CHAPTER 3

The Myth of Inevitability

Picture a gusher. Microorganisms have photosynthesized solar radiation. They and the zooplankton who preyed on them have died and fallen to anoxic depths. Then, over scores of millions of years, sediment has buried this organic matter and subjected it to pressure and heat, baking it into hydrocarbons. Eventually, pressure has forced the substance upward again and, ultimately, into the drillable strata, from whence it may gush. That black fountain crystallizes all the economic, social, and psychological dramas of petroleum into one vivid image (Ziser 2011, 321). Recall, if you have seen it, *Giant*, the 1956 epic film of the Texas oil patch. Petroleum rains down sensually on James Dean, transforming him from a lowlife punk into the crassest tycoon. Today, blowout preventers almost always throttle such spills. Still, the gusher maintains a presence in the assumptions, terms, and measurements of oil firms. Experts describe the commodity's path as a "stream." Hydrocarbons extracted upstream descend to midstream refining and downstream finishing as plastics or fuels. Gravity—one might imagine—pulls oil to its destination. The industry does not even refer to its business as "extraction." "That is what mining companies do," explained one executive in Trinidad, shocked that I would confuse his business with such a nasty affair. An offshore platform, he explained, "produces" oil in the way one might produce a fork from the kitchen drawer. The company brings forth materials that seemingly belong on the planet's surface. One doesn't need—in the fashion of miners—to go down there personally and haul them up. Another term illustrates this sense of modest effort. An oil and gas company "recovers" hydrocarbons, if they are "recoverable," or employs "secondary recovery" to acquire stocks previously considered "unrecoverable." Oil virtually produces itself. Most of it seeps around caprocks—tellingly denoted as "traps"—and rises to the surface. The same Trinidadian expert assured me that 95 percent of it had come up naturally over geological time. He felt duty-bound to bring home the rest. Otherwise—to use the final bit of lingo—hydrocarbons currently impossible to produce remain "stranded" (Bridge 2004, 396). Oil and gas, in short, come up alone, ascend in a rescue operation, or await a delayed release, which is both right and inevitable. Where is the space for deliberation—for conscience—in this seemingly natural plot?

Skeptics do pose two sorts of challenges, a constraint related to supply and another related to pollution. According to the first objection, stocks are limited. Organic matter must bake under pressure and natural radiation for millions of years to become bitumen or asphalt, longer to become petroleum, and longer still to become gas. At a very slow rate of consumption, hydrocarbons are renewable. But industrial societies have exceeded that geological pace by orders of magnitude. Everyone in the industry understands this fact. Only a handful of amateur geologists believe in rapid oil generation, and they clamor ineffectually from the sidelines. Still, this ultimate limit on supply is easy to ignore. It seems too far out—rather like the way in which the sun's finite nuclear fuel limits agriculture. Those concerned about oil supplies notice a proxy variable for dwindling supplies: effort and expense. As companies remove oil from the earth's crust, it becomes harder and harder to find more. In this view, ultradeep drilling, hydrofracking, and tar sands all signal physical and financial strain and the beginning of the end.[1] Are the 1962 predictions of M. King Hubbert coming true? Hubbert anticipated a moment when the rate of extracting hydrocarbons would fall below the rate of locating new sources. The United States passed this point of "peak oil" in the 1970s.[2] The world may have already passed it. For various reasons—particularly centering on unaudited logs of Saudi Arabia's huge Ghawar Field—peak oil seems to be unverifiable (Simmons 2005). Past the peak, oil producers and consumers will descend into a "long emergency" of squabbling over scarce, expensive hydrocarbons. Amid wars, life becomes nasty, brutish, and short (Kunstler 2005; Roberts 2004).

The second limit on production raises a similar specter of decline and strife. This constraint—which I call the "climate boundary"—also depends on a mismatch of rates. Oceans, forests, and soils can fix in biomass and otherwise neutralize a certain amount of atmospheric carbon dioxide per year. Humans could burn hydrocarbons at a stately, sustainable pace.

Current combustion, however, substantially exceeds that rate, threatening to overwhelm stabilizing mechanisms and throw the climate into accelerating shifts. In 2007, the Intergovernmental Panel on Climate Change established a warming of 2°C, leveling off in 2050, as the maximum tolerable level. By tolerable, they meant something less than comfortable: atoll states would disappear. Warming beyond 2°C would inundate the far more populated coastlines of South and Southeast Asia. How much oil can industrial societies burn before provoking such human misery and death? In a 2012 article titled "Global Warming's Terrifying New Math," the activist Bill McKibben compared the carbon content of the world's proven reserves fossil fuels with the climate boundary. "We have five times more oil and coal and gas on the books," McKibben concludes, "[than] the climate scientists think is safe to burn."[3] The world will run out of storage space for burned hydrocarbons long before it runs out of hydrocarbons themselves. The sink, in other words, limits industry more severely than does the supply. Again, this diagnosis is not widely disputed—except by deniers of climate change itself. Within energy firms, their influence is both waning and redundant. The industry has found other ways to insist upon the banal inevitability of oil despite and beyond the threshold of safety.

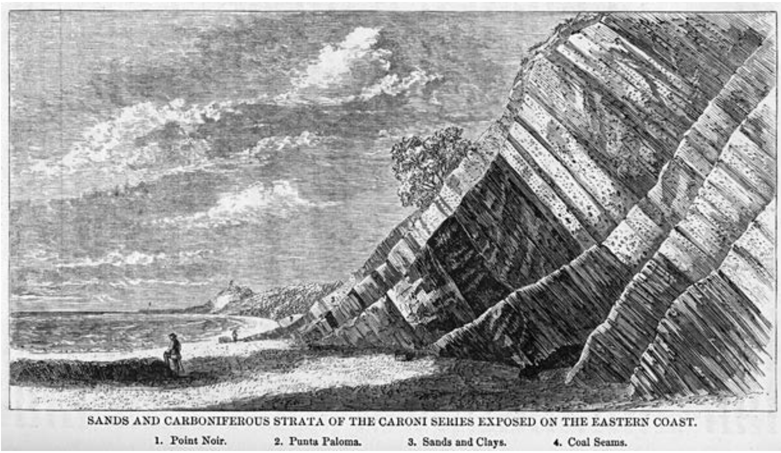
Those arguments surround the silence of complicity. Myths of oil circumscribe, delimit, and obscure the moral reckoning with hydrocarbons and climate change. They always found something more pressing: oil to be located. In large part, diagrams made this choice of priorities, and the evacuation of conscience, appear normal. Geologists picture the underground in ways that suggest permanent, inevitable flows. This simplified view of the world resembles other notions of capitalist growth and technological advance: it depends upon particular ways of seeing.[4] Among Trinidad's oil experts, I investigated the charts and their dissemination. For a century and half, geology had emphasized the dynamic quality of the earth's crust. Substances at depth rose—if not in the past, then now, and if not now, then later. In the lifetime of my informants, geologists had married this model of upward flows to the economic scenarios of supply and demand. Hydrocarbons, they had come to assume, left the ground and entered the global market in one natural, entirely ordinary progression. To provoke conscience, I occasionally cornered people in conversation. "Fuck you, no apologies, oil is here to stay," they might have shouted, as ExxonMobil apparently did to one observer.[5] Fortunately, my West Indian informants spoke more politely and, indeed, cared about climate change. Yet even their efforts to reduce carbon emissions actually produced more oil—and more carbon emissions. It could not be otherwise, they assured me.

Making the Y-Axis

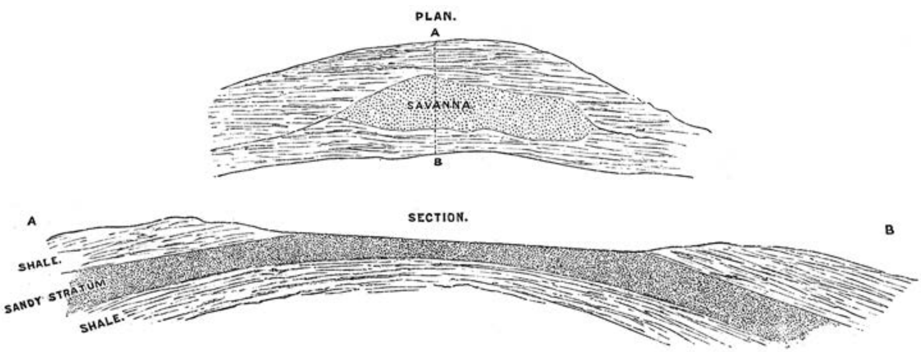
Geology is a science of vertical movement. The things that move are huge and heavy and move very slowly. So says the uniformitarian theory, published in 1830 by the Scotsman Charles Lyell. In some ways, such gradualism defies belief more than did the earlier catastrophist notions of rapid, biblical creation, flooding, and so on. To follow the vertical movement of continents, one must inhabit what the environmental writer John McPhee (1980) calls "deep time." Over millions of years, eroded sediments may turn a floodplain into a plateau. One plate will dive down, deflecting its adjacent plate upward. Describing these acts of elevation requires an otherworldly lexicon: Holocene, Pleistocene, Pliocene, Miocene, Oligocene, Eocene, and so on going back to Earth's pre-Cambrian beginning as a lifeless, cooling moon of the sun. The communicative art of geology lies in making this deep time comprehensible without, at the same time, utterly dispelling its strangeness. Verticality helps strike that balance. The amateur may more easily grasp a thousand feet than a million years. The up-and-down axis, in fact, compresses time. Then, superposition—the principle that layers fall sequentially upon one another—translates descending distance into antiquity and shallowness into newness. Geologists distinguish strata as upper and lower and periods as late and early, but, as often as not, they interchange the terms. The past stretches as an arrow piercing the heart of the earth. One need not imagine much to extend that arrow into the future—as thrusting, gushing, and seeping movements up through and out of the crust. The pressures of profit can easily bake geology into such a predictive belief. In this way, Trinidad and other oil crucibles produced what one might call a vernacular science of hydrocarbon uplift. As in many technical fields, petro experience affords little space for alternatives and less for the most challenging ethical questions.

That amoral vernacular is more visual than linguistic. It relies upon images of deep time, in whose invention the small island of Trinidad played an outsized role. This "visual language for geological science" emerged in the course of the nineteenth-century uniformitarian revolution (Rudwick 1976). At midcentury, Britain's Geological Survey applied that theory to "see geologically" in Canada and elsewhere in the empire (Braun 2000, 22; Stafford 1990). To Trinidad, the survey sent geologist George Wall, accompanied by the artist Jas Sawkins. Their 1860 report made use of two newly available diagrammatic forms: the cliff face and the traverse section.[6] In the first of these techniques, Sawkins simply set his sketch pad on the beach—probably close to present-day Radix on Trinidad's east coast—and reproduced the strata he saw. Although he surely overemphasized the boundaries between rock types, his drawing reproduced the original proportions of strata, scaled against the human form at water's edge (figure 3.1). The cross section, by contrast, took more liberties with the landscape. Consider Sawkins's section of the Pitch Lake (figure 3.2). Neither he nor Wall ever saw any such sandwich of shale, sand, and shale. Rather, as Rudwick (1976, 164) writes, the cross section conducts a "thought-experiment," proposing how the landscape might appear if sliced vertically. Note the absence of any scale in the section, an omission that suggests this hypothetical quality. The geological report did not include a columnar section, the third type of vernacular image. Rather than depicting a particular place, this kind of cross section aggregates and interpolates geological layers. In 1912, Edward Hubert Cunningham-Craig published one of the earliest such diagrams related to Trinidad. This British early petro-geologist studied the Pitch Lake as well as similar outcrops in the nascent oilfields of Burma and Persia. Pictographically, he inserted a "Cretaceous inlier" (from 144–66 million years ago) beneath younger sediments bearing "manjak," a local bitumen variety (figure 3.3). From top to bottom, in other words, the cross section descends in reverse chronological order. Time ran parallel with depth.

During the first three quarters of the twentieth century, British and American scientists both found more oil in Trinidad and drew increasingly refined sections of it. Especially in the heyday of the 1950s, detailed traverse sections represented the high art of exploration. They converted abstract space into known places (Carter 1987, xxiii). A 1958 rendition of the East Penal field—by Peter Bitterli of Shell—catches the eye more



3.1 Wall and Sawkins's diagram of a cliff face, 1860.



3.2 Wall and Sawkins's traverse section of the Pitch Lake, 1860.

than any other (figure 3.4). As depicted, an unconformity of overthrusting Eocene shale traps petroleum in Herrera sands. Then, descending from the upper left, oil wells puncture that caprock and release the hydrocarbons. This and other columnar sections guided the drill bit in a conceptual fashion: charts created a geological and economic abstraction. Let's consider a drawing first published in 1958 by a threesome of geologists at the major firms on the island. Titled "Summarized Miocene Stratigraphy of Southern Trinidad," the graph represents rock formations as horizontal layers associated with prehistoric eras. Columns refer to regions of Trinidad, from southwest to southeast (figure 3.5). "Miocene stratigraphy," the

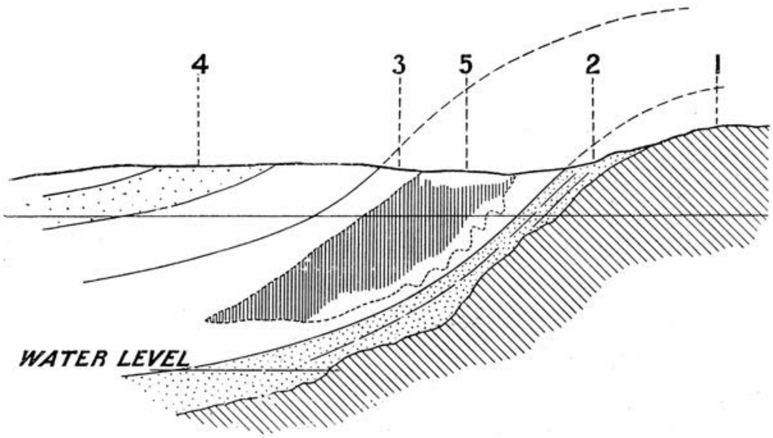
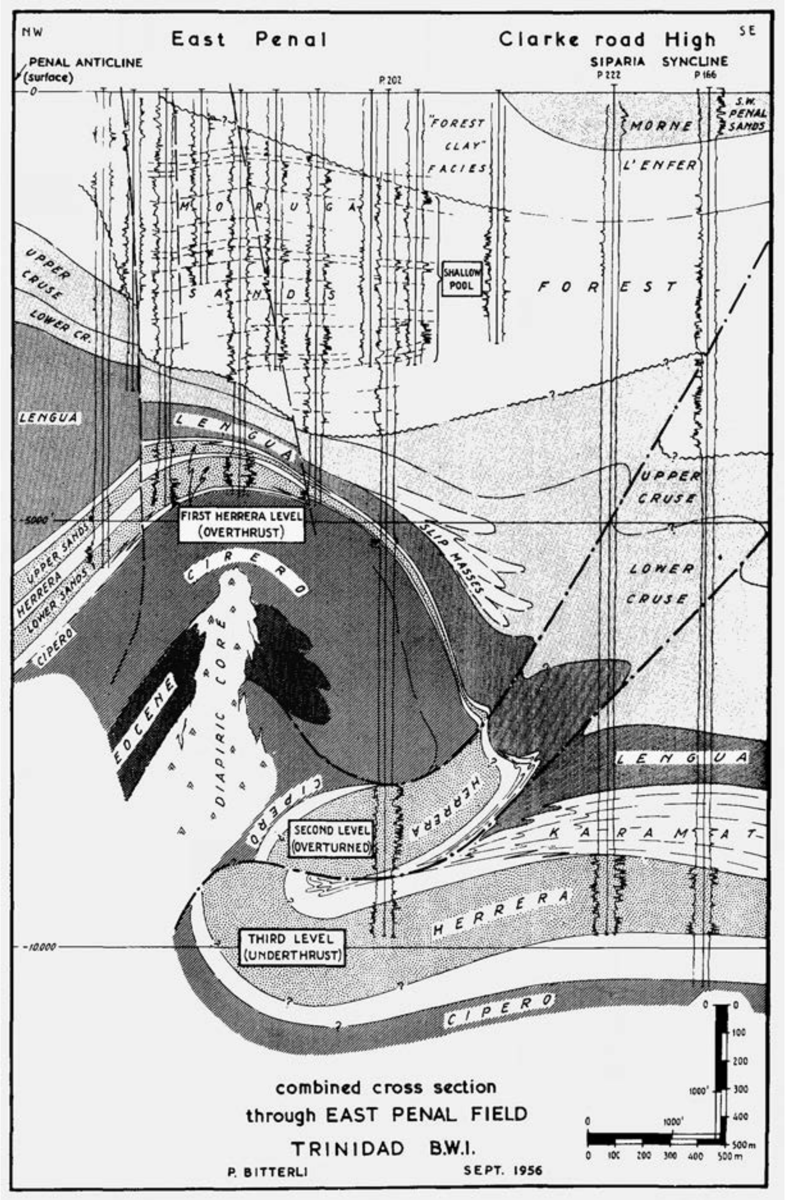


Fig. 8.—Diagram illustrating mode of occurrence of Manjak veins in Trinidad (San Fernando Field). 1. Cretaceous inlier; 2. Oil-bearing sand; 3. Clay; 4. Sandstone; 5. Zone containing Manjak veins.

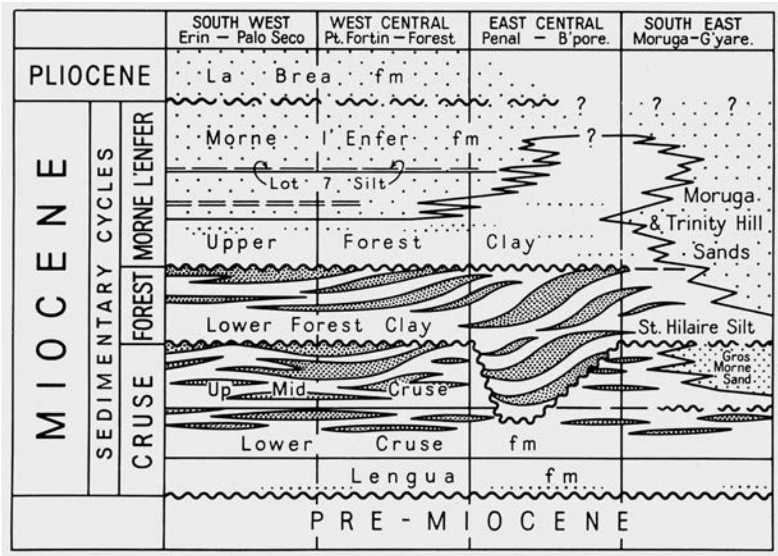
3.3 Cunningham-Craig's columnar section, 1912.

authors indicate, "is essentially a clay-silt-sand sequence which is divided into three major sedimentary cycles, separated by local unconformities" (Barr, Wait, and Wilson 1958, 536). Those unconformities—which might twist and turn bizarrely—appear nowhere in the summarized stratigraphy. Summary required excluding them. Indeed, it required bringing all the data into conformity with a linear time-depth axis. Barr and his colleagues flattened the undulating underground topography to show the past simply as depth. The y-axis was time, and—when implied in traverse sections—the vectors pointed up. Taken together, these works of 1958 show oil in ancient layers and oil rising more recently through layers. Petroleum geology thus mastered the art of describing and depicting upward migration.

In Trinidad and Tobago, no contemporary geologist has represented this verticality with greater expertise or enthusiasm than Krishna Persad. Following independence, his generation took over from the geologists of British and American firms. Texaco, in fact, gave Persad a scholarship to study chemistry in the 1960s. Midway through his doctorate, he switched to geology, and this combination of disciplines has arguably made him the island's most successful independent oil producer. Not merely a businessman, Persad founded the Geological Society of Trinidad and Tobago.

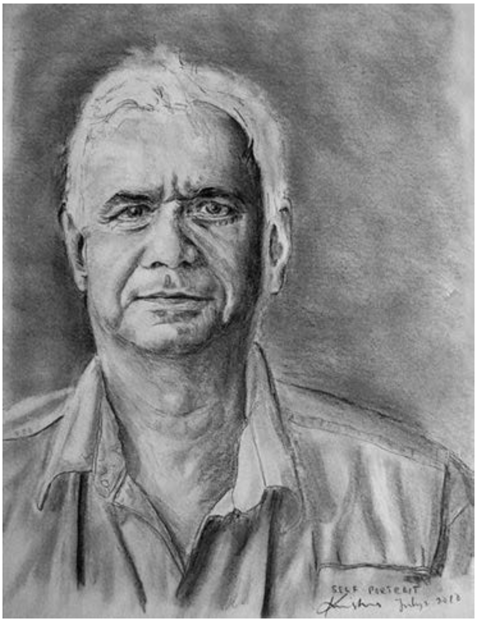


3.4 Bitterli's combined cross section, 1958. AAPG © 1958. Reprinted with permission of the American Association of Petroleum Geologists (AAPG), whose permission is required for further use.



3.5 Barr, Wait, and Wilson's summarized stratigraphy of southern Trinidad, 1958. AAPG © 1958. From the American Association of Petroleum Geologists (AAPG), whose permission is required for further use.

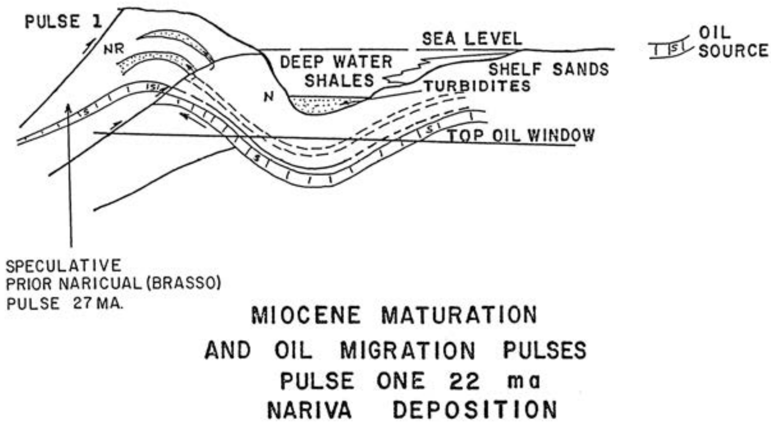
(Virtually all Trini geologists practice petroleum geology.) In his spare time, he travels, paints, and draws (figure 3.6). In 1993, Persad and his wife published *The Petroleum Encyclopedia of Trinidad and Tobago*. The volume reassures readers: "There is little cause to worry [about declining oil supplies] and . . . in fact, we can expect oil production to continue at significant levels for decades to come" (Persad and Persad 1993, 4). In the next two decades, even as Trinidad's oil output fell nearly to zero, Persad compiled the magnum opus proving that it need not be so. In 2011, he completed *The Petroleum Geology and Geochemistry of Trinidad and Tobago*. The volume interprets strata according to plate tectonics—which the geologists of the 1950s had not accepted—and in light of the chemical principle of evaporative fractionation. The charts themselves reproduce earlier work, going back, in fact, to the 1950s. But they also innovate in one key respect: they show the migration of oil. Oil, it is now known, matures from deposited organic matter in formations of between 7,000 and 18,000 feet in depth. This layer is known as the "oil window" (Hyne 1995, 171). From that source rock, petroleum moves upward and laterally, pushed



3.6 Krishna Persad (self-portrait), 2012.

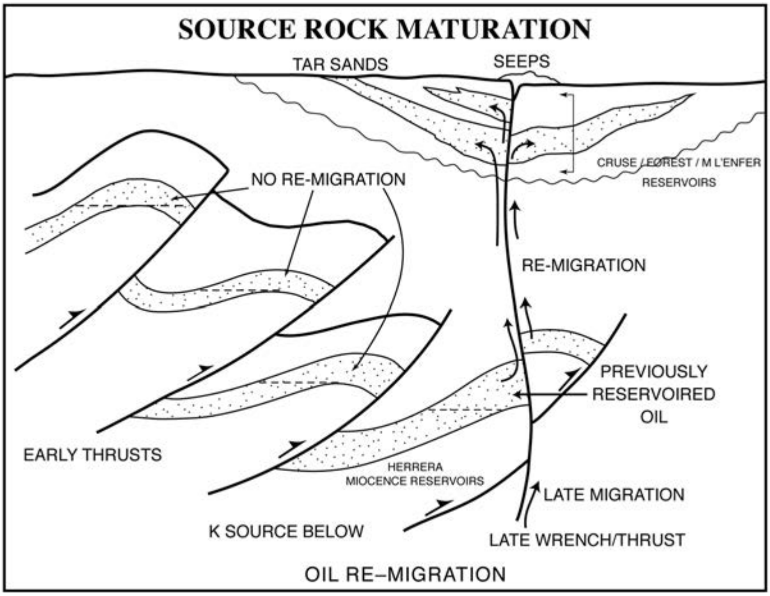
by underground pressure and by gravitational sorting with water. (Oil is lighter than water.) Trinidad, Persad argues, has experienced multiple bursts of tectonic movement and faulting, leading to "oil migration pulses." A characteristic sketch shows petroleum rising along diagonal pathways marked with arrows (left of figure 3.7). Like Bitterli, Persad focused on the unconformities. At the same time, two additional lines recall Barr's summarized stratigraphy: the horizontal line marked "top [of the] oil window" and the vertical arrow labeled "speculative prior . . . pulse." With greater certainty than ever before, Persad's chart gives oil a position and an upward pathway from it. Oil would flow until stopped by a trap. Then, to raise production, oil companies would need only to perforate such rock at the points Persad indicated.

This sense of possibility and optimism brightened my reunion with Persad shortly after the publication of *Petroleum Geology and Geochemistry*. (We knew each other already.) "This is my legacy work," he said of the new book, agreeing to a discounted price that reflected the lean state of public higher education. We talked about oil fractions and the superposition of gas and lighter oil above heavy, waxy crudes. Trinidad was exhaust-



3.7 Persad's oil migration pulses, 2011.

ing the former, but their very existence indicated that dense petroleum still lay deeper. "You could be looking at double, triple the reserves," he exclaimed, as we sat in his home office in South Trinidad.[7] Possessed of a gentle, good-natured humor, Persad frequently slipped between dense science and less scientific buoyancy. We met again the next month—February 2012—in Port of Spain at the Energy Chamber's annual Energy Conference. To the chamber's large membership, Persad presented "Finding Oil in T&T's Unexplored Acreage." The acreage lay below explored strata. "If you drilled deep," he almost pleaded to the suit-attired executives, "you would find black oil." The oil itself was going half the distance. Persad's second slide, titled "Source Rock Maturation," united two concepts usually considered separately: the generation, or maturation, of oil in deep sediments and its later migration into shallower formations (figure 3.8). In the cross section, one pathway took oil all the way to a surface seep. The slide show ended with a note of hope and a surprisingly precise scenario: short-term, medium-term, and longer-term estimates culminated in a "total potential upwards of 3 billion bbls [barrels] recoverable."[8] The geologist's eyes twinkled at the audience. Such confidence, of course, flowed like the liquor at the Energy Conference. Persad enjoyed himself amid the glitter of the Hyatt Hotel. Having once told me any conference was worth going to "if it helps me produce a barrel of oil," he made more petroleum seem guaranteed.



3.8 Persad's migration and maturation of oil, 2012. Prepared by Mike Siegel of Rutgers Cartography Lab.

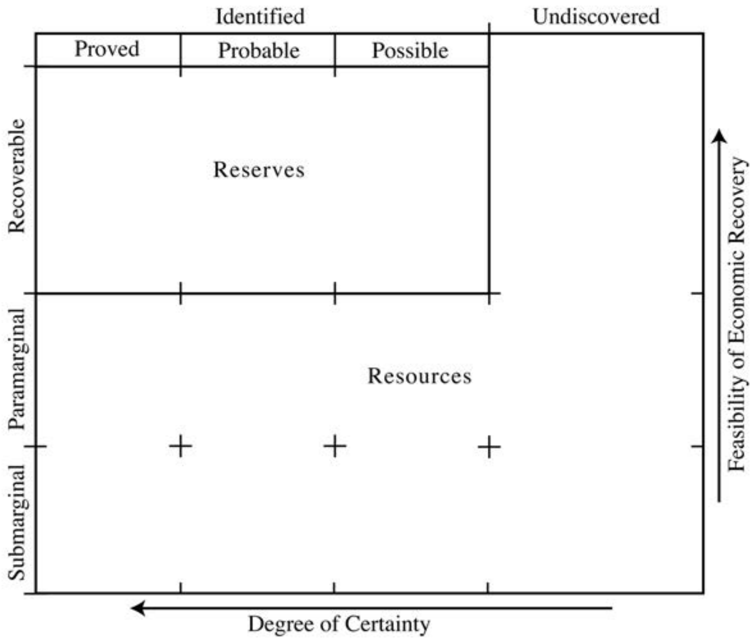
Proving Up

Abundance is not always desirable. Purveyors of goods frequently wish to represent their supplies as scarce, especially to those who might question a high price. Downstream from the wells, manufacturers of plastics or fertilizer are constantly trying to acquire hydrocarbons more cheaply. So too is the car driver, watching numbers dial upward at the gas pump. To these buyers, the oil industry invariably asserts that its commodity is scarce and difficult to obtain. Almost stubbornly, however, oil continually proves to be available. Since at least the 1920s, while producing more and more oil, firms have consciously confronted a problem of surfeit. As they extract oil, they must also "produce scarcity." Or, as Gavin Bridge and Andrew Wood surmise, executives ask themselves, "How [can we] organize scarcity in the face of prodigious abundance" (2010, 565–56)? So-called aboveground risks—such as violence and boycotts—help manufacture scarcity. The Arab Oil Embargo of 1973, two wars against Iraq, and ongoing sanctions against Iran have periodically tightened global hydrocarbon markets artificially. Yet no producer wants altogether to disguise plenty. An industry running out of raw materials has no future. To investors, therefore, oil firms must represent oil as prolific, such that a billion dollars spent on drilling for oil will find oil. The problem, then, centers less on producing scarcity than on telling one story to consumers and another story to investors (Olien and Olien 2000, 137; Chapman 2013, 97). The spokespeople of petroleum must keep their audiences separate and avoid confusing their half-truths. In the 1970s, international bodies devised a set of terms and diagrams that bifurcated their message graphically—into a story about large resources and small reserves. Oil "proved up" from one to the other. That narrative has mostly stuck, persuading the people who need persuading. It unraveled in Trinidad, however, in the late 2000s. There, in a small country, investors and consumers sat in the same room—often as the very same people—and pushed that contradictory message to its limits. Still, they never pushed it far enough to doubt the rightness altogether of oil and gas.

The rhetoric originated with a decision on terminology. In 1926, the American Petroleum Institute (API) formalized a distinction between resources and proved reserves. The former referred to all the oil known to exist while the latter denoted only stocks obtainable at a profit (Wildavsky and Tenenbaum 1981, 171–72). Somewhat counterintuitively, then, reserves lie closer at hand: they are not reserved at all. The profits they bring, of course, depend on conditions. Regulation, factor prices, or high wages might make certain ventures unviable in economic terms. Such ephemeral circumstances vastly complicated the calculation of barrels above and below what came to be known as the "commerciality threshold." Even seemingly stable conditions could shift rapidly as the industry expanded and wells reached deeper, older formations. From its inception, the binary of reserves and resources had to permit the reclassification of oil. Another term, *proving*, conveyed precisely this shift. Again, somewhat at odds with the conventional meaning, the proof referred not to the oil's presence but to its profit margin, or commerciality. An oil company might prove up resources by developing, say, drill bits capable of penetrating harder strata. Here, in fact, the industry borrowed from the language of settler colonialism. The Homestead Act of 1862 obligated newly arrived whites to show "improvements," that is, planting, cultivating, tree cutting, and so on. The government awarded titles to such investors and ejected the others, assumed to be mere land speculators. As oil supplanted agriculture in Texas, Oklahoma, and Southern California, then, new occupiers demonstrated their worthiness in established terms. In Los Angeles, wrote Upton Sinclair in the same year as the API agreement, "Dad . . . had made a big success, and *proved up* a lot of new territory, and was hailed, again as the benefactor of the Prospect Hill field" (1926, 121, emphasis added).

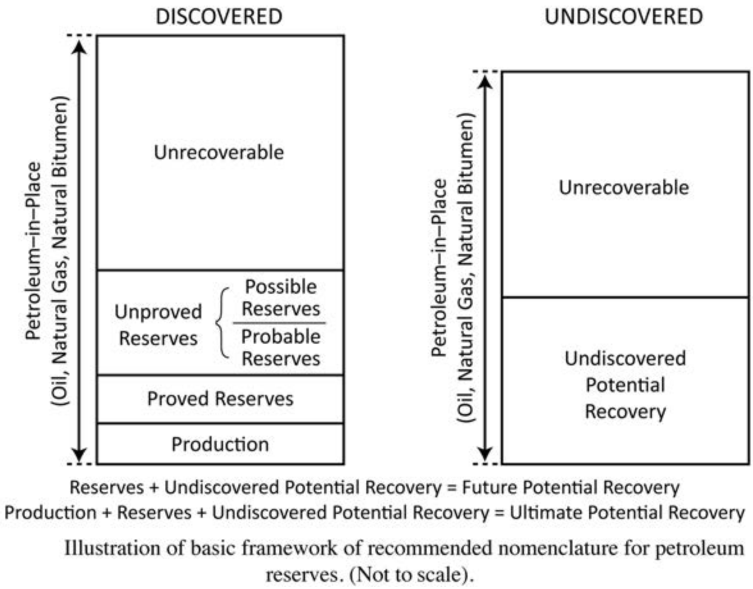
The preposition in this pivotal phrase opened up another field of possibility for graphic representation. Homesteaders proved "up" land in a sense that was mostly metaphorical. That elevation change hinged on modernization, civilization, and other processes imagined as linear. Once the API classification took hold, oil companies proved up petroleum before removing it. In reality, resources became reserves while in the ground. As described in language, however, the geological formation itself climbed the ladder of progress. In all these ways, the word *up* suggested a y-axis, and the API and related institutions eventually charted one. But this search for a visual vernacular encountered more obstacles than in the case of geological cross sections. Oil production depended on two variables that were easily confused: the volume of oil and its commerciality. Even if one could firmly distinguish between these indicators, institutions had to agree on assigning one to the x-axis and the other to the y-axis. After much uncertainty, Vincent McKelvey—a coworker and unstinting critic of Hubbert—provided a workable diagram (Mann 2013). In 1972, as director of the U.S. Geological Survey, McKelvey proposed a "Classification of Mineral Reserves and Resources" (1972, 35; figure 3.9). In his chart, the vertical axis corresponded to commerciality or, in McKelvey's terms, "feasibility of economic recovery." The horizontal axis measured certainty with respect to the existence of oil. This rendering clarified Proved as a category of oil both profitable to recover and known to exist. Despite these useful corrections, McKelvey's chart contained an anomaly impossible to reconcile. Shaped like a backward L, the "resources" block included a portion of economically recoverable oil deemed almost certain not to exist (in the upper right). Such conjunctures could occur. But, by including them in a corner of the graph, McElvey interrupted the sense of a linear trajectory from discovering oil to producing it. The chart suggested right turns and detours on route to riches.

Flawed as it was, McKelvey's graph stimulated better solutions in the 1980s and thereafter. In 1987, the World Petroleum Congress—which united the API with other bodies—issued a report on classification and nomenclature systems. This document presented two simpler charts—



3.9 McKelvey's 1972 chart. © World Petroleum Congress. Prepared by Mike Siegel of Rutgers Cartography Lab.

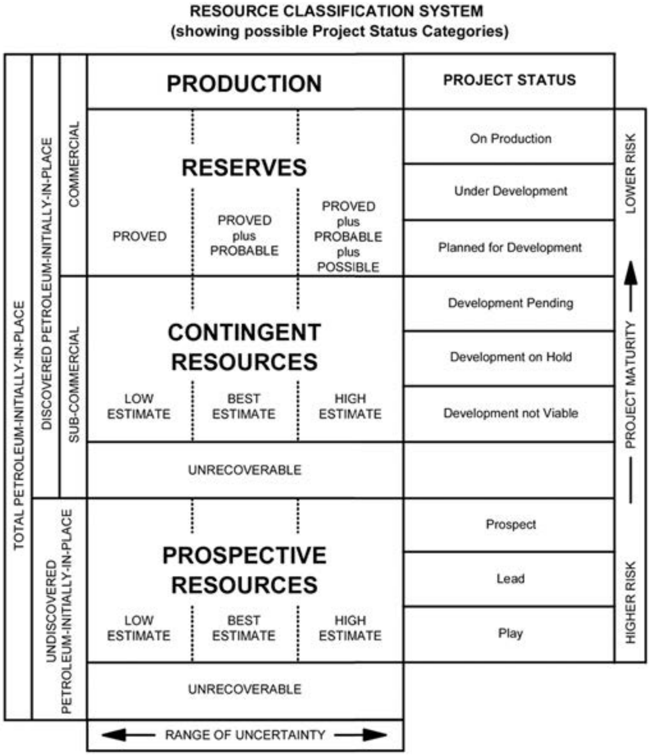
almost flow charts—side by side (figure 3.10). The position of Discovered to the left of Undiscovered suggested an x-axis of certainty regarding existence. More tellingly, the left-hand column of discovered oil and gas arranged layers vertically from unrecoverable to unproved reserves to proved reserves to production. The y-axis, then, represented a commerciality threshold and even a literal flow of hydrocarbons—except that Production lay at the bottom of the chart. The vertical axis inverted geology, suggesting that oil and gas moved downward. Still, this chart portrayed petroleum in the ground and leaving the ground with enough deceptive literalism. A notation "not to scale" advised readers not to compare the sizes of the boxes (Martínez et al. 1987, 266). This warning passed into the now-definitive chart first proposed in 2001. "Guidelines for the Evaluation of Petroleum Reserves and Resources" united the recommendations of three expert bodies: the Society of Petroleum Engineers, the World Petroleum Congress, and the American Association of Petroleum Geologists. Their chart distinguishes a y-axis of financial risk—also denoted as "proj-



3.10 The World Petroleum Congress's 1987 chart (fig. 1). © World Petroleum Congress. Prepared by Mike Siegel of Rutgers Cartography Lab.

ect maturity"—from an x-axis of existential certainty (figure 3.11). Proved reserves lie in a corner, at the intersection of high certainty and low risk. This chart set the standard. In 2011, the same three expert bodies wrote it into their Petroleum Resources Management System, or PRMS.[9] Even before that point, the chart was becoming a visual icon for the oil and gas business worldwide. The graph constitutes what Edward Tufte calls "beautiful evidence": through it, "seeing turns into showing" (Tufte 2006, 9).

This artifice relies upon a subtle conflation of geological and commercial tropes. One might easily confuse the two y-axes: denoting, respectively, migration of geological substances and maturity of investment. Looking very much like summarized stratigraphy, the PRMS chart superimposes reserves upon resources. And resources move up in the same way petroleum rises toward the surface. A manual accompanying the chart conflates these two processes. "Budget decisions," the text concludes, "should focus on increasing project maturity [a]s a specific accumulation moves up the system" (Society of Petroleum Engineers 2001, 22). That sentence shifts subtly from fiscal to lithic measures. In the latter sense, *accumulation*



3.11 Petroleum Resources Management System (PRMS), 2001 (the first version, published under a different title). © Society of Petroleum Engineers (SPE).

denotes a pool of oil stuck below a caprock. The hydrocarbons accumulate precisely because they are not moving up the stratigraphic system. But, in the imaginary of the PRMS, they do move from reserves to resources. Here metaphorical and literal meanings seem to fuse, as if a financial reclassification equated to changes underground. Probably few readers noticed the "not to scale" warning, presumably retained to avoid liability. Likewise, few readers reflect upon what is not in the chart: combustion and, further downstream, global climate change. In this consequence-blind, conscience-free fashion, the PRMS chart established a "zone of qualification," wherein "objects and practices are assessed to common standards and criteria" (Barry 2006, 239). A quality of upward motion reconciled the dissonant measures of commerciality and stratigraphy. Or, in Rudwick's terms, the PRMS established a "stylistic analogy," which allowed disciplines and sciences to borrow seamlessly from each other (1976, 168–69). Thenceforth, geologists and economists played the PRMS chart like a board game, forever advancing pieces toward the upper left corner.

The name of the game is "reserve replacement," and it is a sport of public relations. Reserves exit the chart on their way to refineries, fertilizer manufacturing, and so on. Meanwhile, oil and gas companies prove up resources to refill the depleted reserves. At a rate of 100 percent, replacement maintains reserves at an even level. At higher than 100 percent, reserves actually expand. Unless one discounts estimates from the Middle East, global reserves are keeping steady. In that case, the larger aggregate of resources becomes the real measure of supply, and policy makers need not worry about an impending peak. The credibility of this message depends—more than any other factor—on the commerciality threshold. Timothy Mitchell describes a "gap between the declining quantity of oil known and the quantity of expanding, yet-to-be-discovered oil" as a "space to be governed by economic calculation" (2011, 251). The PRMS chart represents commerciality as a line between contingent resources and reserves. The line is always moving. One might say, in fact, that producers push that barrier downward into the layer of resources as they prove up the affected resources. So the top stratum of resources—which is not actually higher up geologically—waits in a kind of antechamber. From 1987, the World Petroleum Conference tried to dispel this ambiguity. The authors of the report "rejected, for proved reserves, the concept of estimating future economic conditions . . . restricting these estimates to the amount recoverable under the economic conditions at the time of the estimate." Proved reserves, in other words, "are the estimated quantities, as at a specific date," irrespective of deregulation or cheaper technology anticipated in the near term (Martínez et al. 1987, 265). This effort to freeze time unraveled somewhat with the PRMS chart. That graph inserted a layer of contingent reserves just below the commerciality threshold. To make matters worse, futures contracts in the 2000s created an "oil vega," or persistent instability regarding quantities and prices (Moors 2011). Mazen Labban (2010) refers to a "financialization," where markets operate independent of oil's material disposition. Especially under these conditions, the PRMS chart allows the oil and gas business to present its raw materials as scarce to consumers but as constantly replaced to investors—without actually lying.

In Trinidad, this sleight of hand can become embarrassingly apparent as the two messages continually cross. In a small country—containing the entire commodity chain—the same firms both consume hydrocarbons and invest in their production. Having experienced the decline in oil, managing directors follow natural gas with both expertise and concern. By July 2010, proven reserves had been falling steadily, and the annual press conference—at which the gas audit of the previous year is announced—could no longer avoid this fact. Held at the Hyatt Hotel, the event began with a slide presentation from Larry McHalffey, of the Houston-based auditor Ryder Scott. McHalffey and his team had reviewed proprietary well data from every driller and condensed their numbers into the only summary that would be made public. The picture was not reassuring. A retrospective slide showed proven reserves falling from almost 20 trillion cubic feet (tcf) in 2000 to a bit more than 14 tcf in 2009. "There has been a steady decline in reserves in most categories," McHalffey related laconically. Trinidad produced roughly 1.4 tcf in 2009. Straightforward arithmetic indicated a mere decade of gas remaining. As a subsequent slide showed, the reserve-to-production ratio stood at 10. Yet the auditor chose his language carefully. He avoided linking the figure of 10 to years or any measure of time: the reserve-to-production ratio is a unitless "performance indicator," he explained. And, he continued in closing remarks, this number "goes hand in hand with reserves replacement ratio." One could not predict the future. McHalffey labeled the y-axis of his chart Project Maturity. Time was on Trinidad's side, he implied, if its leaders followed orders: "Target at least 100 percent reserves replacement each year," he concluded, perhaps patronizing his audience. The situation, in short, was imperfect but certainly remediable—as long as one overlooked climate change.[10]

The minister of energy took over exactly where the auditor left off. At that point, Carolyn Seepersad-Bachan had served for only two months—having arrived with the new government in May—and was soon to be removed in a cabinet reshuffle. She had worked in the downstream sector, as chairperson of the National Petroleum Marketing Company, and did not project confidence regarding matters further upstream. (Being female among oilmen did not help either.) At the press conference, though, Seepersad-Bachan acquitted herself admirably. Briefer than McHalffey's, her slide presentation contained no numbers or charts. Instead, she showed the map of gas acreage, stretching far out to sea. Promising, ultradeep waters billowed eastward behind Trinidad like a parachute. Replacement was coming, already begun in fact. Smiling attractively, the minister assured her audience, "We have been able to transfer exploration resources into the reserves category." And, moreover, the government was planning "continuous exploration-based activity . . . at an optimal level." The ministry would contract with British Petroleum, British Gas, and other foreign firms to drill below 5,000 feet of water. In this way, Seepersad-Barchan promised magically to "prove up supplies." David Renwick, the dean of Trinidad's energy journalists and editor of *Energy Caribbean*, spotted a contradiction. Posing a question from the press bench, he referred back to McHalffey's slide of reserves and resources since 2000. Resources in the Exploration column had fallen from 30 to 26 tcf. What did this drop bode for the future? Raised with surprising modesty, Renwick's query provoked no response from the minister or from McHalffey. Seepersad-Bachan simply repeated that she would explore more and prove up—a prediction that could never be falsified. The next day, Trinidad's highest-circulation newspaper, the *Express*, reproduced McHalffey's slide of reserves from 2000 to 2009. "Ten years left," blared the headline.[11] Had the performance failed?

Actually, no: it sustained faith in abundance among the adherents who mattered most. Despite skepticism, Renwick mostly agreed with the minister. In *Energy Caribbean*, his headline after the 2008 audit had read "Reserves Being Replaced on a Yearly Basis" (Renwick 2008b, 16). "[The] proven reserves have fallen," he admitted after the 2009 audit, "[but] the probable and possible reserves have not." That article explained the logic of PRMS in some depth: probable reserves lay above the commerciality threshold. They were just not known to exist. If they did exist, in other words, these accumulations of gas would augment Trinidad's profit-producing stockpile. Renwick converted that contingency to a certainty. "Some of that [gas] will inevitably feed into the proven category," he promised readers, "though it has not been happening as fast as industry watchers would like" (Renwick 2009, 74). Renwick and I happened to meet for the first time just the day before the 2010 press conference. Having lunch at the house I had rented, he dismissed much of the concern regarding reserves. Well versed in economics, he considered that discipline to be "the driving factor, not geology at all: the geologists just tell you where to go and drill." Hydrocarbons lay in the earth, accessible as and when funds permitted. This attitude and the audits themselves kept policy focused on when and how—not whether—to extract hydrocarbons. I suggested switching to renewable fuels. "You've got to be practical," Renwick responded gamely. "The world's economy is based on energy, and that energy is based on fossil fuels."[12] Nothing in the press conference the next day changed Renwick's outlook. To this extent then, the gathering achieved its purpose: it announced scarcity to the impressionable public while telling the experts a supply-rich story they could assimilate. Neither alternatives nor conscience ever entered the discussion. "Take [exploration] action now," the Energy Chamber urged determinedly in a letter to the *Express*, a week after the audit.[13]

By 2012, however, even loyal experts were becoming confused. In the intervening two audits, Ryder Scott had tracked a decline in gas reserves to 13 tcf. Rumors of scarcity abounded, and the industry needed to rebut them. "I know what Ryder Scott says," began Philip Farfan, "but I know nothing about Trinidad's reserves. That is quite a statement." Farfan was leading the Understanding Reserves workshop on the last day of the 2012 Energy Conference. Pacing before a slide of the PRMS chart, Farfan began by recalling the moment in 2003 when the U.S. Securities and Exchange Commission (SEC) redefined reserves. "Overnight everybody had to dress their figures down. It was a catastrophic event." Rather than proving up, they actually "wrote down" marketable assets back into the netherworld of resources. But—and here was the good news of the workshop—no oil moved physically that night. Changes to the rules proved how arbitrary—not geological—the rules were. Farfan and his cofacilitator, Tony Paul, had worked as hydrocarbon economists for decades in American, international, and Trinidadian firms. For their workshop audience of journalists and civil servants, they sought to create, rather than dispel, confusion. From the front row of that perplexed audience, Renwick asked for a comparison of the various guidelines. "We have won," Farfan responded joyously. "This is the success of today!" The bulk of the presentation tracked the fortunes of an imaginary Trinidadian gas field and gas company. Wells produced, drawing down reserves, except at three points. At those moments, the firm proved up reserves, in the first instance, by injecting water to force gas out, then by securing a new set of buyers, and last by injecting gas to bring up more gas. This story furrowed the brows of the uninitiated while tickling the genuine oilmen who had stayed around after the energy conference. "A good oil field usually gets better," interjected a jolly Texan. Farfan ended by comforting readers of the Ryder Scott report. "Don't be obsessed today with your reserves. Be obsessed with your resources." Resources, in other words, can cause reserves to grow. "Whether it is nine years left or three years left, what does that mean? . . . What matters, of course, is continuous exploration. You are bound to find something."[14]

Are you really? I asked Farfan, when we met again, nearly a year later. I wanted to know how deep his confidence ran and whether ethical scruples troubled it in any way. He had organized the 2012 workshop because Roger Packer, president of the Energy Chamber, confessed to concerns about gas reserves. "I said, Roger," Farfan recalled, "for fuck's sake get real! I'll show you why it's crap." Farfan seemed bent on personally embarrassing the SEC and Ryder Scott for imposing unfairly pessimistic expectations on Trinidad. Since 2003, proving up required a production contract. Hydrocarbons, in other words, could not be booked as underground reserves until they were at the very point of leaving the ground. What about leaving them below, I asked? Farfan parried with his professional ethic: "I feel that it is my responsibility to get as much out of the ground as possible." On the question of scarcity, he admitted to an outer boundary: "That is true about everything on the planet. I mean the sun is going to be exhausted." When I mentioned climate change, he jumped scale again: "It's hard if you're not a geologist to put the planet in perspective. . . . In a million years do you want us to be like this?" Perhaps, he concluded, we would learn from the Neanderthals, who evolved so admirably in response to global warming.[15] It was a strange—but not uncharacteristic—evasion: one that united the timescale and the inevitability of geological forces. Farfan knew his business and cared deeply about the fraternity of men and women in oil and gas. But, beyond this coterie, humanity faded into the fog of bipedal gropings toward something better. Farfan tacked from the serious to the flippant. "We got here evolving under crisis," he joked, walking toward the large car that had actually brought him to me.[16]

The Circular Back Stream

By 2010, Trinidad's oil and gas club was addressing climate change substantively—but still under an assumption of oil inevitability. The sector was beginning to treat environmentalism as an "aboveground risk," in a class with sabotage and nationalization. The risk lay in the possibility that scientists and activists might persuade consumers to cut their carbon emissions radically. In Trinidad as elsewhere, hydrocarbon insiders imagine such a scenario only with difficulty. Their term for it—"demand destruction"—suggests violent pathology.[17] As one of the milder forms of such tampering, the Intergovernmental Panel on Climate Change had considered establishing markets that would debit for releases and credit for the capture of atmospheric carbon. Having little forest with which to fix carbon in biomass, Trinidad would not benefit from substantial credits. Meanwhile, the debits would hit Trinidad's petrochemical sector and its high-emitting citizenry. To forestall this misfortune—and concurrently with the debate on gas supplies—the hydrocarbon fraternity devised an engineering project to lower the country's net emissions. They would inject carbon dioxide generated at downstream industrial sites into geological formations. This "back stream" would return carbon to its underground source, exonerating Trinidad of responsibility for those megatons (Bridge and Le Billon 2013, 37). Like all forms of what is known as geoengineering, this proposal relied upon technology barely tested (Hamilton 2013, 45–47). Risk abounded. Unanticipated losses—beginning with the Trini cow already killed by a leaky CO_2 pipe—could easily overwhelm the benefits of carbon capture and storage. Still, those advantages promised to be substantial. Through "enhanced oil recovery," the scheme would use injected carbon dioxide to push hydrocarbons up. Trinidad's back stream would reconnect to the upstream and recover unrecoverable oil. Boosters called it a win-win scenario.

Always looking for such Panglossian business propositions, the Energy Chamber began to promote carbon capture in 2008.[18] The officers of this institution saw climate change less as a moral problem than as the sort of political crisis that yields opportunities. But first they had to persuade the businessmen and politicians governing energy policy. Thackwray Driver, the chamber's British-born chief executive officer, viewed climate change with a jaundiced eye. In 1998, he had written a geography dissertation on colonials' misplaced fears of soil erosion in Lesotho (Driver 1998; cf. Driver 1999). He had also moved from London to Port of Spain, married his Trini sweetheart, and taken up work in Trinidad's Forestry Department. Among foresters, he encountered the same stale, colonial dislike of rural settlement, shifting cultivation, and large families. Bravely defending squatters, Driver (2002) challenged the long-standing imperial aversion to population growth. "I don't believe Malthus very much," he later told me, "but I hold that view very lightly: I mean I could be wrong."[19] Then he laughed. I got to know Driver—or "Dax," as he is called everywhere—quite well.

We both lived in Cascade and drove each other's kids to school. "I've always been a bit skeptical of the big claims people make," he once explained languidly on the retreating shore of Maracas Beach. "Let's muddle through and see what happens."[20] The chamber hoped that profits would happen, and, in late 2008, it drew national attention to Clyde Abder's scheme for carbon capture. An engineer, Abder mastered the details and controlled the risks. Men die on gas platforms, he informed me, in a moment's inattention. He sized his students up for potential drug use. Perhaps surprisingly—perhaps seeking a cheerier form of competence—Abder teamed up with the ubiquitous Krishna Persad.

Two years later, in 2010, Persad presented their plan to the Energy Chamber in the glittering Hyatt. This time, his humor nearly got the better of him. Persad's slide show emphasized profit, and a Midas touch. "Let me waft you," Persad invited his audience, "to a land with castles where CO_2 is transformed into black gold." Amid references to Dorothy, *The Wizard of Oz*, and streets paved with gold, Persad recruited partners to "do good and, in the process, make a lot of money." After this jarringly whimsical pitch, Persad explained Trinidad's comparative advantages in the nascent field of carbon capture: the Point Lisas Industrial Estate converted natural gas into ammonia and, as a by-product, dumped pure, high-quality carbon dioxide. Existing pipelines could carry that pollution to the oil belt, where his company would inject it into depleted, depressurized oil reservoirs. Carbon dioxide would repressurize the formation and cut the viscosity of the remaining petroleum. Like the injected water and gas in Farfan's presentation, this technology would cause hydrocarbons to flow. Indeed, oilmen in East Texas had been conducting this kind of "huff and puff" operation since the 1970s. Their wells puffed carbon dioxide down underground and huffed out oil—along with most of the CO_2. Persad would do better. By capping the well deliberately, he would trap up to half of the injected carbon dioxide for an indefinite period. As described, these back stream operations more than compensated for the resulting upstream ones: the puff outdid the huff. Oil coming to the surface, Persad told his audience, is "net cleaner than [the original] natural gas."[21] I was skeptical. Could one really capture more carbon than one emitted at the end of the day?

My search for the answer to this question began as soon as Persad stopped talking. Were carbon capture and enhanced oil recovery "contributing to the problem or to the solution regarding carbon emissions?"

I asked after his presentation. "I have no clue," Persad responded without embarrassment. In the coffee break, when the investors were no longer listening, he confessed to me, "Someone else can do the math. In that area I have no skill." On the net outcome, he revised his earlier statement: "It's neutral at best—*at best*."[22] Persad retreated even further when we met a month later in the oil belt. Inexpertly, he ran through conversion rates, admitting, "You are losing." In net terms, his back stream emitted carbon. Then he calculated some more—muttering, "My initial gut feeling is that it is negative"—and reached for the phone. "I cannot replace that carbon footprint by injecting CO_2?" he asked Abder himself. Persad listened somberly, hung up, and reported, "He said that it is not debatable."[23] I called Abder myself, and we met at his office at the University of the West Indies. "You will never have a positive carbon balance," he lectured, "by injecting carbon dioxide to produce oil."[24] The matter was obvious, in fact: gas always replaced liquid at a lower density. And long petroleum molecules unavoidably hold more carbon than does three-atom carbon dioxide. Finally, stored CO_2 could leak out later (cf. Metz, Loos, and Meyers 2005). On this issue, Persad referred me to Shiraz Rajav. Rajav had recently retired from capping wells for Petrotrin, the national oil company. Known confusingly as "well abandonment," capping could hold the carbon dioxide in place, he believed. But whether "carefully abandoned"—in the amusing phrase—or not, Persad's wells would exacerbate climate change. "[For] the amount of carbon you're going to produce in the air," Rajav reasoned, "you might as well have not put the CO_2 down there." Then, looking out from my balcony in Cascade, Rajav grieved for the Kilimanjaro glacier which he had visited twenty years earlier: "We are human beings before we are oilmen."[25] I had my answer—carbon capture was a net loser—and another question: why did most of these human, conscience-capable oilmen seem so unperturbed by that outcome?

Opportunism clouded judgment, especially at the highest levels. Concurrent with my doubtful probings, the Ministry of Energy was preparing to push Persad's scheme forward. A week after I met Rajav, as an unusually hot dry season was getting worse, the ministry announced the creation of a Carbon Reduction Strategy Task Force. The group would include Persad and Charles Percy, the current president of the Energy Chamber. Percy spoke at the press conference—held, of course, at the Hyatt—asserting that carbon capture is "the only technology known to reduce up to 90 percent of emissions from industry." The statement was true—but only if one discounted the possibility of running an industry 100 percent from solar or wind power (or not running the industry at all). Selwyn Lashley, who managed renewable energy for the ministry, might have corrected Percy. Instead, he heaped further praise upon carbon capture as "an important element in the improvement of oil production."[26] I met Lashley later at the ministry—immediately adjacent to the Hyatt—where he served as chief technical officer. Flanked by two female aides, he began by setting the task force in context: Trinidad and Tobago had "pursued this path of industrialization. It's a reality we have to deal with." He, Percy, Persad, and the rest would search for "absolute reductions in a tangible and sufficient amount." Carbon capture, I ventured, did not qualify as an absolute reduction in emissions. As I laid out Abder's quantitative, physical reasoning, Lashley and his assistants shifted uneasily. "It comes down," he responded, "to how you do your accounting and where you put your envelope." Another country would burn the oil produced from Persad's wells. "You," he affirmed—meaning Trinidad and Tobago—"produce nothing that goes into the atmosphere in your boundaries." The ministry, in short, would lower carbon emissions at the national level while raising them at the global level. "They're piggybacking on a nice concept to get business as usual done," I learned through a leak at the ministry. "It's an energy thing. It's not about the climate."[27]

Such cynicism rested on a more widely shared conceptual foundation of energy without conscience. The reigning geological-economic model made oil production appear inevitable. With or without carbon capture, the oil in South Trinidad was supposedly coming up. As Clyde Abder put it, "We gonna produce that oil one way or another. . . . As long as the world needs oil, oilmen will find it, and they will produce oil."[28] The dry season broke, temperatures cooled, and Persad invited me to a cricket match. Lugubrious as the West Indian side began to lose, he spoke about the heavy, viscous oil lurking at the bottom of his "stripper" wells. He had injected carbon dioxide into a few of them and doubled production from 4 to 8 barrels per day. He had proved up resources, I told him with a feeble smile that he well understood. But this happens anyway, he continued: "In the fullness of time, they [resources] *will* be transformed into reserves."[29] We met again socially on my follow-up visits to Trinidad but did not take up the matter of carbon capture until January 2012. By that time, the minister of energy had praised Persad's method in a speech and—in response to my question—misleadingly claimed "no net carbon dioxide will be released."[30] Persad's huff-and-puff operation was releasing 20 barrels per day. After three vodka tonics in San Fernando, I put the matter as bluntly as I ever had: why not simply keep the 3 billion barrels Persad was seeking in the ground? Ecuador was negotiating a deal to do just that with oil reservoirs under a protected rainforest (Davidov 2012; Finer, Moncel, and Jenkins 2010). Persad would have none of it. Someone else would then get the hydrocarbons, and, "You can't be held responsible if the rest of the world doesn't do what it should."[31] He reminded me of our first conversation on the topic, during which he had told me, "It's going to take a while for the world to change, and meanwhile the train is going down the track."[32] Like a commuter, the oil would arrive on schedule.

Ultimately, any policy to address climate change would have to permit the continued combustion of oil and gas. This consensus became apparent at the 2012 Energy Conference. Dax announced "Striking the Balance" as the theme. Panels on upstream and downstream concerns left little time for other issues. Climate change appeared in the interstices, almost as an afterthought. On the first day, Vincent Pereira of the Australian firm BHP Billiton raised the topic of solar and wind, in a backhanded way. "There is going to be growth in energy demand," he began blandly. Appearing open-minded, he predicted, "Renewable energy is going to grow, but," firmly now, "the reality is that fossil fuels—oil, gas, coal—are going to be 80 percent." He specified no date, but it was clear that energy production would expand dramatically, allowing hydrocarbons and renewables both to grow. What if the global movement against fossil fuels destroyed demand? I queried from midway down the Hyatt's plenary hall. Pereira responded coolly, "Having taken on challenges like this before in our industry, I have to believe that it can be solved."[33] The next day, Peter Wyant presented one of those solutions. Persad had invited him from Saskatchewan, where his agency was monitoring storage in the biggest carbon capture project in the Americas. At the province's Weyburn Field, injected carbon dioxide was delivering oil to the surface. Innocently, I popped my question about the net effect, and Wyant assured me that he was storing more CO_2 than he was releasing. Persad found me immediately after the presentation, excusing his friend with, "He misunderstood your question."[34] The next day—on my way to the reserves workshop mentioned above—I bumped into Wyant in the corridor. This time he understood my question and gaped in a fifteen-second stutter. Then he explained his assumption, really more of a wish: whoever burned Weyburn's petroleum would send the resulting CO_2 somewhere else for storage.[35] We didn't discuss whether that carbon dioxide would push out another round of hydrocarbons. In any case, the train of complicity would roll on. Seemingly, people eager to mitigate carbon emissions cannot but climb aboard.

Petroleum institutions suffer from a diagnosed "inevitability syndrome" (Nader 2004, 775). In this perverse perception, the world always needs hydrocarbons, and the substance must satisfy the demand (Huber 2012, 309; Sawyer 2010, 67). Oil and gas will themselves to come up, to be produced. Or the earth wills them to gush on top of James Dean. The text of *Giant* refers poetically to the "earth-pent oil his labors had just released" (Ferber 1952, 364). In the course of this release, petroleum experts develop an almost animistic belief in geological agency. "The oil (or gas)," writes Rick Bass, "always tries to climb higher than it is: moving, like a miner, through and between pinhead spots of porosity, trying to get up to the area of least pressure." It travels, continues the geologist from Mississippi, "back to the earth's surface, where it used to be." Hydrocarbons—like salmon swimming to spawn—fight upward to their point of origin. This notion of return, of course, emphasizes continuity more than rupture. It suggests an unbroken itinerary from vegetation to sediment to accumulation to the gas station. The voyagers pause only when impermeable layers trap migrating molecules. Bass and his coworkers drill through that rock. "Then the oil or gas . . . is just about obliged to come out. It is as daring a rescue," he congratulates his profession, "as ever there was" (Bass 1989, 27–28). The charts and categories of his profession display this operation as it takes place. They are what Andrew Barry calls "projective devices" (2013, 14). By graphing depth as time and time as depth, the geological cross section implies and predicts upward flow. Then men drill, making the prophesy self-fulfilling. The plot of petroleum always runs forward, downstream.

Why is this graphic novel so believable? It conflates geology and commerce, the natural and the artificial—and does so with particular persuasive power as regards the notion of maturation. A widely used textbook on oil defines "maturity" as "petroleum generation . . . in a source rock."

But a later chapter refers to "mature areas that have been relatively well drilled" (Hyne 1995, 172, 224). In this double use, petroleum matures as it bakes underground and as wells and pumps—and ultimately consumer demand—bring it to the surface. To describe this multiplex uplift, my informants frequently deployed the term *reality*. That conversation-stopping word imputed a monolithic quality to the petrochemical industry and its various commodity chains. The term naturalized what were merely decisions, taken every day in Port of Spain and other energy cities. The "reality" also obscured what should have been obvious limitations. Sediments hold only a finite amount of oil and gas. Demand cannot renew a nonrenewable resource. Yet experts assume that hydrocarbons will not run out as long as governments, corporations, and people don't want them to. Tyler Priest, in a history of Shell Oil, captures this fuzzy thinking unwittingly. He writes of the exploration team going offshore "in the race against depletion" (Priest 2007, 106). In the real reality, they were racing toward depletion. In the reality of charts, however, Shell proved up resources so fast that reserves grew. There is no Malthusian absolute scarcity in this economic thinking. Meanwhile—and of more immediate concern—the atmosphere is imposing its own limitations. The oil fraternity has trouble focusing on this fact. "The Earth has become abstract," writes Bill McKibben, "and the economy concrete to us" (1989, xxiii).

Individuals may have also faded into a strange obscurity—even within the macho hydrocarbon industry itself. "Oil is found in the minds of men," my informants occasionally told me (cf. Yergin 2011, 717). But when the conversation turned to climate change, even the most accomplished geologists felt oddly powerless. In Trinidad, most understood the way in which hydrocarbons were changing the climate and threatening life. Many wished they could do something about it. It took me some time to comprehend this form of passivity and complicity. For social scientists, climate change has thrown human agency into stark relief. High emitters of carbon dioxide now stride across the planet as "geological agents" (Chakrabarty 2009, 206). Yet the experts of oil have not yet adjusted to this inversion of deep and shallow time. Krishna Persad cared enough about climate change to create a solar-powered eco-resort on Tobago. Not merely an object of greenwashing or corporate social responsibility, the family-run enterprise occupied his thoughts and moved his spirit. Why, then, did he at the very same time explore for new supplies of oil in South Trinidad? If not him, someone else would, he always said, as if submitting to an unwelcome fate. Finally, I put it to him that he was the best geologist in the country, a mind that regularly found oil. He also took greater economic risks in enhanced oil recovery than any other producer (Renwick 2008a, 20). Just possibly, oil he did not personally discover or flush out might stay there, and that oil trapped in sediments might keep the world within the safe climate boundary. Persad wavered, taking the scenario seriously: "If I was going to be responsible for tipping the whole world over, then I can't do it."[36] He brushed against the boundary of conscience.