Bloc-notes pour

Origins

Dartnell, Lewis

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Introduction

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each of us is literally made of the Earth, as is all life on the planet. The water in your body once flowed down the Nile, fell as monsoon rain onto India, and swirled around the Pacific. The carbon in the organic molecules of your cells was mined from the atmosphere by the plants that we eat. The salt in your sweat and tears, the calcium of your bones, and the iron in your blood all eroded out of the rocks of Earth’s crust; and the sulphur of the protein molecules in your hair and muscles was spewed out by volcanoes.

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Anthropocene, the ‘recent age of humanity’.

1 The Making of Us

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humans didn’t evolve from apes– we are still apes, in the same way that we’re still mammals.

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Most of the tectonic plates are made up of both continental and oceanic crust,

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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.

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Constructive boundaries form new oceanic crust– the Mid- Atlantic Ridge is

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Those area are therefore more likely to be flooded or submerged by nearby oceans as this new crust is more dense and low lying than what surrounds it

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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.

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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 to dry out East Africa.

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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.

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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.

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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

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We exploited sticks and stones as artificial teeth and claws to hunt for food or to defend ourselves, all whilst being able to keep a safe distance from prey and predators to minimise the risk of injury.

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Intelligence on the other hand is the evolutionary solution to the problem of an environment that shifts faster than natural selection can adapt the body.

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East Africa was bulging upwards with the magma plume rising beneath and this stretched the crust until it fractured and faulted. The geography of the Great African Rift is therefore characterised by a flat valley floor where great chunks of crust have sunk down, and which is lined on both sides by mountainous ridges. In particular, from about 3 million years ago numerous large, isolated basins formed on the valley floor that could fill with lakes if the climatic conditions were wet enough. 26 These deep lakes are important because they provided hominins with a more reliable source of water through the dry seasons each year

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Rain falls over the tall rift walls and volcanic peaks, where it then flows into the lakes dotting the valley floor, a much hotter environment with high rates of evaporation. This means that many of the lakes in the Rift Valley are exceedingly sensitive to the balance between precipitation and evaporation, and even a slight shift in climate causes their water levels to respond very considerably and rapidly– far more so than other lakes around the world and even elsewhere in Africa.

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The rapidly fluctuating conditions favoured the survival of hominins who were versatile and adaptive, and so drove the evolution of larger brains and greater intelligence.

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not only did the variable periods determine our evolution, they are also thought to have been the force driving several hominin species to migrate out of their birthplace and into Eurasia. We’ll explore in detail in the next chapter how our species Homo sapiens were able to disperse around the entire globe, but the conditions propelling hominins out of Africa in the first place again lie with the climate fluctuations in the Great Rift. During each wet phase the filling of the large amplifier lakes and the extra availability of water and food would cause a population boom, while at the same time limiting the amount of space available for habitation along the tree- lined rift shoulders. This would have squeezed hominins along the tube of the Rift Valley and eventually pushed them out of East Africa with each wet pulse of the precessional cycle, like a climate pump. Moister conditions would also have allowed hominin migrants to move north along the Nile tributaries and across the greener corridors of the Sinai Peninsula and Levant region to spill into Eurasia.

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If you look at a map of the tectonic plate boundaries grinding against each other and superimpose the locations of the world’s major ancient civilisations, an astonishingly close relationship reveals itself: most are located very close to plate margins.

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Tectonic stresses also hold open fractures in rocks or push up blocks of crust in what is known as a thrust fault, which often create water springs.

2 Continental Drifters

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There have been between forty and fifty ice ages over the past 2.6 million years, 1 and they’ve been getting progressively longer and colder over time.

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The freeze- ups last on average 80,000 years, the shorter respites between ice ages only around 15,000 years. 3 Each inter- glacial period, such as the current Holocene Epoch we entered 11,700 years ago, is no more than a brief thermal intermission before the climate plunges back into another frosty episode.

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expansive ice sheets and glaciers locked up huge amounts of water, and the sea levels around the world dropped by up to 120 metres,

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As well as being punishingly cold close to the ice sheets, reduced evaporation from the frigid seas would have made the world much drier.

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When construction workers were digging in Trafalgar Square in the centre of London in the late 1950s, they discovered the remains of a range of large animals– rhinoceros, hippopotamus and elephants, as well as lions– all dating from this previous interglacial period.

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It was hotter to today by at least 2C

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in about 12,000 years’ time the Earth’s spin axis will have rolled around to point towards a new north star, Vega, and summer in the Northern Hemisphere will fall in what we currently call December.

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Due to pocession or wobble of the Earth on its axis

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For around 80– 90 per cent of its existence our planet has been significantly hotter than it is today; periods with ice caps at the poles are in fact something of a rarity.

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Holocene: our current interglacial that holds the entire history of human civilisation.

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For the past 30 million years or so, 68 per cent of the northern hemisphere has been continents, with only a third of the Earth’s land south of the equator. 26

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The

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as the world warmed again after the last glacial maximum and sea levels rose, the Bering land bridge once again disappeared beneath the waves. The connection between Alaska and Siberia was severed, and the Eastern and Western hemispheres were cut off from each other. Lasting contact was not made again between the peoples of the Old World and the New for another 16,000 years, until Columbus set foot on the Caribbean islands in 1492. Genetically similar, but living in different landscapes with access to different plants and animals, these two isolated populations of humanity formed civilisations independently from each other but remarkably similar in their domestication of crops and livestock and the development of agriculture.fn3

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What a fact!

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During the ice age around 425,000 years ago (five ice ages before the most recent glaciation) a vast lake of water became trapped between the Scottish and Scandinavian ice sheets and the 30- kilometre- wide ridge of rock then still linking England and France. This lake was filled with meltwater from the ice sheets as well as the discharge from rivers like the Thames and Rhine. And with no outlet to escape through, the water rose and rose, until inevitably it began to spill over the top of the land bridge. These colossal waterfalls scooped out vast plunge pools on the channel floor and gouged backwards through the barrier until this natural dam collapsed. The entire trapped lake emptied itself as a catastrophic megaflood, widening the gaping breach in the barrier and carving the landforms on the floor of the Channel we can see with sonar today. This first megaflood 425,000 years ago

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I'm officially gobsmacked...

3 Our Biological Bounty

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plains between the Tigris and Euphrates, 18 a region called Mesopotamia– ‘the land between the rivers’.

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A ribbon- like oasis running through the desert, the Nile’s reliable summer floods revitalise the plains either side of its course with mineral- rich sediment eroded out of its headlands in the highlands of Ethiopia. The mighty Nile also provided a simple means of transport. The prevailing north- east trade winds blow reliably in north African latitudes– we’ll return to them in Chapter 8– which means that boats can sail south to Upper Egypt; and the Nile’s gentle current then allows an easy return downriver with the flow.

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Only human populations native to Europe, Arabia, South Asia and western Africa are able to digest fresh milk, however.

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Many of the earliest civilisations to emerge did so along the banks of great watercourses like the Tigris and Euphrates, Indus, Nile and Yellow rivers. They provided the lifeblood for reliable agriculture and the first cities, and political power often arose from the centralised control of their waters for irrigation.

4 The Geography of the Seas

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Oceans and seas cover nearly three- quarters of the Earth’s surface. It’s this fact that prompted the author Arthur C. Clarke to quip that we shouldn’t call our planet Earth at all, but Ocean.

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The northern arm of the Tethys dried up, leaving behind as remnants the Black, Caspian and Aral Seas across western Asia.

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Commanding such naval chokepoints, and thus a rival’s access to overseas resources, is often as important as controlling territory on land, and can determine the outcome of wars and the fate of civilisations.

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Even today 90 per cent of world trade is still carried by shipping.

5 What We Build With

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Great Pyramid, built during the reign of the pharaoh Khufu– or Cheops, as he is also known– and completed around 2560 BC. Until the completion of Lincoln Cathedral in 1311 it was the tallest human- made structure in the world.

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The largest human cell, a woman’s egg cell, is about a tenth of a millimetre across, and only just visible to the unaided eye.

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Sedimentary rocks are formed by the deposition and then cementation together of material which either eroded from older rocks or was produced biologically– sandstone, limestone and chalk are all examples. Igneous rocks such as granite, on the other hand, solidify from volcanic lava or magma still deep underground. And when sedimentary or igneous rocks are subjected to high temperatures and pressures– caught in the crunch of continental collisions or when magma intrudes up into them– they are transformed physically and chemically, becoming a metamorphic rock like marble or slate.

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Year 12 - Tectonic Unit: Lovely summary of three main rock types in geology

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During the early Cretaceous Period, around 130 million years ago, coccolithophores expanded out from the shallower waters of the continental shelves to live as plankton in the open ocean. Around the same time calcite- shelled forams also spread from their deep seafloor habitat to the surface waters of the seas. This meant that the vast open ocean itself, and not just the shallower waters around the continents, hosted plankton that produced calcite shells. When shells from dead coccolithophore and foram plankton rained down onto the seafloor they formed a new kind of sediment, creating limestone in the ocean deeps and not just on the continental shelves. 23 Thus marine life was becoming much more adept at removing carbon dioxide from the atmosphere and locking it away in biological rocks on the deep sea floor. And since this time, the carbon dioxide levels on our planet have been steadily diminishing. Now even with the sudden injection of huge amounts of carbon dioxide into the air from flood basalt events, the oceans’ limestone- forming plankton were able to scrub this gas out much more rapidly than any geological processes. Since the early Cretaceous, therefore, the Earth has developed a powerful compensation mechanism for rapidly removing sharp rises in volcanic carbon dioxide before it can trigger runaway warming and mass extinctions. So when 55 million years ago the Palaeocene– Eocene Thermal Maximum started pushing carbon dioxide levels and global temperatures towards catastrophe, plankton saved life on Earth.

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This part of the Carbon Cycle has prevented the repeat of past mass extinctions

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Granitic magma is also formed when continents collide and the crust is thickened beneath the great mountain range that is created, partially melting at the bottom and again rising up through the overlying crust. When this silica- rich magma cools and solidifies it forms great subterranean masses of granite rock, often within the core of the mountain range formed above it by the same convergent tectonics.

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In the end, even the mightiest mountain chain is disassembled grain by grain over the expansive gulf of time of our planet’s history. Eventually, the mountains will be worn down to the merest stump, exposing their heart of hard granite. So when you stand on a pillar of granite, you are stepping on the very core of an ancient mountain range. During its formation, this granite would have had at least 10 kilometres of rock piled on top of it, now worn away over 100 million years or more of erosion. The tors of Dartmoor, El Capitan in Yosemite National Park, Rio de Janeiro’s Sugarloaf Mountain

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skyline of Manhattan follows the underlying geology: the areas with the tallest buildings are supported by the hard schist.

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The reason why London, in contrast to New York, has so few skyscrapers is this thick layer of soft, putty- like clay beneath the city. Towers like The Shard or One Canada Square in Canary Wharf had to be built with very deep- piled foundations to support their weight.

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The underlying geography also explains why North London is so well served by the Tube network, but the south has far fewer lines. South of the Thames the clay layer dips to beneath the depth of the network, and tunnels must instead be bored through much trickier strata of sand and gravel. The London clay is also the reason why the Tube has become so uncomfortably hot.

6 Our Metallic World

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The oval- shaped mound of the Troodos mountains in the centre of Cyprus is the best example in the world of an ophiolite– a slice of oceanic crust that became beached on top of the continental. 11 This oceanic crust was created in deep water about 90 million years ago, at a spreading rift in the Tethys Sea, 12 and became scooped up on top of Cyprus with the closure of the Tethys as Africa pushed up into Eurasia.

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And it was these minuscule early cyanobacteria, swarming in the primordial seas and giving off oxygen exhaust fumes from their photosynthetic machinery, that eventually oxygenated the entire planet.

7 Silk Roads and Steppe Peoples

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The continent of Eurasia, stretching 12,000 kilometres from the Atlantic to the Pacific oceans, contains over a third of the total land surface area of our planet, and has hosted many of the most sophisticated civilisations in history.

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Like Egypt, China was able to achieve such early and long- lasting political unification, and protection from external threats, because of its natural frontiers: 8 the Pacific coastline to the east, the inhospitable highlands of the Tibetan Plateau and Himalayas to the west, and dense jungle to the south. The main weakness was the northern boundary, marked not by a distinct topographic feature like a mountain range but by a smooth ecological gradation from the fertile agricultural plains into the Gobi Desert and then the arid grasslands of Central Asia.

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the camel evolved in North America and migrated across the Bering land bridge during an ice age several million years ago. While it died out in its birthplace, two varieties developed in the Old World: the two- humped bactrian camel in Asia (domesticated about 3000 BC) 19 and the single- humped dromedary in the hotter deserts of Africa (domesticated around the second millennium BC).

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for centuries the Silk Road was enormously influential for the movement of goods, people and ideas, as caravans threaded their way through mountain passes and across deserts.

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The Huns reached the Don river by the 370s AD, 62 in the process displacing other nomad groups who in turn drove settled villagers off their lands in Eastern Europe. Huge numbers of these refugees arrived at the frontier of the Western Roman Empire along the Rhine and Danube rivers, and before long tribe after tribe began to pour into Roman territory–

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The Western Roman Empire had been destroyed by the ‘great migration’ of settled tribes and pastoralists from the steppes.

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By the end of the thirteenth century the Mongol Empire stretched across the entire breadth of Asia, from the Pacific Ocean to the Black Sea.

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The plague hit the Mongol khanates just as hard, their grip on power already weakened by internal rivalries.

8 The Global Wind Machine and the Age of Discovery

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A wind is specified by the direction from which it is blowing, so a northerly wind blows from the north towards the south. Ocean currents, on the other hand, are named the opposite way: by the direction in which they are going. Thus a northerly current arrives from the south and carries you north. This is potentially very confusing, but it does carry a degree of sense. When you’re on land, the direction a wind is coming from is the important aspect: what matters is from where a storm arrives, or the direction in which you need to turn a windmill. But for a ship being carried along by an ocean current, it’s where it’s taking you that is important– especially if it’s towards a reef or shoal that could wreck you.

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Madeira had originally been densely forested– it took its name from the Portuguese for ‘wood’ 10– but the forests were rapidly cleared by Portuguese sailors and the land turned to the cultivation of wine and sugar.

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Contrary to a commonly held view today, no educated person in medieval Europe believed the Earth to be flat. In the third century BC Eratosthenes, a Greek geographer, astronomer and mathematician working at the Library of Alexandria, understood that the world is a sphere and calculated its circumference to be 250,000 stadia, or around 44,000 kilometres– remarkably close to its real value.

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He fudged the numbers. Columbus took the lowest calculation of the Earth’s circumference available at the time, along with the greatest estimate of the breadth of Eurasia, and arrived at a significantly shortened sea distance to the west.

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This allowed him to get sponsored as he could prove he would have enough food/water for journey.

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prevailing winds blow in opposite directions in neighbouring bands of latitude,

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Venetian navigator Giovanni Caboto (or John Cabot)

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Hadley cells, and they operate like paired cogs, separated by the equator and rotating in opposite directions. The movement of the Hadley cells, driven by equatorial warming, is a great heat engine

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Our planet, and its atmosphere, is rotating. Because the Earth is a solid sphere, this means that the surface at the equator is moving faster than that at higher latitudes.

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Any winds blowing in the Northern Hemisphere are deflected by the Coriolis effect to their right, and those in the Southern to their left.

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The band where the returning northeasterly and southeasterly trade winds meet each other around the equator is called by modern atmospheric scientists the Intertropical Convergence Zone (ITCZ). But to sailors it’s known as the doldrums. This is the region of low- pressure air, characterised by light winds or periods of dead calm,

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The location of the ITCZ is determined by rising air warmed by the sun, and so it shifts north and south of the geometric line of the equator

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The

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the Ferrel system is passive: it’s not directly driven by its own rising warm air, but by the rolling of the Hadley and Polar cells it nestles between. It’s almost like a freewheeling gear being forced round by two powered cogs turning on either side of it.

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The Southern Hemisphere, on the other hand, is dominated by open ocean, free of windbreaks. In particular, below about 40 ° only the bottom tip of South America and the two islands of New Zealand impede the uninterrupted rush of the westerly winds all the way around the world.

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These ocean gyres turn clockwise in the northern hemisphere, and anticlockwise in the southern,

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(Because water is so much denser than air, even a gentle ocean current can have a much greater effect on a sailing ship than the wind.)

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Pretty much the entire wind pattern on Earth can therefore be explained by three simple facts: the equator is hotter than the poles, warm air rises, and the world spins.

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The word derives from the Arabic mausim, meaning ‘season’, 30 and the monsoons

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air over the land to rise, and the cooler air over the sea is sucked into the low pressure region left behind, driving a convection current with a steady wind that blows from the sea to the land– an onshore breeze. Conversely, the ground cools much more quickly after sunset, and so the warmer, rising sea air pulls in behind it air from the land to drive an offshore breeze.

9 Energy

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Support for the main left- wing political party in the UK almost perfectly matches the regions of Carboniferous deposits.fn6

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Asphalt (bitumen) that had seeped up onto the surface was used as a cement in the construction of the walls of Babylon 4,000 years ago and as a road- building material around 625 BC. 29 By AD 350 the Chinese were drilling oil wells and burning the fuel to evaporate brine to produce salt, 30 and in the tenth century Persian alchemists were distilling petroleum to make kerosene for lamps.

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The gasoline refined from crude oil had previously been considered too volatile and dangerous to be of much use,

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oil and natural gas are formed from the remains of microscopic marine plankton.

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While the Amazonian rainforest is often referred to as the lungs of the planet, in fact it is the drifting multitudes of phytoplankton in the seas that produce most of the oxygen we breathe.

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The presence of such greenhouse gases in the atmosphere is not in itself a problem– indeed, it is their insulating effect that through our planet’s history has kept the Earth’s surface above freezing and so has been vital for supporting complex life.fn8 But the rapidly rising carbon dioxide level is shifting the current established equilibriums in the natural world, and impacting on how we support our civilisation. It has caused increasingly acidic oceans, threatening coral reefs as well as the fisheries we rely upon for food. 45 Moreover, a warming global climate in turn drives rising sea levels that threaten our coastal cities, and shifts in the world’s rainfall patterns have significant implications for agriculture.

Coda

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We’ve now turned over a third of the Earth’s total land area to agriculture.