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Holy Terror

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Sun Never Sets

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Through the Land of Miracles

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at the Center of the World

SIMON WINCHESTER

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THE MAP THAT CHANGED THE WORLD

William Smith and the Birth of Modern Geology

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FOR HAROLD READING

Illustrations by
Soun Vannithone

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Prologue

Psiloceras planorbis

Above one of the many grand marble staircases within the east wing of Burlington House, the great Palladian mansion on the north side of London's Piccadilly, hangs a pair of huge sky blue velvet curtains, twisted and tasseled silk ropes beside them. Although many may wonder in passing, rarely does any one of the scores of people who climb and descend the stairs inquire as to what lies behind the drapes. A blocked-off window, perhaps? A painting too grotesque to show? A rare Continental tapestry, faded by the sunlight?

Once in a while someone curious and bold will demand a look, whereupon a functionary will emerge from behind a door marked Private, and with practiced hand will tug gently on the silk ropes. The curtains will slowly part, revealing an enormous and magnificent map of England and Wales, engraved and colored—in sea blue, green, bright yellow, orange, umber—in a beguiling and unfamiliar mixture of lines, patches, and stippled shapes.

"The German Ocean," it says to the east of the English coast, instead of today's "North Sea." There is, in an inset, a small

cross-section of what is said to be the underside of the country from Wales to the river Thames. Otherwise all is readily familiar, comfortingly recognizable. The document is exquisitely beautiful—a beauty set off by its great size, more than eight feet by six—and by the fact that it towers—looms, indeed—above those who stand on the staircase to see it. The care and attention to its detail is clear: This is the work of a craftsman, lovingly done, the culmination of years of study, months of careful labor.

At the top right is its description, engraved in copperplate flourishes: "A Delineation of The Strata of England and Wales with part of Scotland; exhibiting the Collieries and Mines; the Marshes and Fen Lands originally Overflowed by the Sea; and the Varieties of Soil according to the Variations in the Sub Strata; illustrated by the Most Descriptive Names." There is a signature: "By W. Smith." There is a date: "Aug^st 1, 1815."

This, the official will explain, is the first true geological map of anywhere in the world. It is a map that heralded the beginnings of a whole new science. It is a document that laid the groundwork for the making of great fortunes—in oil, in iron, in coal, and in other countries in diamonds, tin, platinum, and silver—that were won by explorers who used such maps. It is a map that laid the foundations of a field of study that culminated in the work of Charles Darwin. It is a map whose making signified the beginnings of an era not yet over, that has been marked ever since by the excitement and astonishment of scientific discoveries that allowed human beings to start at last to stagger out from the fogs of religious dogma, and to come to understand something certain about their own origins—and those of the planet they inhabit. It is a map that had an importance, symbolic and real, for the development of one of the great fundamental fields of study—geology—which, arguably like physics and mathematics, is a field of learning and endeavor that underpins all knowledge, all understanding.

The map is in many ways a classic representation of the ambitions of its day. It was, like so many other grand projects that survive as testament to their times—the *Oxford English Dictionary*, the Grand Triangulation of India, the Manhattan Project, the Concorde, the Human Genome—a project of almost unimaginably vast scope that required great vision, energy, patience, and commitment to complete.

But a signal difference sets the map apart. Each of the other projects, grand in scale, formidable in execution, and unassailable in historical importance, required the labor of thousands. The *OED* needed entire armies of volunteers. To build the Concorde demanded the participation of two entire governments. More men died during the Indian triangulation than in scores of modest wars. The offices at Los Alamos may have housed behind their chain-link fences shadowy figures who would turn out to be Nobel laureates or spies, but they were all hemmed in by immense battalions of physicists. And to attend to all their various needs—be they bomb makers, plane builders, lexicographers, codifiers of chemistry, or measurers of the land—were legions upon legions of minions, runners, amanuenses, and drones.

The incomparably beautiful geological map of 1815, however, required none of these. As vital as it turned out to be for the future of humankind, it stands apart—because it was conceived, imagined, begun, undertaken, and continued and completed against all odds by just one man. All the Herculean labors involved in the mapping of the imagined underside of an entire country were accomplished not by an army or a legion or a committee or a team, but by the single individual who finally put his signature to the completed document—William Smith, then forty-six years old, the orphaned son of the village blacksmith from the unsung hamlet of Churchill, in Oxfordshire.

And yet William Smith, who created this great map in solitary endeavor, and from whose work all manner of benefits—commercial, intellectual, and nationalistic—then flowed, was truly at

first a prophet without honor. Smith had little enough going for him: He was of simple yeoman stock, more or less self-taught, stubborn and visionary, highly motivated, and single-minded. Although he had to suffer the most horrendous frustrations during the long making of the map, he never once gave up or even thought of doing so. And yet very soon after the map was made, he became ruined, completely.

He was forced to leave London, where he had drawn and finished the map and which he considered home. All that he owned was confiscated. He was compelled to live as a homeless man for years, utterly without recognition. His life was wretched: His wife went mad—nymphomania being but one of her recorded symptoms—he fell ill, he had few friends, and his work seemed to him to have been without point, without merit.

Ironically and cruelly, part of the reason for his humiliation lies behind another set of faded velvet curtains that hang nearby, on another of Burlington House's many elaborate staircases. There, it turns out, is quite another map, made and published shortly after William Smith's. It was in all essentials a copy, made by rivals, and it was made—if not expressly then at least in part—with the intention of ruining the reputation of this great and unsung pioneer from Oxfordshire: a man who was not gently born, and who was therefore compelled, like so many others in those times, to bear the ungenerous consequences of his class.

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But in the very long run William Smith was fortunate. A long while after the map had been published, a kindly and liberal-minded nobleman for whom Smith had been performing tasks on his estate in a small village in Yorkshire, recognized him—knew, somehow, that this was the man who had created the extraordinary and beautiful map about which, it was said, all learned England and all the world of science outside was talking.

This aristocratic figure let people—influential and connected

people—know about the man he had discovered. He reported that he was hidden, incognito, in the depths of the English countryside. He supposedly had no expectation that anyone would now ever remember, or would ever recognize, the solitary masterpiece that he once had made. He imagined he was doomed to suffer an undeserved oblivion.

But on this occasion his pessimism was misplaced: The messages that had been sent ***did*** get through—with the consequence that, eventually, William Smith was persuaded to return to London, to receive at last the honors and rewards that were due him, and to be acknowledged as the founding father of the whole new science of English geology, a science that remains at the core of intellectual endeavor to this day.

It is now exactly two hundred years since William Smith began work on the map that changed the world. What follows, drawn from his diaries and letters, is a portrait of both a long-forgotten man and the world in which he lived and worked, as well as the story of his great map, which has remained hidden behind the blue velvet curtains of a great house in London far too long.

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It was to be twelve years before William Smith returned to spend much time in London. The man who was hurtling and banging his way northward on that summer evening stagecoach, was then at the low point of his life—a life that, when recounted in as full a manner as the evidence allows, turns out to have been more honorable, more deservedly honored, and on a world scale much more important than he, at that moment, could have imagined.

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A Land Awakening from Sleep

Amaltheus margaritatus

William Smith was born into a world of dogma, faith, and certainty, into a conservative English society that his own discoveries and theories would one day help shake to its very foundations.

And yet already—however conservative the mood of the early eighteenth century may have seemed—there are signs that, viewed from today's perspective, suggest that even at the time of his birth it was imperceptibly readying itself for all that discoverers like Smith would find and do. In countless ways, both great and small, the faiths and certainties of centuries past were being edged aside, and the world was being prepared, if gently and unknowingly, to receive the shocking news of scientific revelation.

Not that any of the vague subtleties of coming change had reached very far. William Smith was born, the first son of the local blacksmith in the hamlet of Churchill in Oxfordshire, on March 23, 1769. It was a measure of the rigor and certitude of both the place and the times that there could be great canonical

precision about such a moment. To religious folk—and most English country folk of the time were religious, their daily rhythms set by the steeple bell, their manners regulated from the parsonage—the event that gave a firstborn child to John and Ann Smith in their cottage on the edge of the green in Churchill took place, according to their implacably held beliefs, exactly 5,772 years, four months, and sixteen days after the creation of the world.

Any student of the Bible could have been quite certain about this figure—in fact he or she could have been quite certain as to the very number of *hours* since the Creation, had the Churchill midwife been scrupulous enough to note the time of the infant's birth. A quick calculation could be made on the basis of an almost unchallenged belief about human origins that was then held by most men and women who lived deep in the English shires—the notion that the world had been brought swiftly into existence exactly 4,004 years before the birth of Christ.

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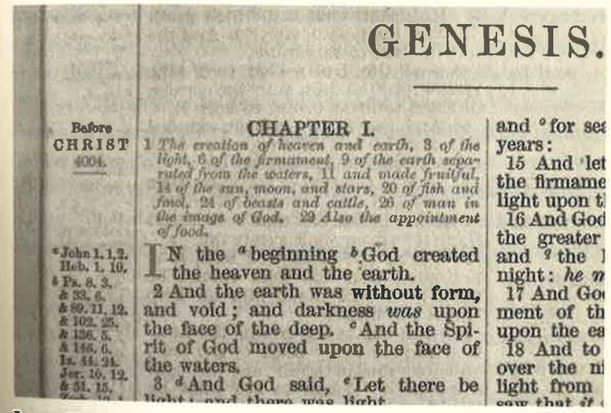
Lest anyone forget, all the Bibles that were in use at the time had dates printed in bold scarlet letters in the margins, annotations to the verses of the Old Testament, designed to act as a gentle reminder. "In the beginning, God . . ." had the number "4004 B.C." written beside it; the text of the Holy Scriptures' subsequent dramas, from Cain and Abel onward, had progressively lower and lower red-printed figures in the margin, until the events in the manger in Bethlehem, by which time the figure had been cycled down to zero.

The dating of the Bible was very much an idea of the later Middle Ages. It had taken decades for anyone to come up with credible numbers. In an effort to do so, scores of scholarly zealots had carefully analyzed the basic biblical idea—which had never, after all, volunteered an age for the earth, merely the manner in which it had come about—by sedulously counting the

number of human generations they believed to have come and gone between the making of Adam and the begetting of Christ. On the basis of their workings it was reckoned, at the close of the sixteenth century, that the world was, give or take, six thousand years old.

It was left to the genial Irish prelate James Ussher, while he was bishop of Armagh, to fix the date with absolute precision. According to his workings, which he managed to convince his clerical colleagues were impeccably accurate, God had created the world and all its creatures in one swift and uninterrupted process of divine mechanics that began on the dot of the all-too-decent hour of 9 A.M., on a Monday, October 23, 4004 B.C.

The cynical and the skeptical may need some reminding of the fine print—of just what was preached in the church in which William Smith was baptized, of the kind of firm beliefs with which his community was invested. Whatever interest Smith the man might later develop in fossils, geology, and the makings of



GENESIS.

Before CHRIST 4004.

CHAPTER I.

1 *The creation of heaven and earth, 3 of the light, 6 of the firmament, 9 of the earth separated from the waters, 11 and made fruitful, 14 of the sun, moon, and stars, 20 of fish and fowl, 24 of beasts and cattle, 26 of man in the image of God, 29 Also the appointment of food.*

[a] John 1. 1, 2. Heb. 1. 10. [b] Ps. 8. 3. & 33. 6. & 89. 11, 12. & 102. 25. & 136. 5. & 146. 6. Is. 44. 24. Jer. 10. 12. & 51. 15.

IN the [a] beginning [b] God created the heaven and the earth.

2 And the earth was **without form,** and void; and darkness *was* upon the face of the deep. [c] And the Spirit of God moved upon the face of the waters.

3 [d] And God said, [e] Let there be

and [g] for sea years:

15 And let the firmame light upon t

16 And God the greater and [h] the night: *he m*

17 And Go ment of th upon the ea

18 And to over the ni light from

James Ussher's dating of Creation is part of the rubric of a Bible from William Smith's lifetime.

humankind, at the time he was born there was no question: The entire process of Creation had taken God the familiar six days, and he had begun it 5,772 years before.

At the start of that late October week, in the year that a modern Christian calendar would style 4004 B.C., the Deity organized the basic concepts of light and dark, sun and moon, wet and dry. He then made every ocean, inlet, river, sandbar, meadow, desert, mountain, icecap, and fjord: The structure of the world, its topography, and the geology that forms the core of this story were complete. By the morning of the twenty-sixth, the Thursday, God had seen to it that life had been begun, and by that evening every first microbe, newt, spider, serpent, eagle, cat, horse, and monkey had been duly set in place, to creep, crawl, swim, fly, leap, spring, and deploy its opposable thumb to climb.

By the following day the botanical phyla were all in place: Every rain forest, grassland, savanna, peony, orchid, rose, palm, apple, pine, and daisy had been left on earth, contentedly to bloom. All of Milton's "rocks, caves, lakes, fens, bogs, dens" were now fully accumulated: An earthly paradise was set, ready to be lost.

And by the Saturday, most important of all, emerged those creatures who would lose it. The first two examples of *ur*-human, in the bipedal and upright (but otherwise subtly different from each other) forms of Adam and Eve, had been created in the Garden of Eden. They were at this stage blissfully unaware, of course, and therefore untroubled by the Fall (which would come later, via the agency of the already created serpent and apple).

Recorded history could now formally begin. Human beings were in place, made in the image of their Maker, and they could do with their world more or less as they and their Maker between them pleased. Thus was it all done. Come midnight on the Saturday, with all this frantic labor done, the weary Divinity slept, having declared that all he had created was good, and fully

ready to begin the adventuring he had ordained for it for the next six thousand years and more.*

Yet, when William Smith was born, the unquestioning acceptance of a notion such as this was beginning to change. There were vague stirrings of enlightenment from among the nation's chattering classes. Some cynical views—in law, criminally heretical ones—that wafted up from the fashionable salons and drawing rooms of London challenged the very likelihood of Divine Creation. Among them was a new notion, still curious and outrageous to most in the eighteenth century, that Earth might in fact be a very good deal older than the human race that inhabited it, such that humankind and its planet might not in fact have been of near-simultaneous origin.

There was no evidence whatsoever for such views—those who doubted Creation were indulging in little more than inspired hunches. In later years the hunches became more certain, and indeed it would be William Smith's discoveries that would go some long way toward confirming them. But at the time he was born they were very much the idle speculations of a tiny group of sophisticates in London. And the capital was a very long way from northwestern Oxfordshire, both in distance and in temper. The muddy and rutted roads that passed across the ridges of the Chiltern Hills, between Oxford and London, did much to keep at bay any such wild and disagreeable ideas as these.

Where Smith was born, among that small muddle of warm-colored stone cottages, with thatched roofs and climbing roses, the village green and the inn and the duck pond and the old

*Few outside the world of the rigid Christian fundamentalists today accept the strict interpretation of James Ussher's arithmetic, which he explained in his monumental work of 1658, *Annalis Veteris et Novi Testamenti*. But nonetheless a 1991 survey showed that fully 100 million Americans still believed that "God created man pretty much in his own image at one time during the last ten thousand years," and anecdotal evidence now suggests that this number is climbing. This might suggest that aspects of the religious climate into which William Smith was born—and that he was to help start changing—are now starting to return.

steepled parish church, beliefs about such weighty matters as humankind's beginnings were unburdened by the complications of too much thought. They were taken on faith as the revelations of Scripture, and when and if they were recounted, they were larded with appropriate and long-remembered quotations from the Book of Genesis.

The infant Smith, whose father and mother were an essentially unremarkable country couple* was thus born into a world of which at least the basis of existence had a certainty. The origins of the planet, just like the origins of mankind, were assumed to be fixed, uncomplicated and divinely directed.

But all such assumptions were to be assaulted, and shockingly so, before the next hundred years were out. To no small degree it was to be William Smith's geological findings, along with a raft of other discoveries, that were to change things. His findings were to prove vitally important in triggering the collision that was eventually to take place between the religious beliefs that were in the ascendant at the time and the scientific reasoning that would provide the spur for the intellectual activities of a century later.

Science was the key—along with the scientific method, with all its underpinnings of observation, deduction, and rational thought. The consequence, once the theories of Charles Darwin in particular had begun to sink in, was a profound modification of the way in which people thought of nature, of society, and of themselves. Which makes it all the more appropriate, given the impact his ideas would have, that it was into a time of suddenly accelerating scientific achievement and technological application that William Smith was born.

For, at the very moment that he was born, things were chang-

*Smith was to feel somewhat embarrassed in later years about his forebears' determined ordinariness, and he tried long and hard to prove that through his mother he was a descendant of Sir Walter Raleigh. He convinced no one and eventually abandoned the quest.

ing, and changing fast. In the year of his birth—which according to parish records at Churchill was 1769—there were, for example, three developments, nicely coincident, that in retrospect suggest all too powerfully that change was in the wind. As indeed it was: For the first time in British history the word *industry* was no longer being used simply to describe the nobility of human labor and had come instead to mean what it does today: the systematic and organized use of that labor, generally with the assistance of mechanical devices and machines, to create what would thenceforth be called *manufactured goods*. The Industrial Revolution, in short, was at hand, and three creations from Smith's birth year are well worth noting, since they more than anything suggest the temper of the times. As it happened, for instance, 1769 was the year of grant of patent for James Watt's first condensing steam engine—perhaps the most important invention of the entire era. Josiah Wedgwood, who had been busily making fine pottery in Staffordshire for some years past, opened his great factory, known as Etruria, near Hanley, also in 1769. And the great field of textile making, which was being steadily revolutionized by a cannonade of new inventions, was most notably advanced by the creations of Richard Arkwright—who made the first water-powered cotton-spinning frame, also in 1769.* Watt, Wedgwood, and Arkwright—a holy trinity from the brave new world that was coming into being—were now unknowingly ushering in the man who would change the view of that world for all time.

In all corners of the industrial world there was change, development, innovation, the shock of the new. Coal, iron, ships, pottery, cloth, steam—these were the mantras of the moment. The great English ironmasters, for example, were approaching their zenith: Cranage, Smeaton, and Cort were developing the processes for "puddling" iron and rolling molten metal.

*James Hargreaves, whose mechanical spinning jenny was destroyed by fearful proto-Luddites, and Samuel Crompton, whose spinning mule was a hybrid of its two predecessors, came only a little later.

Abraham Darby and John Wilkinson were constructing the first iron bridges in the world. Wilkinson, unarguably the greatest of all eighteenth-century champions of things ferrous, was making the first mine railway in 1767, then the first iron chapel (for a congregation of Wesleyans), and was using iron lighters to shift coal to his three furnaces (and, to cap it all, had himself buried in 1808 in an iron coffin).

Iron production was on the way to doubling every twenty years when Smith was born, and coal was too; and—in what would prove of the utmost significance to William Smith by the time he was a grown man—the mania for canal building, to provide a means of transporting all the coal and iron and finished goods, was teetering at its beginnings.

If there were hints of a coming change in the long-held systems of belief; if the industrial world was accelerating out of all imagination; then so also, and as an obvious corollary, social change was underway as well. And when William Smith was born, the rate and scale of alteration to society was such that even those in so small and isolated a settlement as Churchill, Oxfordshire, would be bound to notice.

Parliament, for example, was in the last decades of the eighteenth century passing enclosure acts at the rate of one a week. The formerly common-held land was now gradually being fenced and hedged, and farmed in a way—with the use of new machines and according to the principles of crop rotation—that led to the creation of the English countryside that we still see today, mannered, orderly, and inordinately pretty.

The village of Churchill itself was still unenclosed in 1769. The local farmers worked the fields as most of England had for centuries, taking for themselves alternating strips of the common-held land and on each strip growing crops, or setting each to pasture, or leaving each fallow, as individual mood and season suggested. The method was woefully inefficient, the landscape it created plain and uninteresting.

But then in 1787, under the usual pressure from the local squirearchy and the more powerful farmers, an enclosure act was passed for both the village and its surrounding countryside. Gone, within a year, were the ragged strips of new-plowed land and the mean acres of wood. The gently dipping fields and meadows that are still to be seen today were all hedged and ditched and ha-ha'd into existence when Smith was still a youngster. It was a development that had profound importance for the English farmer and the English countryside. It was also to be of profound importance for the beginning of career and inspiration for the young William Smith.

There was more to the farming revolution than the fashioning of a handsome landscape. To add luster to the newly made meadows there came new breeds of cattle and sheep—Hereford cows, Southdown sheep among them—that started to be introduced in the late eighteenth century, with the animals at last approximating in appearance (fatter, sturdier, and healthier than their bony and goatlike forebears) the look of the breeds to be seen today. Well-to-do farmers were so proud of their new beasts that they had paintings of them commissioned, and by doing so founded an entirely new artistic school of domestic animal portraiture.

Farming methods improved at a staggering rate, and in consequence the output of grain and potatoes and meat rose hugely. White bread became a commonplace in the diet of rich and poor. Cheese became hugely popular. An abundance of cattle feed all year round meant that at long last the winter ritual of eating only salted beef—the cattle hitherto had all died in the first cold snap for want of feed—could now be ended: A joint of roast beef promptly became a central feature of the national dinner table, part of England's national mystique (and, of course, the Englishman's French nickname, *Le Rosbif*).

And this all led to something else. In fact it was during the late eighteenth century—most probably for the first time—that

society suddenly seemed to realize it had become a vastly complicated entity, its characteristics linking and interconnecting with one another in wholly unexpected ways. Such domino effects first became apparent when it was revealed, at the turn of the century, that Britain could no longer feed itself.

The consumption of white bread and roast beef, for example, led indirectly to a set of completely unanticipated consequences. Although the nation's farmers certainly produced a lot—being armed with such weapons as the crop-sowing inventions of Jethro Tull, and the revolutionary land management methods of Thomas Coke, all the benefits of enclosure—and although what they produced, like the bread and the meat, was a delight to eat, it became an unfortunate reality that from that moment on until today, they could not produce enough. England became during this period and for the first time a net importer of wheat and corn.

This was due to the simplest of Malthusian reasons—the fact that the country's population had begun to rise significantly since midcentury. But figures had begun to inch up not because of an increase in birthrate going hand in hand with the rising prosperity, but mainly because of a small but important fall in the nation's death rate. And that was due, in no small part, to the better diet of white bread and roast beef. An unexpected interplay of factors, indeed—all part of the making of Britain as a modern, complicated society, a society readying itself for modern, complicated ideas.

There were other factors in play as well. Health was improving, for example. A child like young William Smith could be more assured than ever before of survival: There was better midwifery, a relative abundance of doctors, the construction of lying-in hospitals for women in labor, the introduction after 1760 of smallpox inoculations, the widespread opening of dispensaries, and a general agreement that fresh air was good for one and that hygiene and ventilation should be regulated—all

such developments, all occurring in the latter half of the eighteenth century, helped to ensure that childbirth was far less risky an adventure than before.

Moreover, people simply knew much more than before. Their lives were more efficient and comfortable than they had ever been. There was ample reason for a new degree of physical contentment—an atmosphere that, for those who were so predisposed, was highly conducive to study, to pondering and wondering. There had been steady improvements in education and literacy (Samuel Johnson's great *Dictionary* had been published in 1755). There was now a mature newspaper industry. The postal system was becoming reliable and even efficient—a letter mailed in London could reach Chipping Norton, which was close to Churchill, the afternoon of the following day, "on every day except Monday"—meaning that people, even in so remote a part of the country as Oxfordshire, could now keep abreast of national developments, could tap into an ever-running wellspring of advice and information.

They could learn, and by comparison with what had gone before, they could learn in double-quick time, something of the trivia of trends—as when eighteenth-century gentlemen farmers were beginning to buy pianos for their newly carpeted living rooms. They could know how a Mr. Chippendale began to turn out enchanting new styles of furniture from a new wood, mahogany, which had been discovered in South America. They could read how ladies in Liverpool, Manchester, and Edinburgh were starting to supplement their inelegant skirt pockets by carrying with them what they would call "indispensables," which would be later called handbags. People in Churchill knew that young ladies of fashion, reading the new colored style journals, were now preferring to sport interestingly pale faces instead of the sunburned cheeks of the peasantry. The women of Churchill could learn all too rapidly how—in part to achieve this look—the recently invented parasols and umbrellas were becoming "quite the thing."

And they could learn of foreign developments—the rising agitation in the Americas being the most vexing—or of the minutiae of their own national government (George III, the capricious and unstable farmer-king who had assumed the throne in 1760, oversaw no fewer than seven governments during just the first decade of his reign).* The population now could and did display its anger and its pleasure at matters of which it came to know. The people could rant against unfairnesses—the naval press-gang, say, which was still much in operation in the port cities. They could cheer and argue over the spread of civil rights—John Wilkes, the "Friend of Liberty," was a prisoner in the Tower† when Smith was born; Thomas Paine was marshaling the ideas that would eventually lead him to write *The Age of Reason*; Edmund Burke was well into his career as the foremost liberal thinker of his time.‡

By 1781—by which time William Smith was a twelve-year-old boy—Samuel Johnson was calling the English "a nation of readers." Few were the major towns that did not have a library. Few were the shop signs in the streets that did not show the name of the merchant instead of merely a picture of what he sold. It was assumed, and with reason, that sufficient numbers of passersby would have no difficulty reading the words on the boards—something that preceding generations (and many on the Continent even then) would have found a considerable challenge.

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*William Smith was born during the administration of the sixth and least distinguished, the duke of Grafton, who acted as caretaker between the administrations of William Pitt the Elder and Lord North.

†The radical politician in whose memory the famous actor Junius Brutus Booth named the son who would assassinate Abraham Lincoln in April 1865.

‡There is a small, Smith-related coincidence here. Edmund Burke made what was perhaps his most famous speech in 1788 when he was opening for the Commons the impeachment proceedings against Warren Hastings, the governor-general of India who, by a coincidence of which the Smith family was only too well aware, had also been born in Churchill. Unlike Smith's small cottage on Junction Road, the house in which Warren Hastings was born still stands. There is some greater fairness in the nomenclature of contemporary geography, however—notably the existence in modern Churchill both of a Hastings Hill and a William Smith Close.

No matter the outcry that allowing the working classes to become educated was to debauch them and tempt them to abandon the manual labors for which they were best suited. "Nineteen in twenty of the species were designed by nature for trade and manufacture," said a writer in *The Grub-Street Journal* at the time of Smith's birth. "To take them off to read books is the way to do them harm, to make them not wiser or better, but impertinent, troublesome and factious." That kind of thinking was rapidly to become outmoded during the years when Smith was growing up: Whatever the political outcome—whatever the effect of the new phenomenon of public opinion, which literacy, communication, newspapers, and libraries encouraged—the nation, save for its most reactionary elements, seemed generally prepared to come to terms with the new mood for change.

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William Smith's formative years unrolled through a period that was both astonishingly vibrant and deeply challenging. Advances were firmly under way in almost all applied areas of science and philosophy, and in social change and artistic endeavor as well. But there was still a terrible hesitation about humans' understanding of the most fundamental questions of why they were where they were, who had placed them there, what was the point, what were their origins, what was their fate?

The hesitation was deep rooted; it stemmed, at least in part, from the frank reluctance of eighteenth-century men and women to accept that there even *was* a need to know and wonder at such things. To inquire with true rigor into matters that lay at the heart and soul of his and all society's beliefs smacked, indisputably, of heresy. Even by the time that young William Smith was starting to take advantage of the world's new and inquiring mood, there was still the wide acceptance—not yet contradicted by any evidence that seemed to matter—that God had created both human beings and all the world in which they

lived. That was that: No more needed to be said.

And yet. A very few bold and more radically inclined thinkers—Joseph Priestley, one of the discoverers of oxygen, and Erasmus Darwin, Charles's grandfather, among them*—were beginning, in these same extraordinary years, to take a more muscular and skeptical approach to the received wisdom of the Church. By the time Smith was coming to his maturity, questions about these fundamentals were being asked by more than the mere metropolitan sophisticates. The hunch that God might not have done precisely as Bishop Ussher had suggested, or during the time he calculated, was beginning to be tested by real thinkers, by rationalists, by radically inclined scientists who were bold enough to challenge both the dogma and the law, the clerics and the courts.

There was in those early days much more questioning than there was answering. It was a period more marked by bewilderment than certainty. While most still believed that the Scriptures could comfortably provide answers to all the questions about earthly origin and human purpose, there was a growing and more frequently admitted sense of puzzlement as well—a puzzlement that seems to have been most keenly felt among those scientists and engineers who were observing the natural laws of physics and chemistry, who were working with steam or fashioning iron or digging cuts through cliffs. Among those and others who knew something of the newly formulated laws of science, there was a new mood of questioning that hinted that maybe, just maybe, the old beliefs, rooted in the blind acceptance of churchly teachings, might not have been wholly true.

A febrile fluttering of questioning began—about what exactly

*Joseph Priestley and Erasmus Darwin, along with Josiah Wedgwood and James Watt, were all Lunaticks, members of Birmingham's Lunar Society, which met monthly on the occasion of the full moon. Freethinking, radical ideas were welcomed by a group that was principally involved in applying scientific discovery to the newly flourishing world of industry.

was the world? How had it, and all that was in it, really come about? Was it sacrilege to wonder such a thing? Was it blasphemy to ask? Would lightning strike down anyone who questioned the likelihood of James Ussher's numbers being correct? Would plague and boils tear at the vitals of anyone who asked out loud just what story might it be that lay buried in the stones beneath our feet?

And all this questioning tended to coalesce around one new and barely structured field of study and fascination. Could it perhaps be that *geology*,* the frail and stripling science that had first been established to inquire into the nature of the earth before and after the Deluge, could it be that *geological* inquiry might hold the answer? This was a science that, after all, had at least the potential—if it could be divorced from churchly dogma—to at least define and then ask the questions to which answers now seemed so urgently needed.

At the time of Smith's birth, geology and those few men who called themselves geologists saw it as no part of their duties to inquire more fully, to delve more deeply, into what were still seen as the realms of the Divine. And yet some scientists were beginning to wonder if geology really was to be confined like this—if it was obliged to function only within the framework of faith, and not to challenge it one whit—then was it truly worthy of being called a science at all?

Maybe, though, it could rehabilitate itself. Maybe geology was the one new scientific discipline that, if applied courageously, might be able to help answer the fundamental and unasked questions that were beginning to trouble those tentative, nervous questioners. Perhaps geology could be the key for those who, in

*The word is first used in English in its modern sense in 1735, though only rarely—and probably not until 1795 can it be considered a mature and full-fledged concept. There was no mention of geology in the 1797 Third Edition of the *Encyclopædia Britannica*; but the Fourth, which came out in 1810, had a lengthy entry, the science by now fully established.

the enlightened, wondering spirit of the times, were at last beginning to tap their fingertips on the stout door of received belief?

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Many Europeans who found themselves in England in the closing decades of the eighteenth century talked of seeing a country "waking itself from sleep." Many in England agreed and wondered out loud: Could it be that in shaking and worrying and waking from its sleep the very land itself, by asking at last what exactly *was* that land, and how it had first come into being—could it be that by doing this they might answer questions that would help lay bare the very core of knowledge?

That was what a few men were at the time beginning to wonder. In turn the wonderment of some of them—a country surveyor here, an Oxford-educated priest there, a fossil-collecting dilettante in this city, a radical-minded landlord in that—would be passed down to the intelligent and inquiring young Oxfordshire lad, who would before long help lay the foundations for a brand-new science that would inquire, quite fearlessly and, eventually, scandalously into the foundations of just about everything. William Smith appeared on the stage at a profoundly interesting moment: He was about to make it even more so.

8

Notes from the Swan

Parkinsonia parkinsoni

In eighteenth-century Britain it was a mark of refinement and impeccable good taste to own and display a collection of fossils. Not only were the objects themselves rare and beautiful, well worthy of display in specially constructed glass cabinets; the simple possession of them hinted at a thirst for knowledge, an awareness of natural philosophy, a sympathetic understanding of the mysterious processes of the earth. And gradually it was from within the world of fossil hunting—a world that would soon be inhabited most prominently by William Smith—that the ideas emerged that would eventually lead Charles Darwin and Alfred Wallace to reach their profound conclusions about the origins of species.

Perhaps for the British ***boulevardier*** in the eighteenth century, the interest in fossils was for their beauty and rarity, little more. The items, be they small or large, plant or animal, or merely the mysterious results of the fossil-making "plastic force," would be displayed with reverence, handled with delicacy, viewed with awe. Collectors of fine jade today are a fair compar-

ison with those of fossils two centuries ago—in that they are proud and protective, given to learning and (usually) the possession of some social standing. The clear and important difference is that the intricacies of objects made of jade are the artifice of human beings, while the strangely beautiful shapes and marks that delineate a fossil are the evidence—if ever in eighteenth-century Britain there was agreement on this matter—of the work of God.

The *Dictionary of National Biography* records the occurrence of the plural word *fossils* 293 times, and 177 prominent men and women from British history are listed as having had an interest in, or more likely a collection of, such treasures. Most of the listed collectors appear to have lived between the mid-eighteenth and mid-nineteenth centuries. Few people whose lives are otherwise worthy of recording seem to have collected fossils before 1700; and as with postage stamps and coins, few contemporary amateur fossilists will admit to a mania for collecting them.

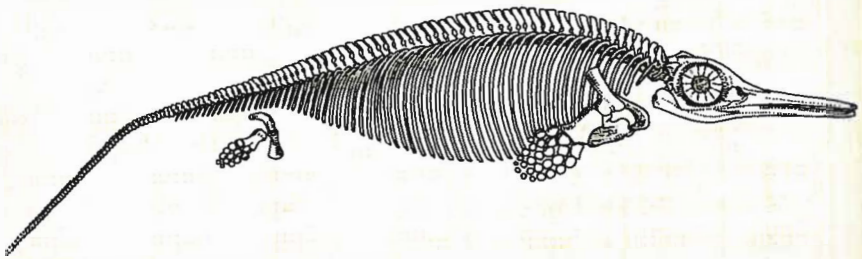
Indeed the fashion—for that is all it was, a fashion—began to die in mid-Victorian times. The spread of travel and a growing amazement with the outside world suddenly began to make anthropological souvenirs more valued as icons than dirt-encrusted items from earth history. All of a sudden drawing rooms became places to record and show off the material rewards of journeying through space, rather than the dusty and mysterious objects that came from journeying through time. What had hitherto been a signifier of drawing-room decorum seemed overnight to become the pastime of the dull, and then steadily to evolve into what amateur paleontology is now: no more than the mark of the nerd.

There is much to learn from the *DNB* about the nature and the habits of onetime fossil collectors. The 177 entries show the typical collector of the time to have had certain outward similarities of background, knowledge, and social standing. Most of them—this being the less sexually enlightened end of the nine-

teenth century—happened to be men, although by chance it was a young Dorset woman who was perhaps the most famous fossil collector of them all.

Mary Anning was thirty years younger than William Smith, and there is no record that the pair ever met—but her birthplace and scene of all her paleontological triumphs, the small seaside town of Lyme Regis, evidently interested Smith: In one of his notebooks there is a rough sketch-map of the Lower Jurassic sea-cliffs there, dated 1794—five years before Mary Anning was born.

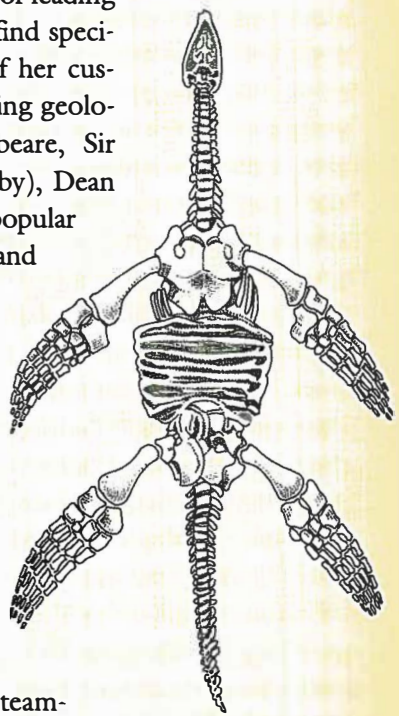
Her life was short indeed, even by the standards of the day—and yet the fact that she survived a lightning strike (which killed three adults) when she was a year old always lent locals a suspicion that hers would be an eccentric and furious one. Most of it she spent carefully prying choice specimens of fossil creatures from the Lias cliffs near her home. Her father had taught her something of fossil gathering, since his own business was making the very cabinets in which the well-heeled local collectors would keep their specimens. Her best-known find is the original ichthyosaur, a massive confection of shiny brown bones she first disposed of to the duke of Buckingham, which is now carefully reconstructed in London's Natural History Museum. She was only twelve when she found it, only twenty-two when she discovered a juvenile specimen of the huge marine reptile later



A fossil ichthyosaur.

named a plesiosaur,* and not yet thirty when she found a near-perfect specimen of the bird progenitor, the pterodactyl, and sent it off to Oxford.

For a while this untutored young woman made a sizable income, either by selling fossils to visitors—for whom Lyme Regis is still a major tourist center today—or leading would-be collectors to the cliffs to find specimens for themselves. The names of her customers are like a roll call of the leading geologists—of the day—William Conybeare, Sir Henry de la Beche (who lived nearby), Dean William Buckland. But slowly the popular craze for collecting began to wane, and by 1847, when Mary Anning died at the age of forty-eight of breast cancer, she had been all but forgotten and had passed into obscurity.



A fossil plesiosaur.

De la Beche, who went on to become the first director of the British Geological Survey, drew a fanciful cartoon for her, showing what Dorset might have looked like in the Middle Jurassic, with enormous and rather genial-seeming monsters rising from the steaming deeps. The drawing became rather popular, and Sir Henry made sure that all the proceeds went to Mary, to help this modest heroine of the science as her fortunes began to decline.

*She wrote to Buckland, the flamboyant and eccentric professor of geology at Oxford, about her discovery of the baby plesiosaur, well knowing that he would find delightful her observation that the animal's neck "had a most graceful curve," and more charming still her discovery that, lodged above its pelvic bone, right where its colon would have passed, was a newly formed coprolite, a fossilised version of the item that, had it lived, the beast was just about to leave steaming in its wake.

There was another woman geologist and collector whose name does not figure in the existing DNB, but should.* She was Etheldred Bennett, a great-granddaughter of a seventeenth-century Archbishop of Canterbury. She was born in 1776, and she definitely met William Smith—indeed, gave him a piece of the well-known Tisbury coral, of which she was England's best-known collector. She made a specialty of exploring the Middle Cretaceous upper greensand in the Vale of Wardour, in Wiltshire: As a relative wrote, "while other ladies of her time were doing needlepoint and chattering over their cups of India tea, she became competent at systematic scientific research, as well as the vigorous fieldwork of fossil hunting." She had a monograph privately printed: *A Catalogue of the Organic Remains of the County of Wilts.* All evidence suggests she died a maiden aunt; her family insisted that one of the specimens later placed in her collection, nestled among her sponges and her corals, and thanks presumably to a cooperative undertaker, was her own heart, unbroken but quite petrified—transformed to resemble a stone, as a geologist's heart perhaps deserves to be.

Most amateur collectors were comfortably established, for fossil collecting was widely seen as a fashion for gentlemen of leisure. Men like, for example, the redoubtable Sir John St. Aubyn, fifth baronet, sheriff of Cornwall until his death in 1839, a grand master of the Freemasons, and a man who augmented his immense collection of minerals by buying for one hundred pounds the entire fossil collection of the remarkable Richard Greene of Lichfield. Greene, so far as we know, was a like-minded swell who had amassed (to the approval of his friend and relative Samuel Johnson) a houseful of "coins, crucifixes, watches, minerals, orreries, deeds and manuscripts, missals, muskets, and specimens of armour," as well as hundreds of ancient shells, graptolite etchings, and ammonites made of iron pyrite.

*And indeed will appear in the *New DNB*, thanks to the efforts of her champion, Hugh Torrens.

Then there was, at almost exactly the same time, the East India Company's naval officer, London banker and magnificently named Searles Valentine Wood the Elder, whose curiosity was first stirred while he was convalescing in Norfolk, but who, once recovered, embarked on a lifelong study of the fossil mollusks to be found in the construction sites of London. He was a member of the little-known body the London Clay Club, and wrote book after book on his enormous collection of fossil bivalves, which he eventually donated to the British Museum. The Natural History Museum in South Kensington, where they rest today, is replete with the evidence of a century's worth of enthusiasms like Valentine's—collection after collection, testimony to the value of the amateur scientists who so flourished in this remarkable time in British history.

Many of the most assiduous fossilists were what used to be called "divines"—a curious happenstance, considering the assault that any intelligent understanding of fossils would later have on divinity's most firmly held notions, like the Creation and the Flood. The Reverend Thomas Lewis of Ross-on-Wye is characteristic of the type: He is proud enough to offer a self-description—"geologist and antiquary"—rather than to note his formal position as vicar of Bridstow. His name may be forgotten by the curacy, but it is remembered in at least three Silurian fossil species that were named after him, all of them appropriately worthy (as may befit a clergyman) and rather dull.

Many of the priestly collectors found in fossil hunting a much-needed intellectual stimulus, a relief from the unengaging topics that normally fill a parson's life. The Reverend George Young, from the Scottish village of Coxiedean, was a theologian attracted to the mysteries of fossils. He had been taught by John Playfair, one of the giants of early academic geology, and he came to prominence in 1819 with his discovery, in Yorkshire, of a gigantic reptile ichthyosaur since identified as *Leptopterygius acutirostris.*

Though the find brought the enthusiastic Presbyterian minis-

ter some national fame—for a while he was held in almost the same esteem as Mary Anning—it equally confronted him with an interesting challenge, an acute mental and moral dilemma. It forced him to ponder two possibilities that his religious beliefs sternly discountenanced: animal extinction on the one hand (there were no living ichthyosaurs—and so this particular species must have vanished), and animal evolution on the other (the crocodiles and dolphins to which this beast appeared to have been related were much less primitive than this—and so some advances must have taken place over time; the less fit and able must have been weeded out and left behind to die). Consideration of either of these possibilities was a heresy and an anathema to contemporary followers of the Bible, who regarded the great book (as do fundamentalists today) as nothing less than a documentary history of the planet.

The Reverend Young was forced in consequence to engage in some interesting spiritual gymnastics to come to terms with the problem. He eventually committed his conclusions to paper in 1840 in a book with what might be considered the somewhat contradictory title *Scriptural Geology*. The science he advanced in it was not overendowed with logic: The ichthyosaur he had found was not extinct, he declared, because a living specimen would probably be found sooner or later: ". . . when the seas and large rivers of our globe shall have been more fully explored, many animals may be brought to knowledge of the naturalist, which at present are known only in the state of fossils." (It would have amused Mr. Young greatly had he been alive at Christmas 1938, when the first coelacanth was found on the deck of a trawler newly come ashore in South Africa. He would doubtless have thought this vindicated his otherwise dreamily unscientific view.)

And as for evolution—Darwin's theory was not to be outlined for another twenty years, but men like Young, students of the realities of the fossil world, were already moving hesitantly toward the brink:

> Some have alleged . . . that in tracing the beds upwards we discern among the inclosed bodies a gradual progress from the more rude and simple creatures, to the more perfect and completely organised; as if the Creator's skill had improved by practice. But for this strange idea there is no foundation: creatures of the most perfect organization occur in the lower beds as well as the higher.

The Reverend Young could not, however, go any further than this: The forces ranged against him—of custom, history, doctrine, and common acceptance—were just far too formidable.

My own favorite, though sadly no more than a peripheral player in this story, is Samuel Woodward, a Norfolk collector and almost exact contemporary of Smith's who worked for all of his forty-eight years in either an insurance office or a bank. He was fascinated by fossils and built up a large collection. He was not nobly born, however, nor could he have been described as a gentleman for whom paleontology was merely an idle pursuit for impressing the neighbors. He was ordinariness personified: His father had been a bombazine weaver, and his own apprenticeship was in the making of camlets.* Smith would probably have liked him: Both were men of modest beginnings, for whom fossils were more a passion, less a pastime for the ***au courant***.

Yet it was not to be one of these modest men but a number of the more gently born collectors and spiritual figures whose influence was eventually to help place William Smith firmly on the flood tide of history. There was William Cunnington, a man still remembered around Devizes as being the antiquary who excavated most of the ancient long barrows with which the chalk downs of the country are littered. It was Cunnington who introduced Smith to the aforementioned Miss Bennett, who fascinated him

*Bombazine is a thick fabric that, in black, is often used as mourning dress; camlets are fine cloths woven from angora or mohair, as fashionable in the eighteenth century as pashmina was to become in more recent times.

with her collection of sponges and corals. The man who would later become the Father of English Geology thus briefly encountered the person who, in some circles at least, is thought of as English Geology's First Woman if not quite (since she remained unmarried, and was described as "somewhat mannish") its mother.

There was the Reverend Richard Warner, a great man for both writing and walking,* but a figure who suffered "severe and reiterated disappointments"—for one of his books was judged a plagiary, another set of volumes was burned by mistake at the printer's, and someone "dressed up as a gentleman" (or so wrote William Smith) made off with his immense fossil collection by giving him a check that then promptly bounced.

There was the somewhat happier Reverend Benjamin Richardson, the rector of the Somerset parish of Farleigh Hungerford. There was also Richardson's longtime friend, the Reverend Joseph Townsend, who was by calling a doctor and a Calvinist minister, then living in Bath, who had been well and expensively educated at Cambridge and Edinburgh. Townsend had traveled widely in Spain, and had brought back hundreds of fossils from the local limestones. He had not, Smith was later to write with relief, drawn any conclusions from his finds, and he was to remark later, and ruefully, "Ah, Smith, were I now to go over to Spain again I should give a very different account of the country."

He would do so because, for the first time, William Smith was beginning to take a keenly intelligent interest in not just the rocks in the cuttings of the coal canal, but of the fossils too. And once he had begun to do so, then who better with whom to discuss his discoveries than the local worthies who had amassed collections themselves? His newfound social standing, his now-close friendship with the widowed Lady Jones of Rugborne, his relatively good financial condition, his ownership (even if mortgaged) of a small and pretty estate at Tucking Mill, his brief occupancy of a substantial terraced house in Bath itself—all these features commended the uneducated Smith to learned men like Townsend and Richardson, Cunnington and Warner, and allowed them to play a role in his life that he would later acknowledge as of huge importance.

*His *Walks through Wales* was an eighteenth-century bestseller; his *English Diatesseron* somewhat less so.

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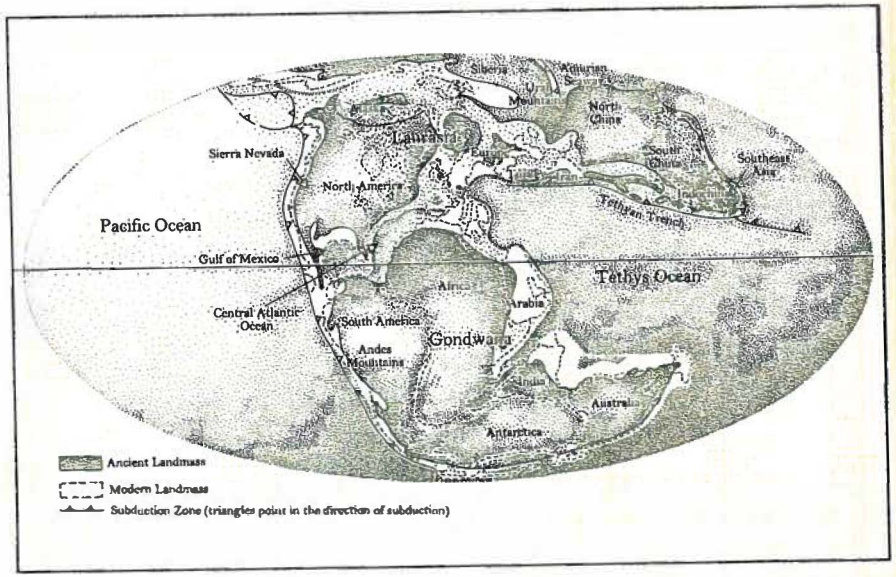
His work on the canal bed and its continuing line of progress was sometimes more confusing than it should be. Smith had no problem recognizing the differences between most of the strata, true: there was a very obvious difference between the red marl and the coal measures, an equally obvious difference between the spawnlike granules in the limestones of the inferior oolite and the arenaceous beds of the Lias. Yet some of the strata through which the excavators were making progress, particularly the finer-grained sandstones, looked too similar. From time to time it proved very difficult, Smith found, to differentiate one bed from another: In one cutting there may have been a sandstone and in another, half a mile away, there may have been another that looked identical—and yet, to judge from a dip and strike that did not vary between the two outcrops, logic suggested that the two formations were not the same at all, had been laid down at different times, and were in fact separated by hundreds, perhaps even thousands, of feet of vertical distance.

To understand the nature of this problem it is perhaps easier to imagine something of the circumstances when the rocks were being laid down. Think, for example, of the conditions in the Lower and Middle Jurassic in North Somerset—something, it is worth remembering, that Smith would have been quite unable to imagine since he had no idea of the ages of the rocks he examined, of the paleogeography of the region, of any of the concepts that permeate modern geology.

He would not have known what modern science allows us to

know, which is that for most of the 51-million-year period of time that began 208 million years ago, when the Jurassic opens, most of North Somerset was covered by a shallow sea, at the western edge of a vast ocean called the Tethys. In addition, since all England was then positioned about thirty-five degrees north of the equator, the waters were subtropical, and warm.

But the sea in those days, much like the sea today, was not uniformly deep, and, since it was at the edge of the Tethyan Ocean, it was at times close to landmasses from which, in places, rivers cascaded or seeped, estuaries were formed, volcanoes erupted, cliffs collapsed, and where currents of sand and water swept down through deep ocean canyons. Paleogeography is a study that involves the constant remembrance of time and space, as well as all the physical conditions in which a particular rock type may be laid down—meaning that at any one time, several



The extent of the Tethyan Ocean in Middle Jurassic times, 152 million years ago.

different rock types may be being deposited or created at different places; and that over any extended period of time the very same rock—or at least, rocks with the very same lithology—may be being laid down at different places.

Hence the confusion. When William Smith was looking at the sandy outcrops of the Upper Lias in a few square miles around the village of Midford, say, he might find a succession of sandy beds in one valley, and another succession of sandy beds in another valley, that looked to all intents and purposes the same, but that his knowledge of their dip and strike and distance apart persuaded him were not the same at all—that the bed lying on top was younger than (that is, had been deposited more recently than) the bed that lay below.

The conditions governing the type of rock, the facies, that had been laid down in each of these two valleys had been exactly the same—they had been deposited near the beach of a warm and shallow sea, with maybe some incoming muddy deposits from a nearby river. But their attitude—going back to the bread-and-butter analogy he had come up with back in his High Littleton days—still applied: they could not have been the same bed of rock, and they must have been separated by scores, maybe hundreds of feet—and hundreds of feet meant at the very least, a long period of time. What the outcrops indicated was two different periods of time, when the same conditions for deposit obtained. How, then, to tell the rocks apart?

The answer lay in Smith's sudden realization that there was just one aspect of the two types of rock, and only one, that differed. The blocks of stone found in the cuttings may have all had the same color, an acid bottle would show them all to have the same chemistry, a magnifying lens would show the sandstones as all having the same grain size. But the fossils that were to be found in the two rocks—the bivalves, the ammonites, the gastropods, the corals—***they were all subtly different.***

Every single one of the specimens of one kind of fossil might

be the same throughout one bed, but would be subtly different from those of the same kind of fossil found in another bed. A period of time would have elapsed between the deposition of the two beds, and thus a period of time between the existence of the two kinds of animals it embraced. Evolution—we can say this today, but Smith had not even the vaguest conception of it back then—would have occurred. Those animals of which there would be fossilized remains that were found lower down in the series would be more primitive; those found in the rock layers above, less so. But that was not the point. The important discovery that Smith made was that certain beds had certain fossils, that they were unique and peculiar to that bed and to that period of time in geologic history. They were never to be seen again in rocks that came later—in other words, in the rocks that appeared above. They were never seen before, either: They were peculiar, that is to say, to a certain and specific period in geologic time; they were the key to making a positive identification of what one rock might be in relation to any other.

Day after day during the late summer and autumn of 1795, whether he was working surveying the canal or simply clambering over rocks that interested him while his horse champed contentedly beside him, Smith tested and retested his theory. At each outcrop he came to he would gingerly chip and pry and prise as many fossils as he could from their enfolding rock. Each evening he would take his specimens back to his elegant new terraced home in Bath. He would wash and dry each fossil, be it a pedestrian looking oyster shell or the magnificent twirling fantasy of a full-blown ammonite, and lay each carefully, on a pad of cotton, in drawer after drawer of his cabinets, carefully noting the rock, the horizon, the facies, and the lithology from which each came.

And as his systematic collecting proceeded, and as the size and quality of his collection was daily enhanced, so his theory was confirmed and reconfirmed: A layer of rock, it now seemed

incontrovertibly true, could be positively and invariably identified simply and solely by the fossils that were to be found within it.

Wherever in the hills around Bath a sandstone appeared with a particular specimen of fossil enclosed within, then it was certain that it was the very same rock, laid down at the very same time. And if this rock-and-fossil assemblage appeared not just in the hills around Bath, but in the valleys of Oxfordshire too, and was found in a quarry in Rutland, beside a road in Lincolnshire, on a peak near York, and finally in a cliff near Whitby, then it, too was the selfsame rock. Not just a similar rock: the same rock. And then, the corollary said, by joining the dots of its occurrence across the land, one could show just where this particular rock occurred all over the nation, and whether it made an outcrop or not. And one could do this not just in the nation, but in theory all over the world. One of the enigmas that was central to an unraveling of the mysteries of the planet had now demonstrably been solved. What he had vaguely imagined might be true when he looked through the mines near High Littleton, was clearly an axiom, a fundamental fact of the new geological knowledge. And he, William Smith, was the first to say so.

Smith was exultant at his realization, and committed his thoughts to paper with excited promptitude. He was in the Swan Inn at Dunkerton, sheltering from the cold on the evening of Tuesday, January 5, 1796. He had decided that evening not to brave the elements, not to go back home to Bath. He took a sheet of paper and wrote in his distinctively bold handwriting a long single sentence. The note survives, its underlining preserved for posterity. It was a sentence that, of all he wrote, is perhaps most deserving to be his epitaph:

> Fossils have long been studied as great curiosities, collected with great pains, treasured with great care and at a great expense, and showed and admired with as much pleasure as a

child's rattle or a hobby-horse is shown and admired by himself and his playfellows, because it is pretty; and this has been done by thousands who have never paid the least regard to that wonderful order and regularity with which Nature has disposed of these singular productions, and assigned to each class its particular stratum.

Later, in more reflective mood, he would write:

For six years I put my notions of stratification to the test of excavation; and I generally pointed out to contractors and others, who came to undertake the work, what the various parts of the canal would be dug through. But the great similarity of the rocks of the Oolite, on and near the end of the canal towards Bath, required more than superficial observation to determine whether these hills were not composed of one, two or even three of these rocks, as by the distinctions of some parts seemed to appear. These doubts were at length removed by more particular attention to the site of the organic fossils which I had long collected. This discovery of the mode of identifying the strata by the organised fossils respectively imbedded therein led to the most important distinctions.

In reflective mood Smith seems more the engineer, less the romantic. In middle age he is, and understandably, no longer quite so astonished at the "wonderful order" that he had realized the fossils displayed—an astonishment of discovery which today remains the most haunting aspect of that hastily scribbled note made at the Swan Inn. But the message remains the same, however eloquent or sentimental the prose. A puzzle had been solved. A riddle unscrambled. Now was the time to make something of the answer.