

and surface pressure, diamonds are in repose on an extremely narrow thermodynamic shelf. They want to be graphite, and with a relatively modest boost of heat graphite is what they would become, if atmospheric oxygen did not incinerate them first. They are, in this sense, unstable—these finger-flashing symbols of the eternity of vows, yearning to become fresh pencil lead. Except for particles that are sometimes found in meteorites, diamonds present themselves in nature in no other way.

Kimberlite is easily eroded. A boy playing jacks in South Africa in 1867 picked up an alluvial diamond that led to the discovery of a number of pipes, one of which became the Kimberley Mine. From that pipe alone, fourteen million carats followed. The rock source of diamonds had never before been known. The Regent, the Koh-i-noor, the Great Mogul had been eroded out by streams. As the ice walls of the Pleistocene moved across Quebec, resculpting mountains, digging lakes, they apparently dozed through kimberlite pipes, scattering the contents southwest. The ice that plucked up the diamonds not only brought questions with it but also obscured the answers. How many pipes are there? Where are they? How rich are they in diamonds? If one ten-millionth of their content is gem diamond, they would be worth mining. They are somewhere northeast of Indiana. They are in all likelihood less than a quarter of a mile wide. They may be under glacial drift. They may be under lakes. A few have been discovered—none of value. Presumably, there are others, relatively studded with diamonds. Many people have searched. No one has found them.

"In Siberia, a few years ago, a couple of diamond pipes were located after diamonds were discovered in glacial drift," Anita told me.

I said, "Possibly some Russian geologists could be helpful here."

Looking out across the water of Lake James at a line of morainal hills, she chose to ignore the suggestion. The hills screened the outwash plain beyond. After some moments, she said, "Rocks remember. They may not be able to tell you exactly where in Canada to look for a diamond pipe, but when you have diamonds in this drift you'd better believe it is telling you that diamond pipes are there. Rocks are the record of events that took place at the time they formed. They are books. They have a different vocabulary, a differ-

ent alphabet, but you learn how to read them. Igneous rocks tell you the temperature at which they changed from the molten to the solid state, and they tell you the date when that happened, and hence they give you a picture of the earth at that time, whether they formed three thousand million years ago or flowed out of the ground yesterday. In sedimentary rock, the colors, the grain sizes, the ripples, the crossbedding give you clues to the energy of the environment of deposition—for example, the force and direction and nature of the rivers that laid down the sediments. Tracks and trails left by organisms—and hard parts of their bodies, and flora in the rock—tell whether the material came together in the ocean or on the continent, and possibly the depth and temperature of the water, and the temperature on the land. Metamorphic rocks have been heated, compressed, and recrystallized. Their mineral composition tells you if they were originally igneous or sedimentary. Then they tell you what happened later on. They tell you the temperatures when they changed. At one point, I wanted to major in history. My teachers steered me into science, but I really majored in history. I grew up in topography like this, believe it or not. Looking at these lakes and hills, you'd never think of Brooklyn. For that matter, you'd never think of Indiana. I didn't know what bedrock meant. I remember how amazed I was to discover, in learning to read rocks, how much history there was. All the glacial stuff arrived just yesterday and is sitting on the surface. Most of Brooklyn is a pitted outwash plain. Brooklyn means broken land."

A day would come when I would pick up Anita Harris at the home of a cousin of hers in Morganville, New Jersey, and drive across the Narrows Bridge to Brooklyn. She had not seen her neighborhood for twenty-five years. Her cousin, Murray Srebrenick, who gave us coffee before we left, was more than a little solicitous toward us, and even somewhat embarrassed, as if he were in the presence of people with an uncorrectable defect. He, too, had grown up in

Brooklyn, and now, as an owner and operator of trucks, he supported his suburban life hauling clothes to Seventh Avenue. On runs through the city to various warehouses, he and his drivers knew what routes to avoid, but often enough they literally ran into trouble. Crime was part of his overhead, and as he rinsed the coffee cups he finally came out with what he was thinking and pronounced us insane. He spoke with animation, waving a pair of arms that could bring down game. Old neighborhood or no old neighborhood, he said, he would not go near Williamsburg, or for that matter a good many other places in Brooklyn; and he reeled off stories of open carnage that might have tested the stomach of the television news. I wondered what it might be like to die defending myself with a geologist's rock hammer. Anita, for her part, seemed nervous as we left for the city. Twenty-five years away, she seemed afraid to go home.

It was an August day already hot at sunrise. "In Williamsburg, I lived at 381 Berry Street," she said as we crossed the big bridge. "It was the worst slum in the world, but the building did have indoor plumbing. Our first apartment there was a sixth-floor walkup. The building was from the turn of the century and was faced with red Triassic sandstone." Brooklyn was spread out before us, and Manhattan stood off to the north, with its two sets of skyscrapers three miles apart—the ecclesiastical spires of Wall Street, and beyond them the midtown massif. Anita asked me if I had ever wondered why there was a low saddle in the city between the stands of tall buildings.

I said I had always assumed that the skyline was shaped by human considerations—commercial, historical, ethnic. Who could imagine a Little Italy in a skyscraper, a linoleum warehouse up in the clouds?

The towers of midtown, as one might imagine, were emplaced in substantial rock, Anita said—rock that once had been heated near the point of melting, had recrystallized, had been heated again, had recrystallized, and, while not particularly competent, was more than adequate to hold up those buildings. Most important, it was right at the surface. You could see it, in all its micaceous glitter, shining like silver in the outcrops of Central Park. Four hundred and fifty million years in age, it was called Manhattan schist. All through midtown, it

was at or near the surface, but in the region south of Thirtieth Street it began to fall away, and at Washington Square it descended abruptly. The whole saddle between midtown and Wall Street would be underwater, were it not filled with many tens of fathoms of glacial till. So there sat Greenwich Village, SoHo, Chinatown, on material that could not hold up a great deal more than a golf tee—on the ground-up wreckage of the Ramapos, on crushed Catskill, on odd bits of Nyack and Tenaflly. In the Wall Street area, the bedrock does not return to the surface, but it comes within forty feet and is accessible for the footings of the tallest things in town. New York grew high on the advantage of its hard rock, and, New York being what it is, cities all over the world have attempted to resemble it. The skyline of nuclear Houston, for example, is a simulacrum of Manhattan's. Houston rests on twelve thousand feet of montmorillonitic clay, a substance that, when moist, turns into mobile jelly. After taking so much money out of the ground, the oil companies of Houston have put hundreds of millions back in. Houston is the world's foremost city in fat basements. Its tall buildings are magnified duckpins, bobbing in their own mire.

We skirted Brooklyn on the Belt Parkway, heading first for Coney Island, where Anita had spent many a day as a child, and where, somewhat impatiently, she had been born. Her mother, seven months pregnant, took a subway to the beach one day, and Anita first drew breath in Coney Island Hospital.

"Cropsey Avenue," she said now, reading a sign. "Keep right, we're going off here."

I went into the right lane, signals blinking, but the exit was chocked with halted traffic. There were police. There were flashing lights. Against the side of an abused Pontiac, a young man was leaning palms flat, like a runner stretching, while a cop addressed him with a drawn pistol. "Welcome home, Anita," said Anita.

The broad beach was silent, so early in the morning, where people in ten thousands had been the day before, and where numbers just as great would soon return. The Parachute Jump stood high in relief. The Cyclone was in shadow and touched by slanting light. Reminiscently, Anita ran her eye from the one to the other and to the elevated railways beyond. When a fossil impression is left in sand by the outside of an organic structure, it is known in geology as an

external mold. One would not have to be a sedimentologist to read this beach, with its colonies of giant bivalves. We walked to the strandline, the edge of the water, where the play of waves had concentrated heavy dark sands—hematite, magnetite, small garnets broken out by the glacier from their matrix of Manhattan schist.

The beach itself, with its erratic sands, was the extremity of the outwash plain. The Wisconsin ice sheet, arriving from the north, had come over the city not from New England, as one might guess, but primarily from New Jersey, whose Hudson River counties lie due north of Manhattan. Big boulders from the New Jersey Palisades are strewn about in Central Park, and more of the same diabase is scattered through Brooklyn. The ice wholly covered the Bronx and Manhattan, and its broad snout moved across Astoria, Maspeth, Williamsburg, and Bedford-Stuyvesant before sliding to a stop in Flatbush. Flatbush was the end of the line, the point of return for the Ice Age, the locus of the terminal moraine. Water poured in white tumult from the melting ice, carrying and sorting its freight of sands and gravels, building the outwash plain: Bensonhurst, Canarsie, the Flatlands, Coney Island. When Anita was a child, she would ride the D train out to Coney Island, with an old window screen leaning against her knees. She sifted the beach sand for lost jewelry. In the beach sand now, she saw tens of thousands of garnets. There is a lot of iron in the Coney Island beach as well, which makes it tawny from oxidation, and not a lot of quartz, which would make it white. The straw-colored sand sparkled with black and silver micas—biotite, muscovite—from Fifth Avenue or thereabouts, broken out of Manhattan schist. A beach represents the rock it came from. Most of Coney Island is New Jersey diabase, Fordham gneiss, Inwood marble, Manhattan schist. Anita picked up some sand and looked at it through a hand lens. The individual grains are characteristically angular and sharp, she said, because the source rock was so recently crushed by the glacier. To make a well-rounded grain, you need a lot more time. Weather and waves had been working on this sand for fifteen thousand years.

If the gneissic grains and garnets were erratics, so in their way were the Schenley bottles, the Pepsi-Cola cans, the Manhattan Schlitz, the sand-coated pickles and used paper plates.

"Colonial as penguins, dirtier than mud daubers," I observed of the creatures of the beach.

"We rank with bats, starlings, and Pleistocene sloths as the great messmakers of the world," said Anita, and we left Coney Island for Williamsburg.

North over the outwash plain we followed Ocean Parkway five miles—broad, tree-lined Ocean Parkway, with neat houses in trim neighborhoods, reaching into shaded streets. Ahead, all the while, loomed the terminal moraine, suggesting, from a distance, an escarpment, but actually just a fairly steep hill. Eastern Parkway defines its summit, two hundred feet high. Two hundred feet of till. Near Prospect Park you begin to climb. One moment you are level on the plain and the next you are nose up, gaining altitude. There are cemeteries in every direction: Evergreens Cemetery, Lutheran Cemetery, Mt. Carmel, Cypress Hills, Greenwood Cemetery—some of the great necropolises of all time, with three million under sod, moved into the ultimate neighborhood, the terminal moraine. "In glacial country, all you have to do is look for cemeteries if you want to find the moraine," Anita said. "A moraine is poor farmland—steep and hummocky, with erratics and boulders. Yet it's easy ground to dig in, and well drained. An outwash plain is boggy. There's a cemetery over near Utica Avenue that's in the outwash. Most people prefer moraine. I would say it's kind of distasteful to put your mother down into a swamp."

Ebbets Field, where they buried the old Brooklyn Dodgers, was also on the terminal moraine. When a long-ball hitter hit a long ball, it would land on Bedford Avenue and bounce down the morainal front to roll toward Coney on the outwash plain. No one in Los Angeles would ever hit a homer like that.

We detoured through Prospect Park, which is nestled into the morainal front and is studded with big erratics on raucously irregular ground. It looks much like Pokagon Park, in Indiana, with the difference that the erratics there are from the Canadian Shield and these were from the New Jersey Palisades. Pieces of the Adirondacks have been found in Pennsylvania, pieces of Sweden on the north German plains, and no doubt there is Ticonderoga dolomite, Schenectady sandstone, and Peekskill granite in the gravels of Canarsie and the sands of Coney Island. But such distant transport, while it

characterizes continental ice sheets wherever they have moved, accounts for a low percentage of the rock in glacial drift. The glacier cuts and fills. Continuously, it plucks up material and sets it down, plucks it up, sets it down. It taketh away, and then it giveth. A diamond may travel from Quebec to Indiana, some dolomite from Lake George to the sea, but most of what is lifted is dropped nearby—boulders from New Jersey in Prospect Park.

"Glacial geology is simple to deal with," Anita said, "because so much of what the glacier created is preserved. Also, you can go places and see the same processes working. You can go to Antarctica and see continental glaciation. There's alpine glaciation in Alaska."

This warm clear summer day was now approaching noon, and Prospect Park was quiet and unpeopled. It was all but deserted. Anita as a child had come here often. She remembered people and picnics everywhere she looked, none of this ominous silence. "I suppose it isn't safe," she said, and we moved on toward Williamsburg.

As we drew close, she became even more obviously nervous. "They tell me it's just the worst slum in the world now," she said. "I don't know if I should tell you to roll up all the windows and lock the doors."

"We would die of the heat."

"This is a completely unnatural place," she went on. "It's a totally artificial environment. Cockroaches, rats, human beings, and pigeons are all that survive. At Brooklyn College, my instructors had difficulty relating geology to the lives of people in this artificial world. In the winter, maybe you froze your ass off waiting for the subway. Maybe that was a way to begin discussing glaciation. In the city, let me tell you, no one knows from geology."

We went first to her high school. It appeared to be abandoned and was not. It was a besooted fortress with battlements. Inside were tall cool hallways that smelled of polish and belied the forbidding exterior. She had walked the halls four years with A's on her report cards and been graduated with high distinction at the age of fifteen. We went to P.S. 37, her grade school. It was taller than wide and looked like an old brick church. It was abandoned, beyond a doubt—glassless and crumbling. Trees of heaven, rooted in the classroom floors, were growing out the windows. Anita said,

"At least I'm glad I saw my school, I think, before they take it away."

We came to Broadway and Berry Street, and now she had before her for the first time in twenty-five years the old building where she had lived. It was a six-story cubical tenement, with so many fire escapes that it seemed to be faced more with iron than with the red Triassic stone. Anita looked at the building in silence. Usually quick to fill the air with words, she said nothing for long moments. Then she said, "It doesn't look as bad as it did when I lived here."

She stared on at the building for a while before speaking again, and when she did speak the nervousness of the morning was completely gone from her voice. "It's been sandblasted," she said. "They've cleaned it up. They've put a new facing on the lower stories, and they've sandblasted the whole building. People are wrong. They're wrong in what they tell me. This place looks cleaner than when I lived here. The whole neighborhood still looks all right. It hasn't changed. I used to play stickball here in the street. This is my neighborhood. This is the same old neighborhood I grew up in. I'm not afraid of this. I'm getting my confidence up. I'm not afraid."

We moved along slowly from one block to another. A young woman crossed the street in front of us, pushing a baby carriage. "She's wearing a wig, I promise you," Anita said. "Her head may be shaved." Singling out another woman among the heterogeneous people of the neighborhood, she said, "Look. See that woman with the turban? She has her hair covered on purpose. They're Chassidic Jews. Their hair is shaved off or concealed so they will not be attractive to passing men." There was a passing man with long curls hanging down either side of his head—in compliance with a dictum of the Pentateuch. "Just to be in the streets here is like stepping into the Middle Ages," Anita said. "Fortunately, my parents were not religious. I would have thought these people would have moved out of here long ago. Chassidic Jews are not all poor, I promise you. Their houses may not look like much, but you should see them inside. They're diamond cutters. They handle money. And they're still here. People are wrong. They are wrong in what they have told me."

We went out of the noon sun into deep shade under the Wil-

liamsburg Bridge, whose immense stone piers and vaulting arches seemed Egyptian. She had played handball under there when she was a girl. "There were no tennis courts in this part of the world, let me tell you." When the boys went off to swim in the river, she went back to Berry Street. "Me? In the river? Not me. The boys swam nude."

In the worst parts of summer, when the air was heavy and the streets were soft, Anita went up onto the bridge, climbing to a high point over the river, where there was always a breeze. Seven, eight years old, she sat on the pedestrian walk, with her feet dangling, and looked down into the Brooklyn Navy Yard. The Second World War was in full momentum. U.S.S. Missouri, U.S.S. Bennington, U.S.S. Kearsarge—she saw keels going down and watched battleships and carriers grow. It was a remarkable form of entertainment, but static. Increasingly, she wondered what lay beyond the bridge. One day, she got up the courage to walk all the way across. She set foot on Manhattan and immediately retreated. "I wanted to go up Delancey Street, but I was too scared."

Next time, she went up Delancey Street three blocks before she turned around and hurried home. In this manner, through time, she expanded her horizons. In the main, she just looked, but sometimes she had a little money and went into Manhattan stores. About the only money she ever had she earned returning bottles for neighbors, who gave her a percentage of the deposit. Her idea of exceptional affluence was a family that could afford fresh flowers. Her mother was a secretary whose income covered a great deal less than the family's needs. Her father was a trucker ("with a scar on his face that would make you think twice"), and his back had been broken in an accident. He would spend three years in traction, earning nothing. Gradually, Anita's expeditions on foot into Manhattan increased in length until she was covering, round trip, as much as twelve miles. Her line of maximum advance was somewhere in Central Park. "That's as far as I ever got. I was too scared." Going up the Bowery and through the East Village, she had no more sense of the geology than did the men who were lying in the doorways. When she looked up at the Empire State Building, she was unaware that it owed its elevation to the formation that outcropped in Central Park; and when she saw the outcrops there, she did not wonder why, in the

moist atmosphere of the American East, those great bare shelves of sparkling rock were not covered with soil and vegetation. In Wyoming, wind might have stripped them bare, but Wyoming is miles high and drier than the oceans of the moon. Here in the East, a river could wash rock clean, but this rock was on the high ground of an island, far above flood and tide. She never thought to wonder why the rock was scratched and grooved, and elsewhere polished like the foyer of a bank. She didn't know from geology.

In Brooklyn College, from age fifteen onward, she read physics, mineralogy, structural geology, igneous and metamorphic petrology. She took extra courses to the extent permitted. To attend the college she had to pay six dollars a semester, and she meant to get everything out of the investment she could. There were also lab fees and breakage fees. Breakage fees, in geology, were not a great problem. Among undergraduate colleges in the United States, this one was relatively small, about the size of Harvard, which it resembled, with its brick-and-white-trim sedate Colonial buildings, its symmetrical courtyards and enclosed lawns; and like Harvard it stood on outwash. Brooklyn College is in south Flatbush, seaward of the terminal moraine. When Anita was there, in the middle nineteen-fifties, there were so many leftists present that the college was known as the Little Red Schoolhouse. She did not know from politics, either. She was in a world of roof pendants and discordant batholiths, elastic collisions and neutron scatteration, and she branched out into mineral deposits, field mapping, geophysics, and historical geology, adding such things to the skills she had established earlier in accounting, bookkeeping, typing, and shorthand. It had been assumed in her family that she would be a secretary, like her mother.

Now when she goes up Fifth Avenue—as she did with me that summer day—she addresses Fifth Avenue as the axis of the trough of a syncline. She knows what is underfoot. She is aware of the structure of the island. The structure of Manhattan is one of those paradoxes in spatial relations which give geologists especial delight and are about as intelligible to everyone else as punch lines delivered in Latin. There is a passage in the oeuvre of William F. Buckley, Jr., in which he remarks that no writer in the history of the world has ever successfully made clear to the layman the principles of

celestial navigation. Then Buckley announces that celestial navigation is dead simple, and that he will pause in the development of his present narrative to redress forever the failure of the literary class to elucidate this abecedarian technology. There and then—and with intrepid, awesome courage—he begins his explication; and before he is through, the oceans are in orbit, their barren shoals are bright with shipwrecked stars. With that preamble, I wish to announce that I am about to make perfectly clear how Fifth Avenue, which runs along the high middle of a loaf of rock that lies between two rivers, runs also up the center of the trough of a syncline. When rock is compressed and folded, the folds are anticlines and synclines. They are much like the components of the letter S. Roll an S forward on its nose and you have to the left a syncline and to the right an anticline. Each is a part of the other. Such configurations in rock compose the structure of a region, but will not necessarily shape the surface of the land. Erosion is the principal agent that shapes the surface of the land; and erosion—particularly when it packs the violence of a moving glacier—can cut through structure as it pleases. A carrot sliced the long way and set flat side up is composed of a synclinal fold. Manhattan, embarrassingly referred to as the Big Apple, might at least instructively be called the Big Carrot. River to river, erosion has worn down the sides, and given the island its superficial camber. Fifth Avenue, up on the high ground, is running up the center of a synclinal trough.

On the upper West Side that afternoon, Anita drew her rock hammer and relieved Manhattan of some dolomite marble, which she took from an outcrop for its relevance to her research in conodonts. She found the marble “overcooked.” She said, “To get that kind of temperature, you have to go down thirty or forty thousand feet, or have molten rock nearby, or have a high thermal gradient, which can vary from place to place on earth by a factor of four. This marble is so cooked it is almost volatilized. This—you better believe—is hot rock.” At Seventy-second Street and West End Avenue, she stopped to admire a small apartment building whose façade, in mottled greens and black, was elegant with serpentine. On Sixty-eighth Street between Fifth and Madison, she was impressed by a house of gabbro, as anyone would be who had spent a childhood emplaced like a fossil in Triassic sand. It was a house of great wealth,

the house of gabbro. Up the block was a house of granite, even grander than the gabbro, and beyond that was a limestone mansion so airily patrician one feared it might dissolve in rain. Anita dropped acid on it and watched it foam.

Jack Epstein, Anita’s northern-Appalachian geologist, went to Brooklyn College, too, and subsequently enrolled in the master’s program at the University of Wyoming. Anita tried to follow, in 1957, but the geology department in Laramie offered no fellowships for first-year graduate students. (“I needed money. I didn’t have a pot to cook in.”) She looked into places like Princeton, with geology departments outstanding in the world, but they were even less receptive than Wyoming. In those days, Princeton would not have admitted a woman had she been a direct descendant of Sir Charles Lyell offering as tuition her weight in gems. Anita applied to ten schools in all. The best offer came from Indiana University, in Bloomington, where her professors were soon much aware of her as an extremely bright and aggressive student with the disconcerting habit of shaking her head while they talked, as if to say no, no, no, no, you cratonic schnook, you don’t know from nothing. Something of the sort was not always far from her thoughts. (“I am not a very orthodox geologist. I do buy some dogma, if I think it’s common sense.”)

Bloomington stood upon Salem limestone, which, in the terminology of the building trade, makes beautiful “dimension stone,” and is cut to be the cladding of cities. It formed from lime mud in the Meramecian age of middle Mississippian time—between 348 and 340 million years before the present—when Bloomington was at the bottom of a shallow arm of the transgressing ocean, an epicratonic sea. “You people in New York may have your Empire State Building,” a professor pointed out to Anita. “But out here we have the hole in the ground it came from.”

Anita and Jack Epstein were married in 1958, and, with their