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Origins

HOW THE EARTH MADE US

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Contents

	Introduction	1
1	The Making of Us	7
2	Continental Drifters	31
3	Our Biological Bounty	60
4	The Geography of the Seas	94
5	What We Build With	127
6	Our Metallic World	156
7	Silk Roads and Steppe Peoples	183
8	The Global Wind Machine and the Age of Discovery	217
9	Energy	255
	Coda	284
	Notes	289
	Bibliography	299
	Acknowledgements	324
	Figure Credits	325
	Index	328

Chapter 1

The Making of Us

We are all apes.

The human branch of the evolutionary tree, called the hominins, is part of the wider animal group of the primates.* Our closest living relatives are the chimpanzees. Genetics suggest that our divergence from the chimps was a long and drawn-out process, beginning as early as 13 million years ago, with interbreeding continuing until perhaps 7 million years ago.¹ But eventually our evolutionary histories did separate, with one side giving rise to today's common and bonobo chimpanzee, the other branching into the different hominin species, with our own kind, *Homo sapiens*, forming just one twig. If we look at our development in this way, humans didn't evolve *from* apes – we *are* still apes, in the same way that we're still mammals.

All the major transitions in the evolution of hominins took place in East Africa. This region of the world lies within the rainforest belt around the equator of the planet, on a level with the Congo, the Amazon and the tropical islands of the East Indies. By rights, therefore, East Africa ought to be densely forested too, but is instead characterised by mainly dry, savannah grasslands. While our primate ancestors were

* We'll come back to the planetary event that saw the emergence of primates as a group in Chapter 3.

tree-dwellers, surviving on fruit and leaves, something drastic happened in this region of the world, our birthplace, to transform the habitat from lush forest to arid savannah, and in turn drive our own evolutionary trajectory from tree-swinging primates to bipedal hominins hunting across the golden grasslands.

What are the planetary causes that transformed this particular region to create an environment in which smart, adaptable animals could evolve? And as we are only one of a number of similar intelligent, tool-using hominin species to have evolved in Africa, what were the ultimate reasons why *Homo sapiens* prevailed to inherit the Earth as the sole survivor of our evolutionary branch?

GLOBAL COOLING

Our planet is a restlessly active place, constantly changing its face. Fast-forwarding through deep time you'd see the continents gliding between myriad different configurations, frequently colliding and welding together only to be ripped apart again, with vast oceans opening and then shrinking and disappearing. Great chains of volcanoes pop and fizzle, the ground shivers with earthquakes, and towering mountain ranges crumple out of the ground before being ground away back to dust. The engine powering all this fervent activity is plate tectonics, and it is the ultimate cause behind our evolution.

The outer skin of the Earth, the crust, is like a brittle eggshell encasing the hotter, gooier, mantle beneath. The crustal shell is cracked, fragmented into many separate plates that rove across the face of the Earth. The continents are made up of a thicker crust of less dense rocks, while the oceanic crust is thinner but heavier and so doesn't ride as high as the continental crust. Most of the tectonic plates are made up of both continental and oceanic crust, and these rafts are constantly jostling for position with each other as

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they bob on top of the hot churning mantle and ride the whims of its currents.

Where two plates butt into one another, along what is known as a convergent plate boundary, something has got to give. The leading edge of one of the two plates is shunted beneath the other and is dragged down into the rock-melting heat of the mantle, triggering frequent earthquakes and feeding an arc of volcanoes. Because the rocks of the continental crust are less dense and so more buoyant, it is almost invariably the oceanic crust portion that sinks beneath the other in a plate collision. This subduction process continues until the intervening ocean has been swallowed, and the two chunks of continental crust become welded together, a great crumpled chain of mountains marking the impact line.

Divergent, or constructive, boundaries are the places where two plates are being pulled apart from each other. Hot mantle from the depths rises up into this rent, like blood welling into a gash in your arm, and solidifies to form new rocky crust. Although a new spreading rift can open up in the middle of a continent, ripping it in two, this fresh crust is dense and low-lying and so becomes flooded over with water. Constructive boundaries form new oceanic crust – the Mid-Atlantic Ridge is one prominent example of such a seafloor spreading rift.²

Plate tectonics is an overarching theme of the Earth we'll return to throughout the book, but for now we'll focus on how the climate change it drove over recent geological history produced the conditions for our own creation.

The past 50 million years or so have been characterised by a chilling of the global climate. This process is called the Cenozoic cooling, and it culminated 2.6 million years ago in the current period of pulsing ice ages that we'll look at in detail in the next chapter. This long-term global cooling trend has been largely driven by the continental collision of India into Eurasia and the raising of the Himalayas. The subsequent erosion of this towering ridge of rocks has scrubbed a lot of

carbon dioxide out of the atmosphere, resulting in a reduction of the greenhouse effect that was previously insulating the planet (see Chapter 2), and leading to declining temperatures. In turn, the generally cooler conditions drove less evaporation from the oceans to create a less rainy, drier world.

Although this tectonic process happened some 5,000 kilometres away across the Indian Ocean, it also had a direct regional effect within the theatre of our evolution. The Himalayas and Tibetan Plateau have created a very powerful monsoon system over India and South-East Asia. But this huge atmospheric sucking effect over the Indian Ocean also drew moisture away from East Africa, reducing the rainfall it experienced. Other global tectonic events are thought to have contributed to the aridification of East Africa. Around 3–4 million years ago Australia and New Guinea drifted north, closing an ocean channel known as the Indonesian Seaway as they did so. This blockage constricted the westward flow of warm South Pacific waters, and instead colder waters from the North Pacific flowed through to the central Indian Ocean. A cooler Indian Ocean reduced evaporation which in turn meant less rainfall for East Africa.³ But most significantly, another huge tectonic upheaval was happening in Africa itself that was to prove instrumental in the making of us.

A HOTBED OF EVOLUTION

About 30 million years ago a plume of hot mantle rose up beneath north-eastern Africa. The land mass was forced to swell upwards by about a kilometre⁴ like a huge zit. The skin of continental crust over this swollen dome stretched and thinned until eventually it began to rip open right across the middle in a series of rifts. The East African Rift tore along a roughly north–south line, forming an eastern branch through what is now Ethiopia, Kenya, Tanzania and Mali, and a western

branch that cuts through Congo and then continues along its border with Tanzania.

This Earth-ripping process was more intense towards the north, tearing right through the crust to allow magma to seep through the long wound and create a new crust of basalt rock. Water then flooded into this deep rift to create the Red Sea; another rift became the Gulf of Aden. The seafloor spreading rifts tore off a chunk from the Horn of Africa to form a new tectonic plate, the Arabian. The Y-shaped meeting of the African Rift, Red Sea and Gulf of Aden is known as a triple junction and right at the centre of this intersection is a low-lying triangle of land called the Afar region, stretching across north-east Ethiopia, Djibouti and Eritrea.⁵ We'll return to this important region later.

The East African Rift runs for thousands of kilometres from Ethiopia to Mozambique. As the swelling from the magma plume bulging beneath it continues, the Rift is still being pulled apart. This 'extensional tectonic' process is causing whole slabs of rock to fracture along faults and break off, with the flanks being pushed up as steep escarpments and the blocks in between subsiding to form the valley floor. Between about 5.5 and 3.7 million years ago this process created the current landscape of the Rift: a wide, deep valley half a mile above sea level and lined on both sides with mountainous ridges.⁶

One major effect of the swelling of this crustal bulge and the high ridges of the Rift was to block rainfall over much of East Africa. Moist air blowing over from the Indian Ocean is forced upwards to higher altitudes where it cools and condenses, falling as rain near the coast. This creates drier conditions further inland – a phenomenon known as a rain-shadow.⁷ At the same time, the moist air from the central African rainforests is also blocked from moving eastwards by the highlands of the Rift.⁸

The upshot of all these tectonic processes – the creation of the Himalayas, the closing of the Indonesian Seaway, and in particular the uplift of the high ridges of the African Rift – was

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to dry out East Africa. And the formation of the Rift changed not only the climate but also the landscape, in the process transforming the ecosystems of the area. East Africa was remoulded from a uniform, flat area smothered in tropical forest, to a rugged, mountainous region with plateaus and deep valleys, its vegetation ranging from cloud forest to savannah to desert scrub.⁹

Although the great rift started to form around 30 million years ago, much of the uplift and aridification happened over the past 3–4 million years.¹⁰ Over this time, the same period that saw our evolution, the scenery of East Africa shifted from the set of *Tarzan* to that of *The Lion King*.¹¹ It was this long-term drying out of East Africa, reducing and fragmenting the forest habitat and replacing it with savannah, that was one of the major factors that drove the divergence of hominins from tree-dwelling apes. The spread of dry grasslands also supported a proliferation of large herbivorous mammals, ungulate species like antelope and zebra that humans would come to hunt.

But it wasn't the only factor. Through its tectonic formation the Rift Valley became a very complex environment, with a variety of different locales in close proximity: woods and grasslands, ridges, steep escarpments, hills, plateaus and plains, valleys, and deep freshwater lakes on the floor of the Rift.¹² This has been described as a mosaic environment, offering hominins a diversity of food sources, resources and opportunities.¹³

The widening of the Rift and the upwelling of magma was accompanied by strings of violent volcanoes spewing pumice and ash across the whole region. The East African Rift is dotted with volcanoes along its length, many of which formed in just the last few million years. Most of these lie within the Rift Valley itself, but some of the largest and oldest are growing on the edges, including Mt Kenya, Mt Elgon, and Mt Kilimanjaro, the tallest mountain in Africa.

The frequent volcanic eruptions spilled lava flows that solidified into rocky ridges cutting across the landscape. These

could be traversed by nimble-footed hominins, and along with the steep scarp walls within the Rift may have provided effective natural obstacles and barriers for the animals they hunted. Early hunters were better able to predict and control the movements of their prey, constraining escape routes and directing them into a trap for the kill. These same features may also have offered vulnerable early humans a degree of protection and security from their own predators that prowled the landscape.¹⁴ It seems that this rough and varied terrain provided hominins with the ideal environment in which to thrive. Early humans, who, like us, were relatively feeble and did not have the speed of a cheetah or the strength of a lion, learned to work together and take advantage of the lie of the land, with all its tectonic and volcanic complexity, to help them hunt.

It is active tectonics and volcanism that have created and then sustained these features of a varied and dynamic landscape over the course of our evolution. In fact, because the African Rift is such a tectonically active region, the landscape has changed greatly since the times of earliest human habitation. As the Rift has continued to widen, the areas once populated by hominins on the valley floor have now become uplifted onto the flanks of the Rift; today it is here that we find hominin fossils and archaeological evidence, completely removed from their original settings. And it is this great rift, the most substantial and long-lived region with extensional tectonics in the world today, that is believed to have been crucial to our evolution.

FROM TREES TO TOOLS

The first indisputable hominin for which we have discovered good fossil remains is *Ardipithecus ramidus*, which lived around 4.4 million years ago in forest lining the Awash river valley in Ethiopia. This species was roughly the same size as modern

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chimpanzees, with an equivalent-sized brain, and teeth that suggest they had an omnivorous diet. The fossilised skeletons indicate they still lived in trees and had only developed a primitive bipedality – the ability to walk upright on two feet. About 4 million years ago, the first members of the genus *Australopithecus* – the ‘southern ape’ – shared several traits with modern humans, such as a slender and gracile body-form (but still with more primitive skull shapes), and they were competent at walking bipedally. *Australopithecus afarensis*, for example, is well known from surviving fossils. One of these is the remarkably complete skeleton of a female who lived 3.2 million years ago in the Awash river valley, which came to be known as Lucy.*

Lucy would have stood at only about 1.1 metres, but had a spine, pelvis and leg bones very similar to those of modern humans. So while Lucy, and other members of *A. afarensis*,† still had a small, chimpanzee-sized brain, their skeleton clearly indicates a lifestyle of long-distance bipedal walking. Indeed, a bed of volcanic ash in Laetoli, Tanzania, has preserved three sets of footprints from 3.7 million years ago. These were probably created by members of *A. afarensis* and look remarkably like those you might leave in the sand during a stroll along the beach.

In human evolution, the development of bipedalism clearly came a long way before significant increases in brain size – we walked the walk before we could talk the talk. These *Australopithecus* fossils, together with those of the earlier *Ardipithecus* species, also show that bipedality didn’t evolve as an adaptation to walking in open, grassy savannah environments as had been thought previously, but first emerged with hominins

* Named after The Beatles song ‘Lucy in the Sky with Diamonds’, which was played loudly in the excavation camp after her discovery in 1974.

† It’s common when discussing organisms to abbreviate the genus name. So *Australopithecus afarensis* becomes *A. afarensis*. The dinosaur *Tyrannosaurus rex*, for example, is most popularly known simply as *T. rex*.

still living closely among trees in wooded areas.¹⁵ But bipedalism certainly became an increasingly useful adaptation as the forests shrank and became more fragmented. Our early hominin ancestors were able to move between islands of woods, and then venture out into the grasslands. Bipedalism allowed them to see over the tall grass, and minimised the area of their bodies exposed to the hot sun, helping them to keep cool in the savannah heat. And the opposable thumbs that became so useful for holding and manipulating tools are also an evolutionary inheritance from our forest-dwelling primate ancestors. The hand crafted by evolution to grasp a tree branch pre-adapted us for holding the shaft of a club, an axe, a pen, and ultimately the control stick of a jet plane.

By around 2 million years ago the hominin species of the *Australopithecus* genus had all fallen extinct and our own genus, *Homo*, had emerged from them. *Homo habilis* ('handy man') was the first, with a gracile body-form similar to the earlier australopithecines and a brain only slightly larger.¹⁶ A dramatic increase in the size of the body and brain, as well as a major shift in lifestyle, however, came with *Homo erectus*, which appeared around 2 million years ago in East Africa. Below the skull, the skeleton of *H. erectus* is very similar to that of anatomically modern humans, including adaptations for long-distance running and a shoulder design that would have allowed the throwing of projectiles. They are also thought to have exhibited other traits shared with us, like long childhoods of slower development and advanced social behaviour.

H. erectus was probably also the first hominin to live as a hunter-gatherer and to control fire – not just for warmth but possibly also for cooking their food.¹⁷ They may even have used rafts to travel over large bodies of water.¹⁸ By 1.8 million years ago *H. erectus* had spread across Africa and then became the first hominin to leave the continent and disperse through Eurasia, probably in several independent waves of migration.¹⁹ This species persisted for almost 2

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million years. By contrast, anatomically modern humans have only been around for a tenth of that time – and at the moment we'd be lucky to survive the next 10,000 years, let alone 2 million.

H. erectus gave rise to *Homo heidelbergensis* around 800,000 years ago, which by 250,000 years ago had developed into *Homo neanderthalensis* (the Neanderthals) in Europe and the Denisovan hominin in Asia. The first anatomically modern human, *Homo sapiens*, emerged in East Africa between 300,000 and 200,000 years ago.

Over the course of human evolution, hominins became increasingly bipedal, and then more efficient long-distance runners,²⁰ with changes to the skeleton including an S-shaped spine, a bowl-like pelvis and longer legs to support this upright posture and mode of locomotion. Body hair became reduced, except on the scalp. The shape of the head also transformed, producing a smaller snout with a more pronounced chin, and a more bowl-shaped brain case.²¹ Indeed, the major difference between the earlier *Australopithecus* genus and our *Homo* lineage was this increase in brain size. Throughout their 2 million years of evolution the australopithecines' brain size was strikingly constant at around 450 cm³, roughly equivalent to that of a modern chimpanzee. But *H. habilis* had a brain a third larger, at about 600 cm³, and brain size doubled again from *H. habilis* through *H. erectus* to *H. heidelbergensis*. By 600,000 years ago, *H. heidelbergensis* had a brain roughly the same size as that of modern humans, and three times larger than that of australopithecines.²²

As well as increasing brain size, another defining feature of the hominins was how we applied our intelligence to tool-making. The earliest widespread stone tools – known as Oldowan technology – date back to about 2.6 million years ago, and were used by the later *Australopithecus* species as well as *H. habilis* and *H. erectus*. Rounded cobbles from a river were used for cracking open bones or nuts against another, flat, anvil stone. Sharpened edges were created by chipping off flakes, and this