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Introduction

AS WE PEDAL our mountain bikes through the scorching Utah afternoon, we finally come to what we're looking for. Dinosaur tracks. Each one is about the size of one of my bike's wheels, a rock dimple big enough for me to sit in. Which I do, plopping myself down to pose for a picture. I'm sitting in a dinosaur footprint, the exact spot where millions of years ago a giant sauropod wandered along on a mysterious errand. Its feet sank into the mud on just the right day, at just the right time, such that the prints endured for eons. Other tracks, of hiking boots and bicycle tires, tell us we are not alone. We've all come to look for America, the ancient America that lies beneath our feet, the remains of a lost world that came long before ours.

For many citizens of the United States, the antiquity of the land is a core feature of their national identity. National parks are cathedrals of primordial American nature: Yellowstone, the Grand Canyon, Dinosaur National Monument. Among the oldest exposed rocks on the planet are those of the so-called Canadian Shield, which cover much of eastern Canada and stretch into the northernmost regions of the United States. They are over four billion years old. And you can walk right on them, your soles touching the basement of time. People come to the New World to see the oldest world of all.

This book tells the story of how and why this view of ancient America came to be. It shows how in the span of a mere century many Americans changed their minds about the age of the Earth and the continent they inhabited. In the late eighteenth century, many people thought our

planet was only about six thousand years old, a number derived by calculating the years and generations relayed in the Bible. They also believed that the Americas were the last lands to emerge from the Earth-drowning flood described in Genesis. Barely a century later, a new possibility seemed far more plausible: not just that Earth was billions of years old, but that some of the oldest lands on the planet could be seen in the United States. This idea seemed obvious to many Americans by the early twentieth century.

Today we call this idea *deep time*. Deep time refers to the billions of years over which the planet was born and life upon it appeared and evolved. The term was coined in 1981 by the writer John McPhee.[1] It exploits two meanings of *deep*. The first one is literal. Old rocks usually lie buried far underground, so it makes sense to call the time in which they were formed *deep*.

But the idea of such an enormous amount of time is also profound. It challenges our minds to the point of paralysis. It seems to burrow into the very nature of things. With the term *deep time,* we feel the same delicious thrill of other twentieth-century projects that hint at a fundamental reality only partially glimpsed: deep space, deep cover, deep structure, deep state. Although people in the nineteenth century did not use the term *deep time*, they did invent a lot of other terms that expressed the profound and unknowable quality of this huge chunk of time. They talked about the immensity of time, the night of time, a past eternity, and the dark abyss of time.

The lengthening chronology was revolutionary because it reshaped many aspects of American life. John Adams once said that the American Revolution was not the war waged by soldiers on the battlefield, but the fundamental change in the minds and hearts of the American people. The same can be said of the deep time revolution. It was not only the fieldwork conducted by geologists and paleontologists wresting dinosaur femurs from cliffsides. It was a transformation in the outlook and experience of ordinary Americans, for whom deep time became a lived reality embedded in their daily lives. The deep time revolution was largely complete by the early twentieth century. We live in its shadow today.

Yet curiously, we have no history of this profound transformation, when the earth literally shifted underneath Americans' feet. We have many excellent histories of the sciences most involved in the transformation (geology, paleontology, and archaeology), of the mania for dinosaurs that gripped the nation, and of the challenges posed by Charles Darwin's theory of evolution by natural selection. I have benefited greatly from those works. But here I am telling a different story, a story about how Americans began to think differently about one of the most essential categories that structures human reality: time. The deep time revolution is one whose contours we have sensed while tracking other stories. But here the focus is on deep time itself, with those other momentous changes cast as supporting characters. The payoff, I hope, is a new history of the United States, from the nation's birth in 1776 to the turn of the twentieth century, when Americans first called themselves "modern." They were modern in part because of the deep time revolution unveiled here.

When we talk about deep time, we often refer to *absolute* or *actual* years—that is, time measured by counting Earth's revolutions around the sun. We say that an asteroid slammed into Earth around sixty-six million years ago, wiping out the non-avian dinosaurs. But reliable measures of actual years did not appear until the turn of the twentieth century, with the invention of radiometric dating. This technique compares the abundance of naturally occurring radioactive isotopes in a mineral sample to their decay products, which form at a known and constant rate. In 1907, the Yale chemist Bertram Boltwood published "actual ages" for rocks in the United States of 1.9 billion years.[2]

The events in this book unfold mostly before the era of radiometric dating, when only *relative* times could be hazarded. Relative dating was based on the so-called law of superposition, first announced in the seventeenth century by Danish cleric and philosopher Nicolaus Steno, which stated that older rocks usually lie under newer rocks. Whether by tides, winds, floods, or volcanoes, rocks generally settled into place from bottom to top. A rock became meaningful in time only in relationship to the rocks lying above and below. "The relative position of the strata we

are respectively examining," wrote one American geologist to another in 1833, was "invaluable to us both." Despite having only relative dates, people in the nineteenth century often proposed actual dates, whether as legitimate guesses, extravagant daydreams, or provocations to enemies. These fanciful dates ranged from thousands to millions of years. In other words, time got a lot longer for people in the nineteenth century even though they did not know how long that time "actually" was.[3]

This is our first clue that deep time is interesting for its meanings rather than for the total year count. The same can be said for time in general. Unlike space, time is maddeningly elusive. We somehow know it is there, but we need material objects to make it real to our senses. We experience time in terms of space: the hands of a clock ticking forward, the sun rising and setting, children growing into adults. This is why many scholars agree that it is more interesting and rewarding to see time not as a brute fact of nature but as an artifact created by human beings to communicate about this world of mundane projects and the cosmic world of the divine. If we see time as a social experience, we can suspend judgment about whether time objectively exists "out there" and instead study the many different forms that the experience of time has taken in the numerous societies that left their chronometric fingerprints behind. What seems obvious and natural in one society seems strange and wrong in another.[4]

The people who deepened time in nineteenth-century America were not simply seeing or discovering part of the natural order that others had missed. They were looking at what had always been there—mountains, prairies, river valleys, lakes—and imagining something fresh. The United States played a starring role in this drama of discovery and imagination. The rocks that had seemed to announce the newness of the New World were soon declaring its vast antiquity. By 1849, one South Carolina geologist could tell a Charleston audience "to assign millions, rather than thousands of years, as the age of the earth." Soon after the Civil War, another naturalist ventured a more radical conclusion: "Thus again we discover that the 'New World' is in reality the oldest." That rocks tell time was a new way for Americans to talk to one other, to the rest of the world, and to God.[5]

This book follows those conversations as they emerged and developed during the nineteenth century. Deep time, first, was a way to forge a national identity. Americans used rock strata and fossils to claim a place on an international stage dominated by great European powers. They argued that while their nation was young, their continent was very ancient indeed. As they claimed temporal equivalence with Europe, they soon moved to asserting temporal priority to promote agendas of all kinds, from the economic exploitation of natural resources to chattel slavery, Native American removal and genocide, and social movements from feminism to eugenics. The deep time revolution in the United States did not roll out all at once. Instead, Americans dug little holes of time here and there, in New England valleys, New Jersey marl pits, Alabama cotton fields, parched Dakota gullies, and the severe granite flanks of Yosemite. They unearthed a world unsuspected, a lost era of armored fish, coal-producing forests, plodding dinosaurs, and snarling saber-toothed cats. They slowly sewed these pieces together into a tapestry of national glory, a continental antiquity surfacing as the new United States.

This task was largely complete by the early twentieth century, when the United States enlisted dinosaur diplomacy to announce the nation's imperial aspirations. Like a triumphant Roman emperor hauling an Egyptian obelisk back to Rome because he could, Americans shipped gargantuan dinosaur casts to Europe to signal that they had finally arrived on the international stage. It was with especially pleasurable schadenfreude that Americans presented Dippy the Diplodocus to King Edward VII of England. Americans still dream with dinosaurs, from the docile ruminants in Rudolph Zallinger's murals to the genetically engineered monsters of *Jurassic Park* (fig. I.1 and plate 1). By the early twentieth century, the New World/Old World distinction no longer referred to a geological—let alone a theological—reality. With Americans deploying radiometric dating to show that they too lived atop primordial rocks, no longer could Europeans allege that their continent was literally older. The major difference between the United States and Europe was now seen to be cultural, as one French observer noted between the two world wars. It was gleaming cars versus collapsing castles, the

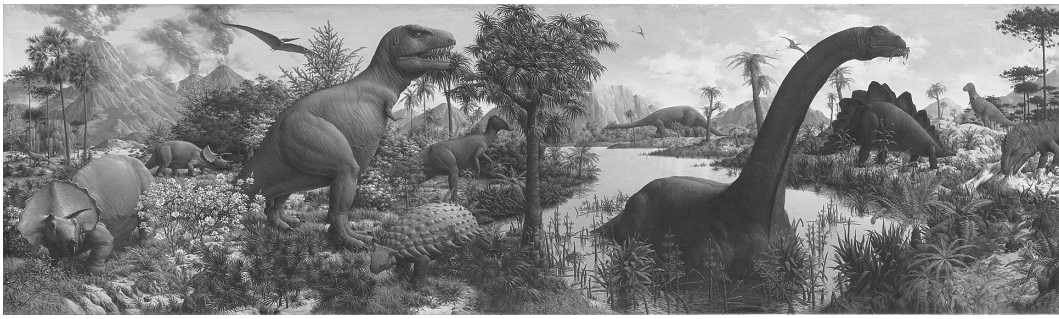
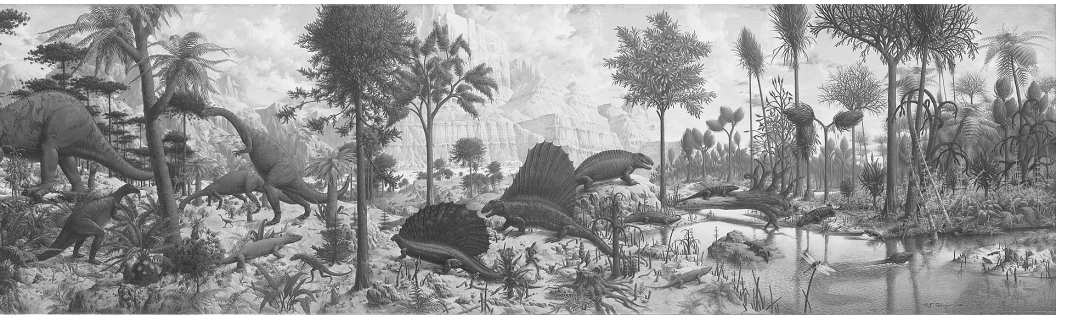


FIGURE I.1. Gentle ruminants populate a segment of Rudolph Zallinger's mural, *The Age of Reptiles* (1947), at Yale University. Created before the asteroid extinction theory of the 1980s, the mural suggests gradual extinction through such agents as volcanos steaming ominously behind the oblivious T-Rex.

efficient and materialistic New World contrasted with the genteel charms of the Old.[6]

Who were these first people to imagine this more ancient America? The pioneers were paleontologists and geologists, born during the Revolutionary era and eager to professionalize the gentlemanly hobby of fossil collecting. Filling private cabinets and new scientific academies with fossilized oysters, stony fern fronds, and fearsome reptile teeth, they mixed science with piety and nationalist ambition. Some had trained for the Protestant ministry before turning their attention to fossils. Many were medical doctors, using their anatomical knowledge to identify and reconstruct the remains of long-extinct animals. In Britain, some of them are still remembered in the names of diseases they described, such as Hodgkin's lymphoma, named for Thomas Hodgkin. Among Hodgkin's leading correspondents in the United States was the physician Samuel George Morton of Philadelphia, notorious today for his enormous collection of human skulls that he measured to insist on the racial superiority of white people. Here, however, we will recover the lost Morton: the internationally influential paleontologist who helped to establish the Cretaceous as a transatlantic geological formation shared by Europe and North America. A few fossil collectors were women. Plants and shells were deemed appropriately feminine



scientific pastimes, and women were counseled to avoid mentioning that flowers were sexual organs analogous to those of animals. Most difficult to recover are the voices and experiences of the many Native and enslaved peoples who formed part of the deepening of time in North America, but I have tried to incorporate them into the story told here. Living within their own chronological schemas, American Indians were subjected to temporal imperialism over the course of the nineteenth century, by which the new language of deep time was used to exclude or belittle other ways of measuring time. Planters deployed slaves to gather and haul fossils, while at the same erecting imagined racial hierarchies that consigned black people to the lowest, most primitive rungs of human social development. Deep time, in short, was a language of exclusion as well as of inclusion. Educated white naturalists deemed some peoples and not others capable of imagining and living in deep time.[7]

Organizers of knowledge rather than abstract theorizers, nineteenth-century American fossil hunters tucked their finds into mahogany cabinets and small wooden boxes. This was God's work. Believing that the order of nature reflected the harmony of the divine, they penned tiny, precise labels for each specimen, some of which survive today as yellowed fragments in America's older natural history museums. They nestled their precious samples in hay-lined wooden crates and dispatched them to colleagues in the United States and abroad. The grateful response was seldom long in appearing: "Your present of Rocks has arrived." For these were not just rocks. They were "hidden treasures of

the Physiological & fossil world." The gnashing dinosaur jaws and curling ammonites decorating the collectors' many letters remind us of the sheer excitement and joy pulsing just underneath the sober scientific prose. From Europe, Mexico, India, and the Far East, fossils and rocks also poured into the United States. All these specimens, accumulated slowly but surely, formed a mighty citadel. The United States was not new, Americans announced from the ramparts, but rather old—as old as Europe, and perhaps older still.[8]

Deep time also bolstered state and corporate power. From theory in the eighteenth century, deep time became infrastructure in the nineteenth. Coal, gold, iron: the industrial age set its table with the fruits of the Earth. Americans monetized rocks and minerals on a grand scale, transforming them into commodities that industries could reliably locate and exploit for profit. The chemical revolution of the late eighteenth century, which prioritized observation and standardization in lieu of idiosyncratic system building, allowed for a much easier assaying of rocks and the separating out of precious metals. Naturalists coined the term *natural resource* to describe the rocks and minerals that powered the Industrial Revolution. American cotton and sugar cane planters, miners, canal diggers, and railroad engineers soon joined in, taking note of stratigraphy and fossils. Whether to dig, drill, or farm above or below a particular stratum could involve a major investment of money and time. By 1860, approximately thirty state geological surveys had been founded, which were joined in 1879 by the United States Geological Survey. These agencies hired a professionalizing cadre of geologists and paleontologists to probe North America's rocky substratum.[9]

Americans did not work alone. Collaboration with European naturalists was essential to the formulation of the idea of deep time. Plunging under the Atlantic Ocean and resurfacing on the opposite shore, rock formations shared by Europe and the United States were transformed during the nineteenth century into an economically legible antiquity. *Synchronous* was the word Americans began to use to describe the ribbons of same-age rock that encased the planet. Locally inspired names for these synchronous bands (such as the Devonian, named for Devon, England) became a shared international code that facilitated resource

extraction across borders. These names also flagged the scientific credentials of the modern nation where they were first recognized. Geologists contributed many names, from the Permian (for Perm, Russia) to the Jurassic (for the Jura Mountains on the France-Switzerland border) to the Mississippian and Pennsylvanian. Deep time underlay the international latticework of capitalist institutions.[10]

The twentieth century dawned with deep time embedded further still in American life. Colleges, universities, natural history museums, magazines, popular books, and silent films spread the idea of deep time to the public. The discovery of prehistoric human remains in Europe in the 1850s energized Americans further still. Human antiquity was a wrenching realization for the many Americans who had long believed that deep time extended only to Earth and its plant and animal inhabitants. Humanity itself, they believed, was cordoned off as God's final creation, lovingly placed in the Garden of Eden about six thousand years ago. But the *caveman*—a word coined in the 1850s to refer to prehistoric humans—suggested that humanity, too, had now joined the rest of creation in deep time, with humans evolving from ape-like ancestors thousands and perhaps millions of years before.

Americans turned to the caveman as an anchor for a nation adrift in the swirling currents of modernity, cut loose from traditional beliefs and ways. What could the caveman teach modern Americans about their society and culture, the dreams and darkest yearnings that lurked beneath their conscious perception? By the 1920s the caveman had become the blank screen onto which a diverse group of influential American intellectuals projected their aspirations: the sociologist (and paleobotanist) Lester Frank Ward; the feminist Charlotte Perkins Gilman; the museum director Henry Fairfield Osborn; Charles Knight, the first major American painter of prehistoric subjects; and the psychoanalyst Beatrice Hinkle, among the first American popularizers of Swiss psychiatrist Carl Jung. These Americans, most of them born after the Civil War when the national compass sought new directions, were the first to imagine that humanity's remote antiquity could point to a better future for the United States. Filmmakers, etiquette advisers, and cartoonists carried their message to the masses in cities, towns, and farms, where it

penetrated unevenly and with varying results. The point is that prehistory and modernity were not separate developments but simultaneous inventions, one the companion of the other. The gleaming future promised by modern progress was rooted in deep time's immensely long backstory, as evolution by natural selection replaced Genesis as the controlling narrative of life on Earth. Modernity needed prehistory just as surely as prehistory needed modernity.

Finally, deep time was an inward journey. A book about deep time is not obviously a book about God. And yet the American Protestants who populate this book often described deep time in the same terms they used to discuss the divine. First and foremost, they were preoccupied by the fundamental unknowability of deep time. Mid-nineteenth-century Americans described the long chronology just as they described the unknowability of the divine. Deep time was a concept that could not be conceived, a span of time so great that the finite and material human brain failed to grasp it. The naturalist David Dale Owen observed that the early Earth was "a period so remote as to defy human conception," while his contemporary Jacob Green deemed the time span between then and now "incalculable."[11]

As a new concept that could not be conceived, deep time presented an exciting cognitive problem different from the long-standing Christian idea of eternity. Christian theologians had long argued that God existed outside of space and time: the divine eternity was both unseen and unchanging. This was so foreign to human beings' lived experience of a visible and changing world that eternity became one of the attributes that made the divine deliciously mysterious and incomprehensible. Visible, material, and changeable, deep time was therefore the opposite of the Christian eternity. Yet it was still so immense as to be as incomprehensible and awesome as the deity. In his history of the American Civil War, published in 1867, the naturalist-historian John William Draper felt compelled to begin at the very beginning: the pre-Cambrian origins of the North American continent (a decision that may explain why his history necessitated three volumes). Draper saw "something majestic and solemn" in the "vast lapses of time" that "our finite faculties vainly try to grasp." One gets the distinct sense from Draper, Owen,

Green, and others that American naturalists enjoyed trying to grasp the ungraspable antiquity of rocks and fossils. They had embarked on a new quest, a journey whose goal was more than empirical knowledge. It was a journey into the soul, what the poet Emily Dickinson, who had studied geology at the Amherst Academy, called the "subterranean freight."[12]

To make deep time real to the senses, Americans crafted a virtual deep time of portable objects: tiny plaster models of trilobites, wooden blocks representing coal strata, linen posters painted red with exploding volcanoes, magic lantern shows featuring primordial landscapes, and magazines and books teeming with scowling sauropods. With this proxy world, they hoped to reveal to the senses what was inconceivable to the mind. They often referred to the *sensorium*: the entire sensory apparatus that included the five senses and the brain's reception and interpretation of sensory stimuli. They imagined that not just humans but also the tiny creatures of long ago possessed this sensorium, a gift from the loving Creator. Piercing the oceans of the infant planet, the light of heaven had reached the "sensorium" of the trilobites drifting below, they wrote. How "marvellous" this was: literally a thing of supernatural wonder. In turn Americans activated their own sensorium to make that ancient world palpably real to their eyes and hands. By midcentury they had crafted a new, portable proxy world small and light enough to be mailed, hoisted aloft on the public lecture circuit, displayed at the front of a college auditorium, or squirreled away in a fossil cabinet. These little things pulsed with meanings that were scientific, educational, ornamental, and spiritual all at once. Casts, posters, books, and magazines further expanded the number of participants in the deep time revolution. While published naturalists often took the credit, these objects were in fact created by artisans and craftspeople whose names appear in tiny script at the edges of book engravings—if they appear at all.[13]

As the mood ripened for communion with the past, the mobile deep time objects were joined by large, immobile objects that created a total experiential world. You went to them; they did not come to you. Murals, moving panoramas, dioramas, painting sequences—and of course the enormous dinosaur skeletons in museum lobbies—these appeared in American cities, towns, and classrooms beginning in the

1850s. Monumental and grand in its sheer size, this immobile deep time gallery enfolded the American public in wondrous lost worlds lying just beyond the here and now. Like a stained-glass church window, the brontosaurus in the lobby pointed to another realm tantalizingly out of reach to all but the human imagination.

Deep time also absorbed another aspect of divinity: omnipotence. A vast canvas of time became the stage for the greatest changes in the history of the planet. Time's agency swelled, with all kinds of natural processes unfolding across its broad lap. The most important was climate, an old agent that was now assigned a starring role in the history of life. Although Aristotle and other ancients had assigned agency to climate, the modern idea of climate change was born in the nineteenth century, when oscillations in planetary temperature over eons were filled with godly power and nationalist purpose. Americans gazed at their continent and saw God's handwriting in the scraped rocks and valleys of the last glacial era. They concluded that God had breathed long global winters and springs, creating and extinguishing life according to his hidden plan.

Slowly but surely, deep time became a new way to talk about God. The long chronology superimposed onto a new, naturalistic timescale the older categories of the divine: infinity, unknowability, wonder, and meaning. The shift from the short Genesis chronology to the billions of years of deep time transcended sects and creeds. Like Manifest Destiny, the mid-nineteenth-century idea that Americans were ordained by God to conquer the North American continent, deep time appealed to many denominations of Christians. Deep time in fact bolstered Manifest Destiny by supplying the opening chapter to the glorious narrative of American progress. In the beginning, God created North America. Then a new nation, consecrated by nature and nature's God, expanded westward across a continent whose antiquity was slowly unveiled and sewn into a golden national future. Swollen with the importance of their vocation, American geologists and paleontologists styled themselves explorers of "time-worlds," their vocation "sublime." The new language of deep time gave Americans a vocabulary with which to frame their nation's place in the cosmic order. Even as it reduced them to specks in a plan-

etary history spanning billions of years, deep time amplified Americans' perceived role in the cosmic order by exposing the sheer immensity of the scale on which their actions unfolded. By the twentieth century, deep time had become a moral outlook. Far from diminishing Americans' moral responsibility in a planetary history so old it defied conception, deep time inserted Americans into breathtaking temporal vistas filled with purpose and shimmering with meaning.[14]

But deep time has also brought Americans—and many others—deep anxiety. Our modern preoccupation with our role in changing Earth's climate—epitomized by the new term, *Anthropocene*—makes us uneasy in part because we are assuming the role that the first theorizers of deep time had assigned to God: control of the future. Nineteenth-century Americans saw primordial life forms culminating in their own Age of Man, a future that God had seen at the outset of everything. Their Age of Man was distinguished from earlier ages by what they thought were the unique moral capacities of human beings. Today, we have seamlessly applied this view to our own era, engaging in the moral imperialism pioneered by nineteenth-century Americans. We project our ethical vision into a distant planetary future that we have convinced ourselves is our own responsibility. One geologist has recently called this conjunction of deep time and morality "timefulness." The Anthropocene makes us anxious about salvation, reconceived in natural terms. That our brains cannot conceive of this awesome past and future time span only adds to the sense that deep time caresses divinity itself.[15]

How did we get here? The answer lies in the deep time revolution, the century between roughly 1800 and 1900 during which Americans invented a primordial antiquity for their continent, their nation, and their innermost selves. If not the traditional God, then some creative force, the invisible behind the visible, walked for eons upon eons with the beings into which he had breathed life, lavishing his children with his creative energies, to their endless wonderment. Or so it seemed to a growing number of Americans, whose story is told in the pages that follow.

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