation you would interpret to what we actually encountered," Mr. Pontecorvo said.

Obviously, the bedrock topog-

raphy could not be mapped with enough precision until all the soil was removed and the surface was fully exposed. But besides being an engineering necessity, the unearthing of geological features, especially a 40-foot depression known as a pothole, has offered scientists a rare window into the deep past.

"There are areas in local parks that have small vertical potholes exposed," said Cheryl J. Moss, the senior geologist at Mueser Rutledge, "but I'm not aware of anything in the city with a whole, self-contained depression on this scale."

Ms. Moss and Mr. Pontecorvo are scheduled to give an illustrated lecture on the site at 7 p.m. Wednesday at the Tribute W.T.C. Visitor Center, 120 Liberty Street, opposite the pothole.

"It's been called the Grand Canyon of Lower Manhattan," Mr. Pontecorvo said.

Charles Merguerian, chairman of the geology department at Hofstra University and a consultant to Mueser Rutledge on the trade center project, put it even more simply: "Beautiful!"

"It is very unusual to see such features near sea level," he added.

Shown photographs of the rocks, Sidney Horenstein, a geologist and environmental educator emeritus at the American Museum of Natural History, said, "You don't find such an array of rock types in the few places in the city that the glacial deposits are exposed."

Across much of the trade center site, bedrock level is roughly 70 feet below street level. In the southeast corner, however, the pothole adds another 40 feet to the depth, meaning that its bottom is about 110 feet below street level.

Yet when the pothole filled with rainwater this summer, it looked like nothing so much as a little mountain pond. Crevices around the edge were filled with pockets of densely packed cobblestones, possibly some of the very stones that the glaciers used to do the carving.

"As the ice passed over New Jersey," Ms. Moss explained, "it picked up local rocks such as red shale and sandstone and gray basalt from the Palisades. As ice melted from the advancing gla-

cier, raging streams of water flowed in front of it. The strong currents picked up the sand, gravel and boulders and carried them downstream across the World Trade Center site.

"As these rocks bounced across the bedrock, essentially sandblasting the surface, the softer layers started to erode out and the harder rock left behind became polished. In places, the water swirled in whirlpools of varying sizes, carving out deep potholes and larger basins."

Along the east side of the pothole, the rock layers run vertically — not horizontally. The result, where the surface has been carved away in a concave form, is an abstract canvas of swirling, concentric rings; not unlike a gouge in a wall that reveals many layers of old paint.

This speaks of a period far more ancient than the glaciers, about 500 million years ago, when the edges of the colliding North American and African continental plates got shuffled together.

"That's when all this got pushed into a vertical orientation," Dr. Merguerian said. He estimated that the rock around the pothole had once been 20 miles below the surface, based on the presence of a high-pressure mineral called kyanite.

Ultimately, geology at the trade center site is in the service of construction, meaning that the pothole and other features are either being covered, filled in or blasted away. "It's nice to look at," said Robert B. Reina, a supervising structural engineer at Mueser Rutledge, "but it's all got to go."

Construction workers have developed an appreciation of this otherworldly site, even as they have labored to obliterate it. For instance, Joe Racanelli, a foreman, has been collecting those smooth and colorful cobblestones from New Jersey and lugging them home to the Bronx.

"I can't help it," he admitted.

And a mechanic who introduced himself simply as Al made it plain that this was one New York pothole he would miss.

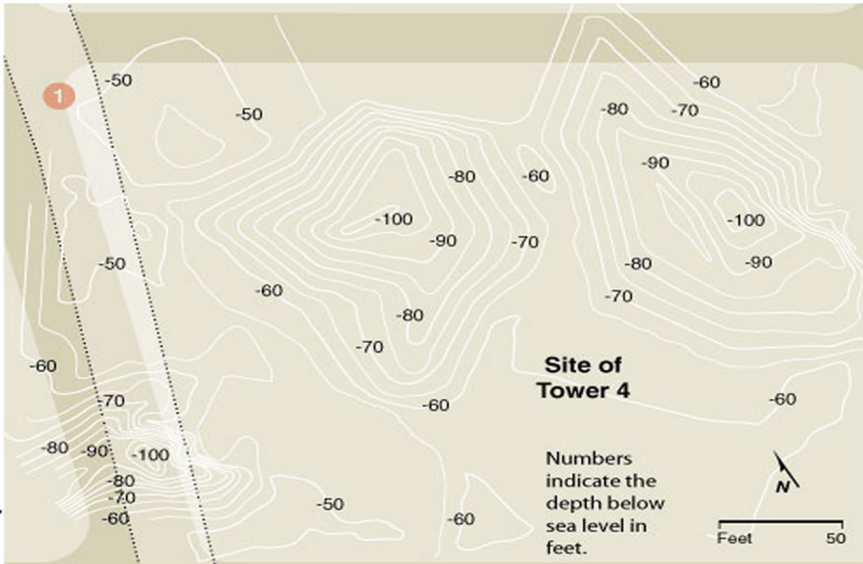
"I think they should keep it," he said. "Turn it into an aquarium. Fill it with fish. Do something special — not just another building."



A worker is framed by bedrock that was scoured by a retreating glacier 20,000 years ago.

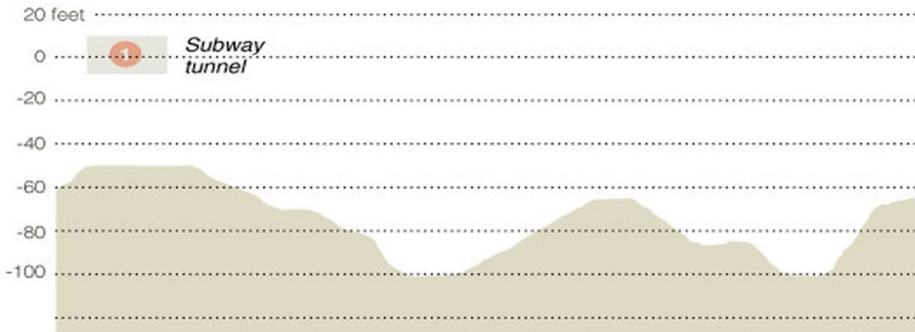
Glacial Terrain At Ground Zero

Excavations for Tower 4 at the southeast corner of the World Trade Center site uncovered a landscape carved by glaciers out of bedrock at least 20,000 years ago, with deep pools known as potholes.



BELOW CITY STREETS

Map at upper right shows bedrock contours of the Tower 4 site from above. At right is a cross section. In the measurement scale, 0 is close to sea level and is 10 to 20 feet below street level. That means the bottoms of the potholes (-100) are about 110 feet to 120 feet below the street.



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