

Time travel and tipping points

Modern methods for gazing back through deep time reveal crucial tipping points marked by cataclysm, extinction, evolution – and yet our unfathomably ancient planet persists. Truly coming to grips with such vast timescales isn't easy, but as **Lauren Fuge** discovers, it could be key to our long-term survival.

It's a warm winter's morning and I'm standing in a bone-dry creek bed at the precipice of deep time.

I'd rolled out of my tent early – dusty and tired and distinctly unshowered – to hike along Enorama Creek in the heart of the arid, ancient Flinders Ranges. Slivers of brittle rock slid beneath my boots as I descended the steep bank to find the only golden spike in the Southern Hemisphere – just five hours north of Adelaide, South Australia.

The bronze-coloured disc is in the shade of a river red gum, embedded in the rock at the conspicuous divide between slabs of purple tillite and sandy dolomite. It's engraved with the cryptic letters EDIACARAN – GSSP 2004, marking it as a Global Boundary Stratotype Section and Point. Colloquially known as golden spikes, these are geological waypoints precisely placed at stark changes in the rock strata, representing transitions between ages. They are records of cataclysms and proliferations, of makings and unmakings – proof of an Earth history too vast to even capture the shape of in my mind. There are less than 100 such markers in the world, so it's somewhat remarkable that there's one less than 500 kilometres from my home, tucked in an out-of-the-way creek down a dirt road.

HEIDI BARR

DEEP TIME



The dull, scratched disc is deceptively modest for a monument at the delineation of two worlds, and so small that I have the urge to cover with my palm the moment complex life burst into being. I sink cross-legged onto the sun-warmed tillite and lift my hand to the dusty metal.

You know the sci-fi concept of warp drive, where a spacecraft can jump between two distant locations by folding up the fabric of space-time? One moment in the Milky Way, the next in a galaxy a hundred million light-years away? In this creek bed, fingers pressed to the golden spike, time suddenly scrunches up beneath me – and for a brief instant, I'm connected to one of the most crucial climate shifts in history.

Seven hundred million years ago, glaciers gripped the Earth from pole to equator in the most intense ice age the planet has ever seen – the first iteration of Snowball Earth. For the full billion years previous, the planet had been slimy and static: volcanoes lay dormant, the atmosphere simmered at low oxygen levels, evolution stagnated with life no more complex than algae, and the climate remained largely in stasis. But when Snowball Earth hit, the world changed – fast.

Where I sit in the creek bed, present-day North America ripped away from the Australian continent, opening up a rift valley not unlike those still forming in Africa today. This flooded to become a sea, and when the glaciers retreated and the world abruptly warmed again, life made the leap from single cells to multicellular. The waters of this inland sea soon squirmed and slithered with the first complex life: the Ediacaran biota. Animals emerged and rapidly increased in abundance, size, complexity and diversity, resulting in creatures with the first identifiable heads and bodies, and potentially the first brains and sensory organs. Their soft bodies squelched over sediments that would eventually compress into rock, that as the sea dried up would sink and fold and lift again in the great machinations of this planet's crust, until I stand on their dredged-up peaks atop nearly a billion years of history.

Today, the Ranges have been twisted, buckled and eroded so thoroughly that layers run vertically through mountains and the walls of creeks angle up towards the sky. Years have made unparalleled weapons of wind and rain, slicing through the rock to expose a more ancient time beneath – in some areas of the Flinders, you can travel a couple of dozen kilometres and pass through hundreds of millions of years.

Time is thin here; the eons slip in and out of each other. It's one of the few places where I've ever felt close to glimpsing just how immensely old the planet is – just how many generations stretch out behind me, and just how many stretch out ahead.

In Enorama Creek, one hand on the weathered disc carefully placed to mark a massive planetary

GOLDEN SPIKE



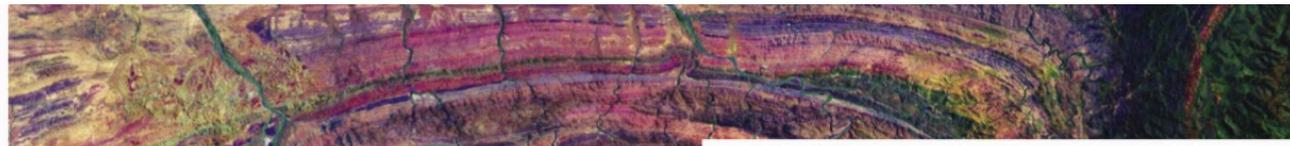
A Global Boundary Stratotype Section and Point (GSSP) is a reference point on a stratigraphic section which defines the lower boundary of a geologic time scale stage. Once a GSSP boundary has been agreed upon, a "golden spike" (neither golden nor spiked) is laid into the geologic section to mark the precise boundary for future geologists. There are currently 75 ratified spikes; just one, in South Australia, is in the Southern Hemisphere.

change, I'm touching the beginning of everything we are, tucked into the rocks like a memory.

Several months and a whole mental world away from the Flinders, in a laneway café in Adelaide's east end, geologist Alan Collins walks me back through a billion years of history. Colour-coded blobs move mesmerisingly across his laptop screen, sliding across a map of the globe. Like the shattered shards of a mosaic, they slam together into supercontinents, break apart, then rearrange into new formations. Each blob represents a tectonic plate, each colour represents the continent it belongs to in today's world, and each second of the video leaps forward 25 million years.

This, Collins tells me, is the first full plate reconstruction of the past billion years, and it's a key step towards understanding how complex life began. That moment of beginning marked in Enorama Creek – when life worked out how to combine cells and make complicated creatures – is still shrouded in mystery. Why, scientists wonder, did evolution kickstart then instead of at any point in the billion years before?

"We have a million hypotheses of why this happened, but absolutely none of them are scientific at the moment," Collins tells me. "We have no models for what the world looked like."



TOP LEFT: ROYAL GEOLOGICAL SOCIETY OF AUSTRALIA

ABOVE: IAN ROBERTS / SOUTH AUSTRALIAN MUSEUM

But now, on his laptop screen, we watch the Flinders Ranges begin to fold up out of the Earth. It's 800 million years ago and the Australian continent is only half there – the south-east corner is completely missing. We're part of the supercontinent Rodinia still, but as I watch, North America yanks away from the Flinders and skids off around the globe. The inland sea opens up, and as Snowball Earth gathers pace, the years tick away in the corner of the screen – 800, 700, 600 million years ago – water flows in.

"We're now in the Cambrian," Collins says casually. "It's possible trilobites and things are swimming around in the oceans now. And we've got this big, big continent – this is Gondwana."

Soon North America returns to the rapidly growing conglomerate, and just like that, Gondwana morphs into Pangea: the last supercontinent before the fragmented period we live in today.

When a billion years is packed into less than a minute, the tectonic pulse of the planet is visible: supercontinents form, splinter, form again 90 degrees around the globe, and then splinter again. Each cycle lasts around half a billion years and affects the flow of material out of the deep Earth, shifting the upwelling and downwelling zones.

This mind-boggling kind of perspective is important not just for pure geological understanding, but to give context to the incredible changes the planet has seen.

Many of the elements required by life – for example, the phosphorus that forms the backbone of our DNA – came from the deep Earth. They must have been hauled up to the surface at some point, but there is no big picture understanding of how the planet's many interrelated systems combined to make this happen. This new geological reconstruction – published in the journal *Earth Science Reviews* and led by Andrew Merdith from France's Université de Lyon – is the beginning of just such a framework, showing how the Earth as a whole evolved, and potentially helping scientists quantify and test models about the evolution of life.

The Flinders Ranges were once a seabed, hardened by time and buckled into mountains by tectonic forces. The false-colour aerial view (left) shows the rugged folds of the Vulkathunha-Gammon Ranges National Park. Years of erosion have cut through the rock, revealing impressions including fossils representing the earliest

multicellular organisms on Earth. *Spriggina flouderersi* (below) is one such early species, dating back to the Ediacaran Period. There is still some debate about where the Ediacaran biota belongs in the tree of life – scientists aren't yet sure if these early fossils represent plants, animals, or something in between.

In this creek bed, time suddenly scrunches up beneath me – and for a brief instant, I'm connected to one of the most crucial shifts in history.



For Collins, this global plate model is one thread in the pursuit of an all-encompassing Earth systems theory, asking some of the most fundamental questions: How did the planet come to be? Why does it move and breathe like it does? How did life arise? Why is everything the way it is?

"This is the stuff that I love," he enthuses. "This is only really happening in the last five years – people are starting to really see where the links are."

Collins and his team at the University of Adelaide were involved in pulling together the data to build the reconstruction, in conjunction with researchers from France, Canada, China and elsewhere in Australia.



This was fed into a piece of software developed by the University of Sydney. Called GPlates, the software is like GIS – a system for representing data related to positions on the Earth’s surface – but reaches back in time in an attempt to map what the world was like on the grandest possible scale of history: where the plate boundaries were and how they evolved, how continents collided and how they tore apart.

Putting this map together involved digging up and scrutinising research from decades past, including evidence for the locations of plate boundaries and how they changed over time.

“A lot of it is integrating data that’s been out there for years, bits of chemistry or some paper 20 years ago,” Collins explains. “It’s really just data mining on this whole-Earth scale.”

When you piece it all together, he says, you end up with “a horrendous, four-dimensional jigsaw puzzle: three dimensions on the surface, and then it goes through time as well”.

In 2017, the collaboration published a full plate reconstruction stretching from 1–0.5 billion years ago, encompassing all the exciting moments such as massive climate swings and the explosion of animal life. Now, the team have added the most recent 500 million years up to the present day – so when Collins hits play on his laptop, a quarter of the planet’s history unspools before me in 40 seconds.

As we watch the plates peel out of the supercontinent Rodinia then zip together into Gondwana, I find myself on that same precipice of understanding I felt in Enorama Creek. Balanced on the rim of deep time, I squint into the vast chasm of the Earth’s past, and for an instant I can almost focus all the way down.

It’s astounding that science now has the capability to do this – to collect, synthesise and represent data in a way that helps humans understand our temporal location in a vast planetary history. Our brains were arguably not built to deal with scales much beyond our own lifespans, yet geology is now radically extending our abilities to perceive time.

But staring so far back into the past doesn’t come easily. “It’s impossible,” Collins tells me. “But there’s loads of games you can play. What I do with primary school kids is talk about toilet paper.”

Imagine one sheet of toilet paper is 100 years. If there are 200 sheets in a roll, then a single roll represents 20,000 years. A hundred of those and you’ve jumped back two million years, to when our genus *Homo* split off from our other hominid ancestors. “Then you can go back and you can keep on playing,” he says. “Once you’ve got a whole building full of toilet papers [30,000 rolls], you’re back in the Precambrian.”

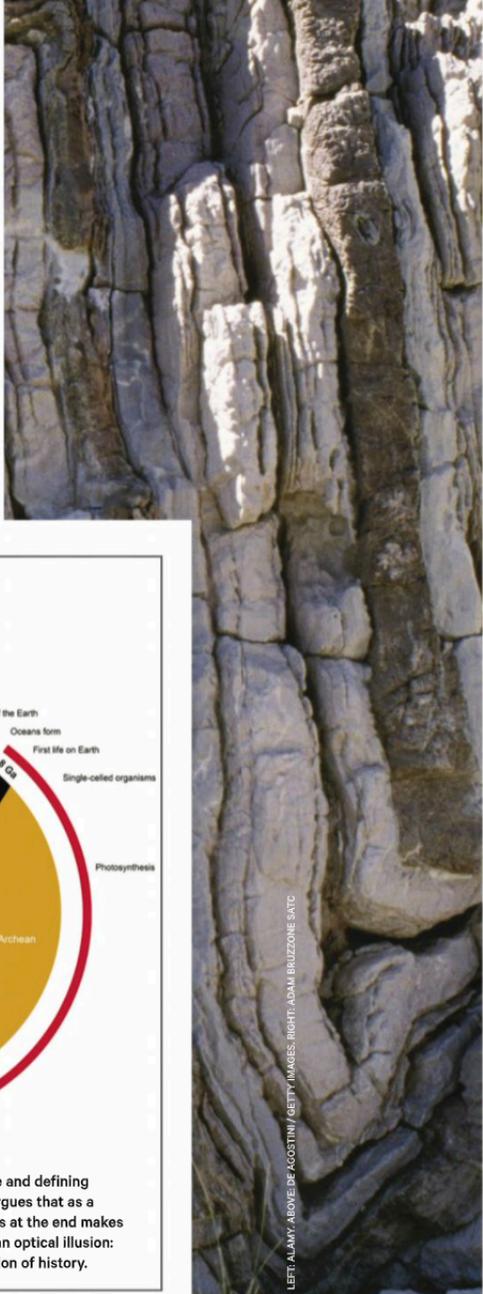
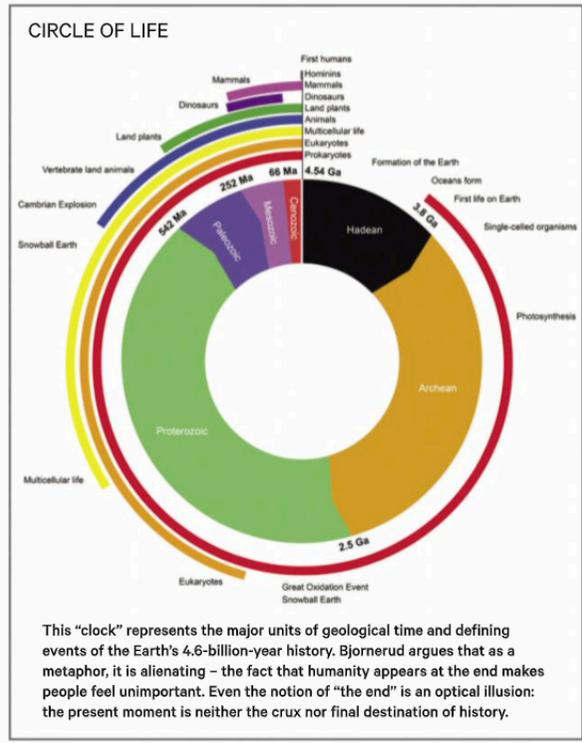
“But even then, it’s all very arbitrary,” Collins admits. “It’s hard to get your head around the timescales.”

Many minds have tried to grasp this slippery problem, including palaeontologist Stephen J. Gould in his classic 1987 book *Time’s Arrow, Time’s Cycle*.

“An abstract, intellectual understanding comes easily enough – I know how many zeroes to place after the 10 when I mean billions,” Gould writes. “Getting it into the gut is quite another matter. Deep time is so alien that we can only really comprehend it as metaphor.”

These metaphors go far beyond toilet paper, contorting language in attempts to simulate true understanding – for example, imposing the entirety of geological time onto a kilometre, where humanity occupies only the last few centimetres, or onto a 24-hour clock, where we evolve in the last seconds before midnight.

A particularly striking metaphor comes from John McPhee, the American writer who coined the term “deep time” in his 1981 book *Basin and Range*:



“Consider the Earth’s history as the old measure of the English yard, the distance from the king’s nose to the tip of his outstretched hand,” he writes. “One stroke of a nail file on his middle finger erases human history.”

I’m hiking down a tributary of Arkaroola Creek, right in the centre of the king’s palm. Above me the winter sun glares down, and beneath me lies 700-million-year-old glacial tillite: a jumbled mix of lavender, reddish purple and pastel grey rock, studded with ice-scoured pebbles and boulders dropped by glaciers during the first Snowball Earth.

I’m just outside Vulkathunha-Gammon Ranges National Park, 200 km north of Enorama Creek but along the same spine of mountains. The landscape tells the same story of deep time. Some kilometres back I passed a hilltop capped with buff-coloured rock that was once an ancient reef, home to unusual sponge-like structures that emerged after the great melt 650 million years ago and may, as a small sign quietly notes, be among the earliest signs of multicellular life on Earth. Now, I’m walking on tillite that appears to flow down the creek in a series of frozen cascades. The region is once again transformed today – both ice and shallow sea have vanished, replaced by drought-gripped rock and red dirt. I slip between the precious shade of shrivelled red gums; the black eyes of Sturt’s desert peas blink at me; algae clings to the surface of shrunken waterholes.

I climb out of the creek and enter a moonscape of volcanic basalt, formed 830 million years ago when the continents tore apart. As I pick my way over crumbled chunks of rock mottled with green and orange, I’m travelling up the king’s hand, towards his arm and through time. The millennia speed up in my head and the planet reveals its restlessness: rocks move as though they have tides; mountains rise and fall like breaths. Reading the landscape through time reveals not just its age, but the threads that make up the vast story of its history.

Though located on different sides of the planet, these two places – Agios Pavlos in Crete, Greece (left) and Arkaroola in the northern Flinders Ranges (below) – were created by similar tectonic forces. Compression can crumple horizontal layers into spectacular folds, often uplifting older time periods and offering a glimpse into

many parts of the distant past. These two places are also both geologically messy: Crete lies above a subduction zone between the African, Aegean and Eurasian plates, and so is pushed and pulled from many directions, while Arkaroola’s chaotic geology preserves evidence of many different environments over more than a billion years.

Consider history as the distance from the king’s nose to the tip of his hand. One stroke of a nail file on his finger erases human history.



“I don’t think any of us really understand what a billion years means,” Marcia Bjornerud tells me later, in a video call across time and space, oceans and seasons. “But little by little, you start filling in geologic time with stories, and I think that’s where we will understand.”

Bjornerud is a professor of geosciences at Lawrence University in Wisconsin, in the US, where she studies rock formation and mountain building. She’s also the author of a slim, powerful book called *Timefulness: How thinking like a geologist can help save the world*. In our conversation, she mentions two distinct Greek words for time: *chronos*, which is the straightforward measurement of seconds, minutes and hours, and *kairos*, which is “time within a narrative”.

“That’s what really makes geological thinking different,” Björnerud says. “We do want to quantify time, but the power of geology has been to recreate these narratives of earlier ecosystems and tectonic events on Earth. That’s where you start developing a sense of how long a billion years is.”

Reading the land in four dimensions can give us a consciousness of what she calls timefulness: a “clear-eyed view of our place in time, both the past that came long before us and the future that will elapse without us”.

It’s important to understand because we too live in geologic time: “We’re part of this continuum – we have deep roots evolutionarily in the tree of life.”

As I walk the remnants of vanished worlds in Arkaroola Creek, where the ebbs and flows of the landscape are visible, I’m keenly aware of my own deep roots in the Earth – as an organism not separate from or above the rest of nature but inextricably linked to the ancient, almost alien animals that teemed in the shallow seas of the Flinders.

Geology confirms how deeply we are bound to the planet itself. As writer Robert Macfarlane describes in his epic work of literary non-fiction *Underland: A deep time journey*, humans are in fact part mineral beings: “Our teeth are reefs, our bones are stones – and there is a geology of the body as well as of the land. It is mineralisation – the ability to convert calcium into bone – that allows us to walk upright, to be vertebrate, to fashion the skulls that shield our brains.”

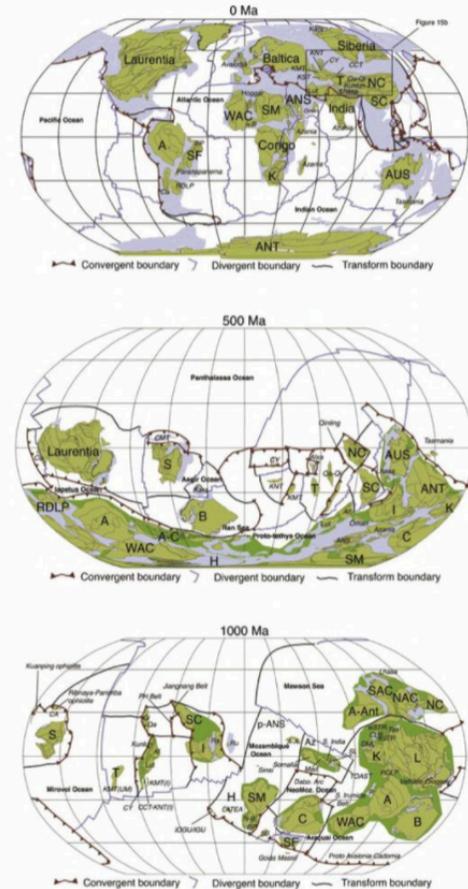
With this knowledge in my minerally fortified mind, the boundaries between living and non-living begin to blur; the illusion of separation breaks down.

“Dazzled by our own creations,” Björnerud writes, “we have forgotten that we are wholly embedded in a much older, more powerful world whose constancy we take for granted.”

Standing on the king’s palm and gazing back down his arm, I wonder what the enormity of time can teach us about the planet’s future.

Geologists have been prudently placing golden spikes around the world since 1977, as part of an ongoing project to provide reference points for their colleagues of the future. Like the disc embedded between glaciation and complex life in Enorama Creek, they mark sharp and stable snapshots of when the planet lurched from one chunk of geological time to the next. Some of these boundaries are clear in the rock record; others are based on distinct changes in animal life; all herald transitions in Earth’s history. Near a small town in north-west Tunisia, for example, a golden spike is hammered into a parched, furrowed hillside at a striking red

TECTONIC TIMELAPSE



Snapshots from the first full-plate tectonic reconstruction of the last billion years. White areas represent oceanic crust, while green areas are modelled continental lithosphere, and blue areas are additional present-day continental crust. To create this, geologists synthesised decades of research, including figuring out the locations of mountains (where continents have hit each other) and ocean basins (where continents rifted), as well as the bathymetry of the ocean (related to the locations of mid-ocean ridges, subduction zones and trenches). Scientists think the Earth was once like Mars and Venus – with a rigid outer layer and no apparent plate tectonics – but for a reason they don’t yet understand, something shifted, plate tectonics was kickstarted and everything changed.

LEFT: JIM COLLINS
ABOVE: WOLFGANG BERGHEIMER, BRIGHTON, ILLINOIS, GETTY IMAGES

layer of iridium-rich sediment – just a few millimetres thick – sandwiched between two dark layers of clay. This rare metal was strewn across the world 66 million years ago – as debris from the asteroid strike that wiped out three-quarters of the Earth’s species. Below the iridium layer: dinosaurs. Above the iridium layer: the mammalian rise to dominance.

The golden spike in Enorama Creek doesn’t mark a mass extinction, but it does mark a massive change: Snowball Earth.

Weird climate events like global glaciations are interrelated with both plate tectonics and evolution.

“Just after the first Snowball Earth is when we start to see a lot of chemical evidence of eukaryote cells filling up all the ecological niches,” Collins explains. “Then you get multicellular creatures start to form.”

This particular era is also when oxygen in the atmosphere increased dramatically for the first time in a billion years, roughly reaching the 21% that allows us to breathe today.

“That’s because life is going,” Collins says. “Oxygen is one of the few elements that isn’t coming directly out of the Earth – it’s coming from photosynthesis.”

But life could only proliferate and photosynthesise because essential nutrients were ground out of rocks by glaciers and washed into the seas. These floods caused bacteria to bloom and churn out oxygen, which in turn helped the water absorb the nutrients, which allowed bacteria to churn out even more oxygen. And so the world turned on and on, until the first animals wriggled through warm waters, dinosaurs reigned and fell, and primates began to chip tools from stone.

These vital floods of nutrients were likely the result of Snowball Earth – “glaciers are incredibly good at eroding down mountains,” Collins notes. Geology is also suspected to have caused the massive ice ages in the first place, with large-scale weathering of rocks locking away carbon dioxide and cooling the atmosphere below freezing, shattering a billion years of climactic stability. Plate tectonics even helped us escape the ice’s grip, as volcanoes formed,

While plate reconstructions can reveal the planet’s dynamism by packing billions of years into seconds, evidence of the Earth in motion is all around us. The rock cycle is a current affair. Glaciers flow under gravity like rivers of ice, acting as powerful forces on the landscape – not only gouging striations into the rocks (as pictured at left

in the Endicott Fjord in Alaska) but carving out the fjords themselves. Similarly, volcanoes (below) are constantly cycling material from the planet’s depths up to the surface, forming brand new rocks as lava cools.

This new ability to look deeply into the past can help us pinpoint the moments at which the planet tipped – where everything changed.



spewed out greenhouse gases and sent temperatures skyrocketing again.

Models of the planet’s surface through time, like the one Collins helped build, are key to understanding what was happening geologically in the lead-up to Snowball Earth, and thus give context to the radical evolutionary changes that followed. But perhaps most importantly, this new ability to look deeply into the past can help us pinpoint the moments at which the planet tipped – where something shifted, the Earth’s systems responded, and everything irrevocably changed.

Now, more than ever, these past tipping points are vital to understanding the edge we find ourselves teetering on today.



As far back as 1873, Italian geologist Antonio Stoppani recognised humanity's activities as a "new telluric force which in power and universality may be compared to the greater forces of Earth".

But our dominion over the Earth then is nothing compared to now.

Today, our surging population and insatiable industrial metabolism are outgunning the planet's own forces. We have become the dominant influence on the climate and environment, casting aside the stability of the Holocene and driving ourselves into a planetary epoch of our own making: the Anthropocene.

It's no small thing to redefine a geological era, but the rocks tell us it's true. The dramatic boundary in Enorama Creek represents a rift in normality that kickstarted the whole complex tree of life – and now that we are turning up the heat ourselves, it too is being hardened into the rock record.

Since the Industrial Revolution, we have scattered soot across the planet and relentlessly stirred in radioactive elements, inconceivable mounds of plastic, pesticides, excess nitrogen and phosphorus, billions of skeletons from livestock, and enough concrete to spread a kilogram over every square metre of the Earth. Each year mining shifts three times more rock and dirt than all the world's rivers, and humans are reconfiguring the course of

evolution as we rearrange species across continents and eliminate many more.

"What signatures our species will leave in the strata!" writes Macfarlane in *Underland*. "We have become titanic world-makers, our legacy legible for epochs to come."

Soon, the sedimentary layer of the Anthropocene will be filled with microplastics fossilised into the bodies of zooplankton and the glacially paced atomic pings of buried nuclear waste, decaying over tens of thousands of years – and compacting down to a ribbon of history about as thin as the king's fingernail, reminiscent of the apocalyptic stripe of iridium in Tunisia. As Elizabeth Kolbert writes in *The Sixth Extinction*, if civilisation ended today, in 100 million years all "the great works of man – the sculptures and the libraries, the monuments and the museums, the cities and the factories – will be compressed into a layer of sediment not much thicker than a cigarette paper".

We are now not just part of the grand geological narrative of the Earth but directly impacting it, transforming systems far bigger and more complicated than ourselves – with repercussions for generations to come. In *Timefulness*, Bjørnerud names it "temporal illiteracy": "We are navigating recklessly toward our future using conceptions of time as primitive as a world map from the 14th century, when dragons lurked around the edges of a flat Earth."

Truly understanding the Anthropocene requires us to think on vastly different timescales than we're

used to. You can imagine a year, or ten, or even a century – but beyond our parents' parents or our children's children, the details fuzzi; the imagination fails. The geologic record is perhaps the only thing that can give context to our current temporal location.

"Understanding the magnitude and the rates of changes in the past is really all we have to go on to know how serious our predicament is now," explains Bjørnerud. "By almost all measures, the rates of change in the last century or so are almost unparalleled in the geologic record."

Geoscientists and ecosystem scientists feel a deep, existential sense of alarm, she notes, because they, more than anyone, recognise the analogous tipping points in the past and the terrifying nonlinear responses that can result.

Bjørnerud hopes we can drag ourselves back from this edge by listening to the warnings of deep time. "All of those moments of transition from one geochemical regime to another, or one climate system to another, have been times of great upheaval and long-term instability before Earth settled back into a new equilibrium," she explains.

In some sense, this shows remarkable resilience, promising that the planet itself will survive our negligence and our malice.

"There's reassurance in seeing that the world has been through a lot," Bjørnerud says. "There have been terrible mass extinction events, occasional meteorite strikes – and yet, overall, it's a very robust place. There has never been a moment where life was completely extinguished."

And yet more than 99% of all life that has ever lived on this planet is now extinct. As we hurtle along our current path, we appear keen to add ourselves to this statistic.

"At its best," Macfarlane writes, "a deep time awareness might help us see ourselves as part of a web of gift, inheritance and legacy stretching over millions of years past and millions to come."

Deep time may seem to offer a dangerously false comfort – that our behaviour doesn't matter when

While some rocks appear interchangeable to many people, others are windows to earlier times. In Arizona's Painted Desert (centre), the Blue Mesa Member exhibits thick and colourful bands, which tell stories of an ancient river system that wound through the landscape over 200 million years ago, and detail the mineral types

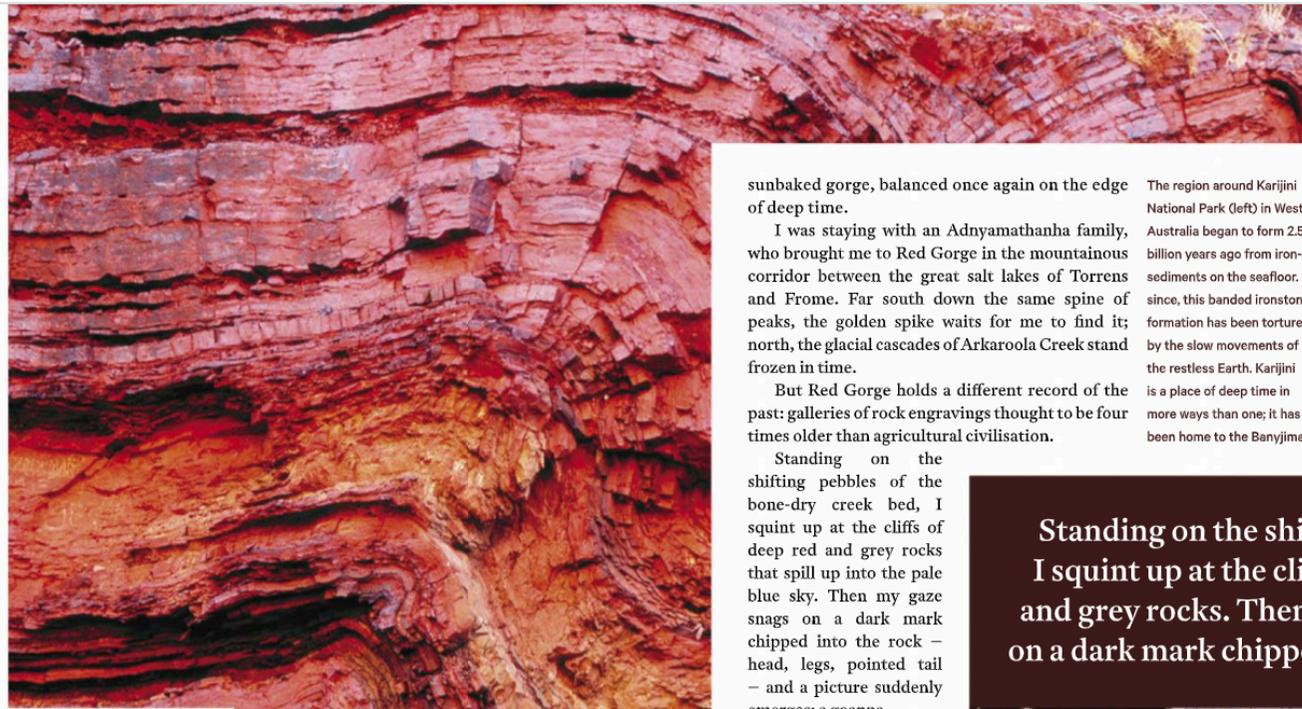
and water levels present at each layer. The Rainbow Mountains in China's Zhangye Danxia geopark (below) tell a similar story of a watery origin, while the sandstone waves of Arizona's Vermilion Cliffs National Monument (far left) plunge us back into the Jurassic period, when winds forced the migrations of sand dunes across desert.

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our species will vanish in the blink of a geological eye. But perhaps instead we could use it to recognise that what we are now urgently trying to save is not the planet – it is ourselves.

The Flinders Ranges have been home to the Adnyamathanha people for at least 49,000 years. While geology is just beginning to construct a deep time consciousness through rebuilding the stories of past landscapes, Indigenous cultures have always seen themselves embedded in a larger planetary narrative.



Modern dating techniques place Indigenous Australians on this continent for at least the last 60,000 years, but as Michael-Shawn Fletcher – a Wiradjuri man and physical geographer at the University of Melbourne – tells me, “according to our understanding, we’ve always been here.”

“This linear notion of a sequence of events in time doesn’t exist – stories of the past are wrapped up into understandings of the present,” he says. “The agents that made landscapes and Country are still very much with us today, and they need to be serviced and understood and respected.”

The land is seen as thoroughly alive, breathed into being by the creatures and the humans who inhabit it. People are strongly influenced by the geology, topography, flora, fauna and climate, all of which feature in stories that act as guiding principles for existing as an inseparable part of the landscape. Whatever happens to the land happens to the people, and whatever happens to the people happens to the land, resulting in a very different kind of responsibility to the natural world.

“There’s no imagining of the landscape or Country without people,” Fletcher says. “In the geological sense, by placing everything on a continual timeline, you place yourselves in the world differently – it almost creates a transience.”

In Fletcher’s opinion, the problem lies in viewing our species as non-permanent and unimportant in Earth’s linear scheme – perhaps

even an imposition on the landscape, such as when we squeeze all of geological history into a single day where humans arrive on the scene mere seconds before midnight. By embedding people within a timeless narrative in a place they have forever lived, Indigenous traditions underpin an inseparable relationship with the Earth, right here, right now.

Perhaps recording time is almost unnecessary; what matters most is the present. Even for the Western world, Fletcher suggests, quantifying the deepness of time – both into the past and into the future – may be less important than recognising and fostering this fundamental connection. He warns that if we view time as a linear history of events, we might think we can simply “fix” a mess created in the past and move on.

“What after then?” he asks. “We can just take our foot off the pedal? No, it’s about that constant relationship development. We’ve got to start treating the Earth like a family member.”

Before standing in Enorama Creek with a billion years folding up beneath me, before the reconstructed plates slid under my gaze at 25 million years per second, before I learned of Snowball Earth or timefulness or how the stroke of a nail file can erase human history, I found myself at an Adnyamathanha engraving site in a

sunbaked gorge, balanced once again on the edge of deep time.

I was staying with an Adnyamathanha family, who brought me to Red Gorge in the mountainous corridor between the great salt lakes of Torrens and Frome. Far south down the same spine of peaks, the golden spike waits for me to find it; north, the glacial cascades of Arkaroola Creek stand frozen in time.

But Red Gorge holds a different record of the past: galleries of rock engravings thought to be four times older than agricultural civilisation.

Standing on the shifting pebbles of the bone-dry creek bed, I squint up at the cliffs of deep red and grey rocks that spill up into the pale blue sky. Then my gaze snags on a dark mark chipped into the rock – head, legs, pointed tail – and a picture suddenly emerges: a goanna.

A new depth to the world falls into focus as my eyes flick from rock to rock. Animals and prints leap out from what a moment ago had seemed totally inert landscape – lizards and emu footprints, echidnas and snakes, kangaroo tracks stalked by human prints. Medicine men and women are depicted with huge eyes and staffs, and suns are circles with long rays reaching out in all directions: visual echoes of the soft, symmetrical bodies of the Ediacaran biota.

The engravings multiply the longer I look, stretching 20 metres above my head. Though dating is difficult, I’m told that some are thought to be more than 45,000 years old.

One of the most stunning is a series of human footprints, chiselled into boulders stepping up the banks of the creek. They trace the path of an invisible figure as it leaps up, up, up the rocks – light, agile, completely at ease in the landscape.

But it’s when I spot a human handprint that I feel time contract. The engraving is just a shallow imprint in the iron-coloured stone, surrounded by depictions of snakes and kangaroos, but the

The region around Karrijini National Park (left) in Western Australia began to form 2.5 billion years ago from iron-rich sediments on the seafloor. Ever since, this banded ironstone formation has been tortured by the slow movements of the restless Earth. Karrijini is a place of deep time in more ways than one; it has been home to the Banyjima,

Kurruma and Innawonga people for at least 20,000 years. In New South Wales, this sandstone formation (opposite) is on the traditional lands of the Gadigal people of the Eora nation, while South Australia’s Red Gorge (below) has been a place of deep cultural significance to the Adnyamathanha people for nearly 50,000 years.

Standing on the shifting pebbles, I squint up at the cliffs of deep red and grey rocks. Then my gaze snags on a dark mark chipped into the rock.



fingertips are outstretched as though someone is pressing into the rock from behind. Instinctively, I lift my own hand and gently fit my fingers into the chiselled grooves.

It isn’t like the golden spike in Enorama Creek, like a warp drive transporting me back through time – it is, instead, as if this person stands here with me in this gorge, as present today as ever, hand extended to help. ●

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LEFT: WOODSTOCK / GETTY IMAGES

ABOVE: ALSCAPE / GETTY IMAGES; RIGHT: LAUREN FUGE