

# NOTES FROM DEEP TIME

A Journey Through Our Past and Future Worlds

HELEN GORDON

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<i>Eon</i>	<i>Era</i>	<i>Period</i>	<i>Millions of years before present</i>	<i>Epoch</i>	
Phanerozoic	Cenozoic	Quaternary	2.58	HOLOCENE PLEISTOCENE	
		Neogene	23		
		Palaeogene	66		
	Mesozoic	Cretaceous	145		
		Jurassic	201		
		Triassic	252		
	Palaeozoic	Permian	299		
		Carboniferous	359		
		Devonian	419		
		Silurian	444		
		Ordovician	485		
			Cambrian	541	
	Pre-Cambrian	<i>Proterozoic Eon</i>		2,500	
		<i>Archean Eon</i>		4,000	
<i>Hadean</i>		4,600			

## DEEP TIME ON CAMBRIDGE HEATH ROAD

‘Ten thousand years is nothing,’ the geologist told me. ‘Ten thousand years ago is basically the present.’

Ten thousand years ago Britain was still a peninsula connected to the continental mainland. In America meltwater from retreating ice sheets was filling up the great lakes: Superior, Michigan, Huron, Erie, Ontario. Worldwide, the human population numbered only a few million. If ten thousand years is basically nothing, then it’s a nothing that encompasses the entirety of recorded human history, from the development of writing to space travel and the atom bomb.

Geologists, I was beginning to realise, see the world a little differently from other people. It comes from living half inside what we might call human time and half inside another larger, weirder scale – that of deep time. If human time is measured in seconds and minutes, hours and years, then deep time deals with hundreds of thousands of years, with the millions and the billions. Thinking about it engenders a sort of temporal vertigo. To live in deep time is to take the long view, which means getting your head into a somewhat different place. In deep time it is not just what happened last week or last year or

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last decade that matters – it’s also what happened a million, 50 million, 500 million years ago. It’s about the ways in which the succession of events across those millions of years can be said to explain why you’re here right now in this particular place, in this particular moment.

\*

Some time ago I became a little obsessed with the bright white chalk of the North Downs, the long ridge of hills that push up out of suburban south London. It was late January. The previous year a longish relationship had ended, and on New Year’s Day what might have become a new relationship had also finished. The explanation from the man involved had been couched, somewhat confusingly, in a reference to the ending of J. M. Coetzee’s *Disgrace* – a novel that I’d read but which seemed, and continues to seem, to me, to have little bearing on that particular romantic situation. Feeling the need for distraction and a change of scenery, I bought a train ticket.

Travelling south out of London, it’s when you reach the North Downs that you begin for the first time to get a sense of separation from the city. Sitting on the broad back of a fallen oak tree, looking out across a bare, flinty field towards far-off grey and silver towers, you might begin to get some perspective on things – distance, at least.

After lunch I followed a path along the Ridgeway, an ancient long-distance route through the Chiltern Hills and North Wessex Downs, sticky brown mud slipping over soft white rock. Somewhere between the commuter towns of Coulsdon and Caterham, I came across an information board conveying several simple but confounding facts. That the ground I was walking on was the remains of a long-vanished, prehistoric

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ocean. That this ocean had disappeared shortly after the end of the age of the dinosaurs. That whenever you are standing on chalk, you are standing where the sea used to be.

Wanting to know more, I visited the Natural History Museum in South Kensington and smaller, local museums where rows of specimens were displayed in dusty cabinets with narrow labels written out on long-defunct typewriters. I read introductions to geology and talked to sedimentologists and stratigraphers and palaeontologists. I joined field trips to quarries and exposed cliff faces, and learned that the history of deep time is written in the rocks all around and underneath us. In a lump of chalk I found a milky-grey spherical sea sponge the size of my smallest fingernail, its surface pricked with countless tiny holes. I read that some scientists believe that sponges were the first animal group to branch off the evolutionary tree from our common ancestor, making them the sister group of all other animals.<sup>1</sup>

\*

Several years after that trip to the North Downs, I stood one summer afternoon peering through the chain-link fence of a building site on Cambridge Heath Road in east London. It was a little after 5 p.m., and the workmen had gone for the day, leaving behind just a solitary excavator looking, as excavators do, a little beastish with its drooping, angular neck and large metal jaw resting on top of a mound of dark earth. It was the hole the excavator had dug that I was interested in.

Walking around London, we know, if we care to think about it, that beneath our feet are many layers of rock, most of which have never seen by human eyes because there were no eyes to see them when they were first formed, or through the long story of



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them being buried and hidden and lost. Anyone with a thirst to tread on *terra incognita* might as well dig downwards in their own back garden as travel to the middle of Antarctica. Geologists learn to read these layers and from them construct a story about the past. Each layer represents a former world that came into being, existed for thousands or millions or years and then vanished, compressed into a layer of rock.

‘Most humans are chronophobes,’ the geologist Marcia Bjornerud has written.<sup>2</sup> ‘We worry about where the time has gone, whether we’re spending it wisely, how much of it we have left. Geology puts things in temporal perspective.’ An excavation in the middle of the city is a portal to the past, a space to look backwards and recalibrate. For the last month I’d been searching for such a site. Then Jonny, my husband, messaged me from his office. On the train into Liverpool Street he’d spotted the excavation on Cambridge Heath.

The sides of the hole showed three distinct layers of earth and rock set neatly on top of one another like a layered pink, white and yellow angel cake. The preciseness of the layers gave the appearance of an illustrative diagram in a geology textbook. The top layer was about a metre deep. A confusion of pale greyish brown earth filled with fragments of broken orange and dusty pink brickwork, lumps of black tarmac and nobbly clumps of cement. This is what geologists call ‘made ground’ – in a city it’s the stuff that will have been constantly rehashed, recycled and added to by successive generations. Made ground is human history, like the artefacts in the V&A Museum of Childhood across the road, where, when I was a child, my parents sometimes took me on a wet Saturday afternoon. If – I suppose I should write ‘when’ – we disappear from this planet, the made ground is one of the things we’ll leave behind. A footprint. A sign saying, ‘We Were Here’.

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The layer below the made ground was damp sand and gravel the colour of yellow sponge cake soaked in tea. We know that this layer is older than the made ground because of the work of a seventeenth-century Danish doctor: Niels Stensen, better known as Nicolas Steno. Studying the formation of sedimentary rocks such as those beneath London – i.e., rocks formed (often underwater) from the deposition of tiny fragments of older rocks or fossil remains, or from chemical processes such as the evaporation of seawater – Steno observed that, for a new layer of sediment to accrete, there must already exist a firm layer for it to settle on. Older sedimentary rock layers therefore underlie newer ones.

The damp sand and gravel weren't very far below the surface – only a metre or so down from where buses lumbered through the rush-hour traffic and signs outside the bar under the railway arches advertised '£2.50 tequila and Jager shots ALL DAY LONG!' – but there was no evidence of any human presence in this layer. As the workmen on the building site dug down, they had travelled beyond the cosy familiarity of human time into the world of deep time. What the evolutionary biologist Stephen Jay Gould called geology's 'most distinctive and transforming contribution to human thought'.<sup>3</sup>

\*

The layer of sand and gravel in the excavation on Cambridge Heath Road was deposited about 2 million years ago during a unit of time known as the Pleistocene Epoch, when the Thames flowed through what is now Bethnal Green, following a course somewhat north of its present position. Staring down at the damp sand, I tried to think about 2 million years. It's a number that's easy enough to write down but difficult to really comprehend.

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‘The great challenge is to get people to really understand the immense amounts of time we’re dealing with,’ a friend who lectures in geology told me. A report commissioned by the Natural History Museum calls deep time is ‘foundational to our full understanding of life’s origin and diversification, it is a critical concept for understanding geology, physics, and astrophysics.’<sup>4</sup> We need to grapple with deep time if we want to make sense of the world around us, the long march of evolution, the rapidly multiplying challenges of climate change that threaten life as we think we know it. Without deep time we cannot begin to answer the questions ‘Why am I here?’, ‘Where have I come from?’ and ‘Where am I going?’

In the world of deep time, the 2 million years since the sandy layer was deposited is not very long. The earliest vertebrates lived more than 500 million years ago. Photosynthesis goes back at least 3 billion. And faced with all these millions and billions, the brain rebels, refuses to engage fully. Perhaps this is a psychological defence mechanism. In the UK average life-expectancy is 81 years. In the US it is a little less – 79 years; in Japan it’s 84 years – a little more.<sup>5</sup> We find it difficult to conceptualise much beyond five generations: two behind and two in front. As the Scottish scientist and mathematician John Playfair wrote about geological time in 1802, ‘how much farther reason may sometimes go than imagination may venture to follow’.<sup>6</sup>

In the Museum of Childhood there is a doll’s house from seventeenth-century Holland, built around the same time that Steno was formulating his work on sedimentary rocks. There is a miniature Dutch-style kitchen complete with Delft tiles, pewter plates, intricate jelly moulds. It was probably created not for a child but for some wealthy woman.

Who was she? That information has not been recorded. The three centuries that have passed are easily long enough for a

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woman's name to disappear. From the perspective of deep time, however, the unknown seventeenth-century Dutch woman and I exist essentially in the same moment along with all the rest of human history.

\*

Below the sand and gravel the earth changed again, and the next layer I recognised as the London Clay. Thickly sticky, a morose dark brown almost purple in places, like many rocks it was formed through geological or 'deep time' processes (in this case, sedimentation and burial) operating at speeds so slow as to be invisible to humans. To watch the creation of around a metre of the London Clay you'd need, in addition to a time machine, a massively powerful time-lapse camera trained for several hundreds of thousands of years on the sediment collecting on a prehistoric seabed. In deep time things happen very, very slowly, but they happen over long enough periods to have huge effects. Here a new rock formation is laid down, there a section of the sea floor is lifted up to become the top of a mountain. The top of Mount Everest was once a seafloor.

The presence of the London Clay in Bethnal Green indicates that around 55 million years ago this area was covered by a warm tropical sea. Were you able to travel there, you would find, somewhere near by, a lush green shoreline with a climate similar to that of present-day Indonesia. A place where *Hyracotherium*, a fox-sized ancestor of the horse, grazed between *Nypa* mangrove palms and waxy-petalled magnolia.

'The most interesting thing about going on a field trip with geologists is their imagination,' the Geological Society of London librarian and poet Michael McKimm told me when I visited the society's headquarters in London's Piccadilly.<sup>7</sup> 'You're

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all standing on a beach and what they are trying to imagine is why a certain rock structure exists, what happened in the past to get to that point.’ As the eminent nineteenth-century geologist Charles Lyell put it: ‘we may restore in imagination the appearance of the ancient continents which have passed away.’<sup>8</sup>

Among the sciences it is something of a curiosity: a discipline that involves building worlds in your mind and presenting them to others using descriptive language. For a writer with a background in literary publishing – a sphere where people who perhaps spend too much time thinking about language tend to congregate – geology had an immediate appeal. I recognise something of this impulse in the words of the American writer John McPhee – often credited with the first use of the term ‘deep time’, in his book *Basin and Range* (1981) – as he describes his early encounters with geology, reflecting that ‘There seemed, indeed, to be more than a little of the humanities in the subject: Geologists communicated in English; and they could name things in a manner that sent shivers through the bones.’<sup>9</sup> *Batholiths, McPhee wrote. Xenoliths. Desert pavements. The slip-face of a barchan dune.*

In the introduction to one well-known geology textbook – *Geological History of Britain and Ireland*, by Nigel Woodcock and Rob Strachan – the authors write: ‘Philosophers of science have struggled to characterize the way a geologist works and thinks. Having identified physics as the quintessential science, they have typically measured other sciences against its supposed objectivity, predictability and precision. Geology has therefore been viewed merely as a derivative and imprecise form of physics.’<sup>10</sup> In the scientific pecking order, theoretical physicists look down on the experimental physicists, who look down on geologists. ‘Who do geologists look down on?’ I asked my lecturer friend. ‘Geographers,’ he said.

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‘Geology,’ Woodcock and Strachan write, ‘has an essential historical dimension, which distinguishes it from pure physics, chemistry or biology. The geological record is inevitably complex and incomplete, and deciphering it requires an interpretative reasoning similar to that applied to human history.’<sup>11</sup>

Or as one geologist put it to me, the science requires ‘grey data skill sets’. The ability to piece together a story from incomplete, missing or fragmentary data. To use imagination to complete a half-formed picture. Or, as another said: ‘It’s Sherlock Holmes stuff, basically.’

A few years ago the Geological Society held a celebration of poetry and geology. ‘As far as I’m aware we are the only science society that has held a poetry day really driven by its members,’ McKimm told me. The then president, Bryan Lovell, read an extract from Alfred Tennyson’s ‘In Memoriam A. H. H.’. Completed in 1849, just forty years after the establishment of the Society – which is the world’s oldest national geological group – the lines reflect the shifting world of deep time as newly revealed by the Victorian geologists:

*The hills are shadows, and they flow  
From form to form, and nothing stands;  
They melt like mist, the solid lands,  
Like clouds they shape themselves and go.*<sup>12</sup>

‘Poets and geologists have a common cause,’ Lovell told the assembled crowd. ‘A search for words to help us to understand what we do.’

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Several years after my first visit, I went back to Cambridge Heath Road. Where the hole had been was a six-storey hotel. Its bar had bare, over-sized light bulbs and exposed pipes. There were Massage Mondays and Nespresso machines in every room. I drank a glass of ginger ale while a Spanish couple scrolled through their phones and members of the European Investment Bank's sports and cultural club milled around shouldering matching sports bags. Across the road, a group of schoolchildren in bright yellow tabards lined up in crocodile formation, two by two, in front of the museum entrance.

Beneath us were two basement levels and beneath that the world of the London Clay. From the London Clay layer continue to the next layer and back another 30 million years and you would find a vast ocean filled with long-jawed ichthyosaurs, flippered plesiosaurs, and razor-toothed, blunt-nosed sharks. Another 50 million years and you would be on dry land: a steep-sided mountain, foothills fringed with tropical forests, lakes and marshes frequented by ancestral crocodiles basking, one assumes, on glistening prehistoric mud. Worlds beneath worlds beneath worlds. Millions and millions of years stacked on top of one another like a deck of playing cards.

Were we able to watch all of deep time unfolding – another time-lapse film – we'd see hot dry deserts turn into lush jungles, rise up as craggy mountains, wear down to a low line of hills. A shifting, sliding cartography. In deep time everything is provisional. Bones become rock. Sands become mountains. Oceans become cities.

And being conscious of the immense span of time necessary to encompass all of these miraculous changes reminds us again that our own allotted span is shockingly brief – as individuals, as a species. A friend of mine once took a weekend pottery course and fashioned a terrible, lumpy brown vase.

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‘Just think,’ the tutor brightly told departing students, ‘you’ve all made something that will probably outlast you.’ My friend, staring at the misshapen clay, was horrified. *This* was what everything would amount to? The impersonal, eroding sweep of the ages challenges our instinct for memorialisation – the desire to frame photographs and certificates, to put up gravestones, to append our name (if we have the spare cash) to a gallery wing or lecture theatre, to autograph motorway underpasses and the doors of public toilets – our need to ask, what will we leave behind? What will survive us?

\*

Like finding a fossil sponge nestling in a seemingly amorphous lump of chalk, I retain a persistent memory of an event from my childhood that may or may not have taken place. The uncertainty is because memory is notoriously unreliable and no one else was present to witness what happened, and because it occurred when I was so young that the memory appears to me free-floating, chronologically unbound and therefore suspect.

I was walking with my parents and brothers in the Firehills, the gorse-covered cliff tops near Hastings on the south coast. Running ahead, coming to a fork in the sandy path, I took the right-hand way towards the cliff edge, ignoring a ‘Footpath Closed’ sign. As I’ve told and retold the story to myself, the path led up a slight incline that prevented me from seeing ahead to where, the other side of the rise, what must have been a recent cliff fall had taken out the path. I have a memory of the world suddenly expanding and opening out. The broad sweep of sunlit cliffs, the warm coconut scent of the cadmium-yellow gorse and the far-below shining sea. The few steps between myself and the cliff edge: I’d stopped running just in time.



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The memory – or, if it isn't a memory then the recurring image in my head – is associated not with fear exactly but with a sudden strong sense of the smallness of the individual body, the largeness of the world. Something destabilising but also invigorating. Like contemplating the stars arcing across the night sky, or the depth of the Mariana Trench, or the expanse of deep time – all the former worlds that hover just out of sight, momentarily screened by the everyday, the insistent rush of *now*, waiting to be brought back into the light.