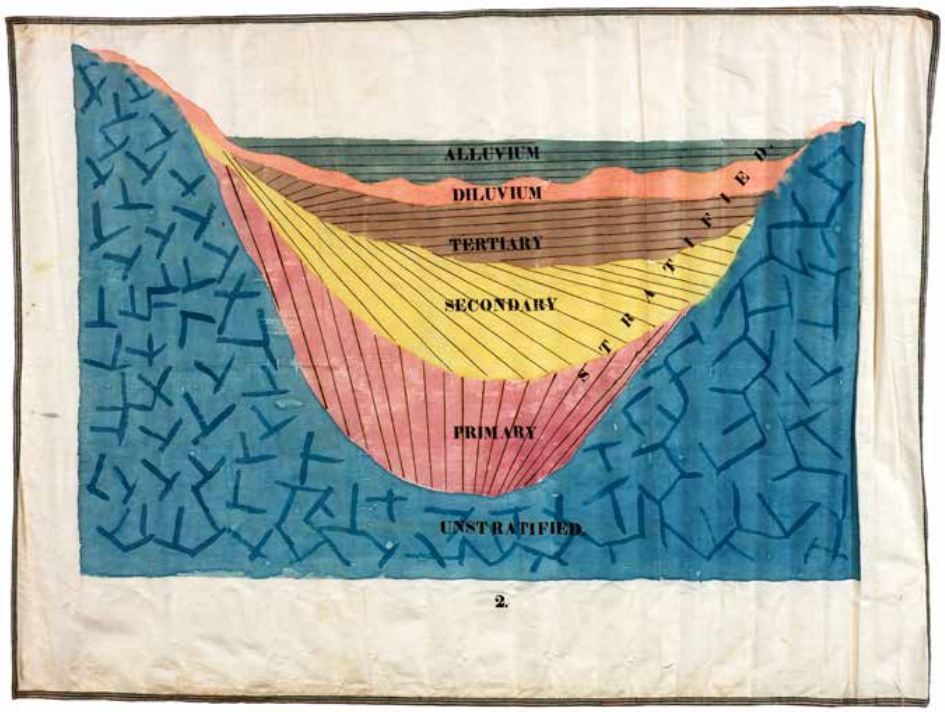


Orra White Hitchcock, Drawing of slate, Devonshire, England, 1828–40. Pen and ink on linen, 22 × 69 cm.

DISORIENTATION

Fear might be the best way to begin this section. This is at least the suggestion of Dipesh Chakrabarty in his interview: "I grew up in a place where fear was very much still a part of my life. Something about that reverence has to be brought back to supplement our very Aristotelian sense of wonderment …"

Chakrabarty has been one of the first to convince historians — meaning historians of *human* adventures — to pay attention to the disorientation induced by the introduction of coal and gas into the rhythm of social and world history. Everything happens as if the global — what modernity was supposed to deliver on the surface of the planet — is entering into conflict with what Chakrabarty calls the "planetary" — that is, the same planet once dreamed of, except now it appears concrete, material, reacting to human actions, and above all, *limiting* global development.

Everybody nowadays is aware of the name geologists have given to this disorientation: the *Anthropocene*. Nobody has done more to make the discipline of stratigraphy known to the general public than Jan Zalasiewicz. The study group that he has assembled and guided has provided a scale for measuring the magnitude of human intervention into geological history that had not been realized before. And, indeed, "in the Anthropocene, almost everything becomes geology" (Jan Zalasiewicz). Hence the sad beauty of Zalasiewicz's summary of this human intervention, a picture achieved by reducing some of the geological data to a one-meter measure. How odd to realize that the biomass, according to this metric, is just five kilos per square meter, whereas the stuff humans have been able to produce — rubble, ruins, soil and all — weighs as much as fifty kilos! We knew "man was the measure of all things," but we did not know the surprising length of that measuring stick. And to learn that the collective pressure of human activity is comparable only to asteroids at the end of Cretaceous or giant volcanoes at the end of the Permian, does not make the measure any less distressing.

After all, volcanoes too have been dragged into our culture, as Karen Holmberg argues, but it's not reassuring that humans have become volcanoes themselves, especially as their kind of industrial eruption works 24 hours a day, 365 days a year.

No wonder that the word Anthropocene has metastasized to the point that Clémence Hallé and Anne-Sophie Milon can refer to "the Infinity of the Anthropocene." The news is so disorienting that every discipline, every interest group offers an alternative term, insisting on this or that other variable, in order to cope with the maelstrom. That's actually the good thing about this new geological label: it has spread everywhere and yet it is impossible to settle quietly "in" the historical period it designates.

It is actually one of the characteristics of the present that this disorientation can be observed in many different sites and at very different scales — which is what the layout for this volume allows. Witness the care with which an artist like Sonia Levy follows the work of oceanographers and biologists as they accompany and maybe preserve (or at least learn as many lessons as possible from) the threatened corals gathered in the basement of a Museum in London. It is every component of the former nature that has to be taken care of.

The same puzzlement has moved Robert Boschman to explore the archeology of our only real predecessors, those hunter-gatherers living 12,000 years ago, who within only a few generations had to adjust to massive climate change. The Young Dryas episodes narrated by Boschman offer a meditation on how to cope with a massive disorientation in the order of the universe. Except our European ancestors might have been nimbler in shifting their ways of life than we modern humans are; prisoners of our mammoth technosphere.

To order the universe is precisely what becomes difficult in a time such as ours. According to John Tresch, "cosmograms" are objects, stories, images, and narratives that capture the spirit of a time or a new situation for which there is no received name. Just what we need when the whole machinery of time is getting out of joint. Cosmograms order the world just at the moment when there is no order. "What do they *do* — how do they propose, institute, challenge, satirize, critique, prop up, or quietly reinforce an order of the universe?" When Tresch quotes Elisée Reclus's "Humanity is nature becoming aware of itself," we take stock of the distance between the optimism of geography in the nineteenth century and this more recent slogan of the activists in France today: "We're not defending nature, we *are* nature defending itself." Human consciousness is what seems to be in short supply today.

In times of uncertainty the crucial question is to decide whether we are able to tell the right story, and this time not to build a world of fiction but to have an imagination realistic enough to follow what the real world is made of and how; that is, what's the story the world itself tells. A problem that Richard Powers, the great American novelist, has done more than anyone else to solve practically, by writing stories *as they are*: "And like it or not, the man and his measurements and the mountain and the neighbors and the forest and all that story's readers are all a part of it."

Around the Pluriverse in Eight Objects: Cosmograms for the Critical Zone

John Tresch

Antechamber: How to Do Things with Worlds

What might the universe look like, seen from the Critical Zone? There shouldn't be anything strange about the question, since this is where we've always been: stuck down here in the mud, despite visits to the moon and stratosphere. But the question of *how to represent the universe from ground level* is usually passed by in favor of stunts and special effects. Philosophers and scientists climb imaginary look-out towers to give us the universe as angels, aliens, or gods would see it: from up above the Earth, or up above the entire system of systems, bound and concentric when we were medieval, and aimlessly scattered when we thought we were modern.

The exhibition *Critical Zones: Observatories for Earthly Politics* asks how we can rethink our science, politics, and art. How can we represent the shifting universe to ourselves, from the point of view of terrestrial beings — grounded in a territory, in vital, messy, gravity-bound interdependence with infinitely numerous but equally earthbound others? How do we reposition ourselves in relation to, and within, a cosmos where over two hundred years of entrenched policy are steadily eroding and volatilizing the self-regulating cycles of air, soils, rock, water, and organisms?

A shift of reference is required — to take on the carefully established facts and mappings of the Critical Zone sciences without allowing them to float in the untethered, dead, and neutral space of "abstract science." If we think about how to map the emerging cosmos in a way that acknowledges all its differences of temporal and geographical scale, and that recognizes our profound involvement with the objects it studies, we might look at how this has been done in the past. How has the universe been drawn together in a single object or image?

Aiming at what I see as the target of this exhibition, I suggest we consider earlier cosmograms, or representations of the universe: objects that convey what the cosmos contains, its inter-relations and hierarchies, its history and direction, and humans' place within it. We can inspect both familiar Western cosmograms and those less well known to us, asking about the stories they tell and the maps they draw, joining living people to others, to the land, and to ancestors, and tracing their metaphysical topologies — as in Australian Yolngu paintings of the Dreaming.[1]

Science also produces cosmograms: from Francis Bacon's boat passing beyond the pillars of Hercules in *The Great Instauration* (1620), to Auguste Comte's positivist calendar (1849), Charles Darwin's speculative tree (first sketched in 1837), and Dmitri Mendeleev's periodic table (1869), right up to the mass-audience pop cosmologies of Carl Sagan, Stephen Hawking, Richard Dawkins, Neil deGrasse Tyson, and the Large Hadron Collider — the massive bounded cathedral that tests and confirms physics' "standard model."[2] All these cosmograms depict in different ways and with variable effects the order of the universe.

Beyond the question of their content and aesthetics, we can ask why these cosmograms were made, by whom, and in response to what historical pressures. Where are they placed and how are they distributed? What theory of representation do they imply? Above all, what do they *do* — how do they propose, institute, challenge, satirize, critique, prop up, or quietly reinforce an order of the universe?

To help us think through how to compose a new cosmological dispensation, I'll invite you into an imaginary chamber, a memory theater, a virtual exhibition space, a mental museum of cosmograms from the past. Our quick tour around these landmarks will prepare us to draw the map of relations for today's puzzling cosmological conjuncture. Looking at cosmograms as they *perform* cosmological arrangements shows us how to do things with *worlds*.

As we strive to get out from under the impossible view of science as a unified and otherworldly knowledge that miraculously grasps the stable truth of a reality *out there*, we can plot some significant inflection points: those which show how *one* cosmology came, in many crucial domains, to gain an ascendancy over all others, or rather inserted itself as more fundamental. We might grossly summarize this cosmology as "scientific." With slightly higher resolution, this "major" cosmology presents the universe and knowledge of it as *mechanical*, *material*, and *objective* — MeMO, for short (the reductionism is a feature, not a bug).[3] Through what concrete representations did *this* cosmology, this "naturalist" ontology, impose itself on the universe, to the point that it became commonsensical, the inevitable and self-evident foundation for different and varied systems of meaning, symbols, beliefs, values? With what other "minor" cosmograms

1 See Helen Verran, "A Story about Doing 'The Dreaming,'" *Postcolonial Studies* 7, no. 2 (2004): 149–64; Philippe Descola, "La fabrique des images," *Anthropologie et Sociétés* 30, no. 3 (2006): 167–82.

2 See Gabriel Popkin, "Catching 'Particle Fever': Documentary Gives Physics Fans a Look inside the Large Hadron Collider," *Science News* 185, no. 5 (2014): 28.

3 See Alexandre Koyré, *From the Closed World to the Infinite Universe*, vol. 1 (Baltimore, MD: Johns Hopkins Press, 1957); Peter Dear, *The Intelligibility of Nature: How Science Makes Sense of the World* (Chicago: University of Chicago Press, 2006).

Fig. 1: Zhang Heng, *Directional Seismograph*, 132 CE.

— offering up other ontological possibilities, both from within the West and beyond — did it contend, generating what clashes and truces, acknowledgements and denials?

Above all, what do we do with this cosmology now? The scientific "view from nowhere" — with its image of knowledge as pure, abstract, and free of history and value, unbound from ethics and precaution — encourages a relation to our planet that neglects the very ground on which we stand. But we vitally need well-constructed facts to see the processes at work and test possible outcomes of further interventions.

We step lightly on our tour of cosmograms; it shows the modern, naturalist cosmos as just one among many others, and gives an attentive ear to other ways of putting the universe together. This means taking seriously the different worlds that make up what William James in 1907 called "the pluriverse." James wondered why philosophers and scientists have been obsessed with the idea of one, single, unified reality. Why, he asked, should the world be just one; "why is 'one' more excellent than 'forty-three,' or than 'two million and ten'?"[4]

Why not *eight*?

Our sampler extends back about two millennia, roughly unfolding with a convenient historical sequentiality — though having them all here, under soft lights in a darkened room, warps the timelines and hints at how these eras and collectivities remain present, at work on each other. In these eight image-objects our own planet is palpably present, as is the puzzle of how the "external" world is already inside us, and how our internal worlds are grounded in what's outside. Any livable picture of our universe has to start and end here.

I. Seismoscope

THE FIRST OBJECT stands about three feet tall, a metal, egg-like vessel on an octagonal base. Eight dragons face downward around its shell toward eight small frogs looking up with open mouths (*see fig. 1*). It is said to have belonged to the court of the Chinese Han emperor, and made

4 William James, "Lecture 4: The One and the Many," in *Pragmatism: A New Name for Some Old Ways of Thinking* (New York: Longman, Green, and Co., 1907), 49–63, here 51. See also Martin Savransky, "The Pluralistic Problematic: William James and the Pragmatics of the Pluriverse," *Theory, Culture and Society* (July 2019), https://doi.org/10.1177/0263276419848030; Mary-Jane Rubenstein, *Worlds Without End: The Many Lives of the Multiverse* (New York: Columbia University Press, 2014).

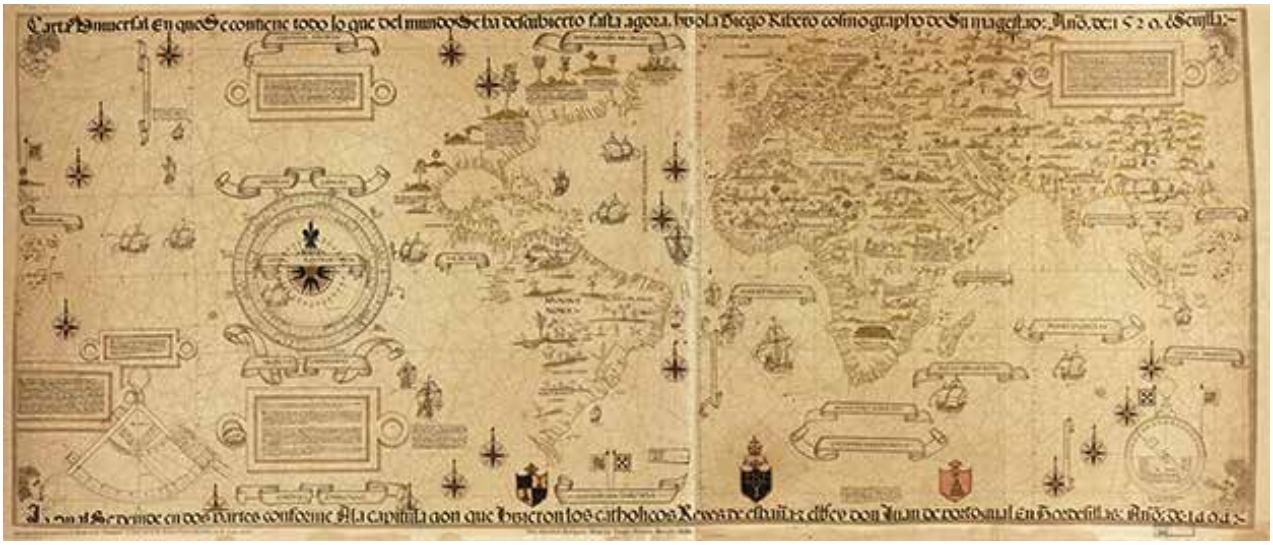


Fig. 2: Digeo Ribero, *Carta universal en que se contiene todo lo que del mundo se ha descubierto fasta agora*, 1533. Reproduction, 58 × 140 cm.

by the astronomer Zhang Heng in 132 CE — on the opposite side of the Earth from the Mediterranean, where the Greek word *cosmos* was first being recorded.[5]

In their 2002 book *The Way and the Word*, Nathan Sivin and Geoffrey Lloyd compared and contrasted ancient Greek and Chinese views of the universe in the five hundred years around the start of the Common Era — along with the social and institutional forms that shaped them.[6] In the cities of the Peloponnesus, the Greek gods were giving way to naturalistic notions: *physis*, *arche*, *logos*, and *cosmos*, an orderly whole. Lloyd explains that the variety in pre-Socratic and Athenian philosophy had everything to do with the setting of the Agora, where wealthy landowners shopped for tutors for their sons. The period's explosion of conceptual innovations — making sense of the cosmos through stasis and change, the one and the many, appearance and reality (atoms, elements, or numbers) — resulted from philosophers trying to best their rivals in a competition for teaching jobs.

By contrast, Sivin shows, in Ancient China from the era of Han unification, philosophers emphasized the continuity and unity of tradition and the wisdom of ancestors. Natural knowledge was supported by a vast state bureaucracy with extremely difficult entrance exams. Mastery of tradition, not innovation, was valued.

Ancient Chinese cosmology merged Confucian ethics and Taoist metaphysics, built around the analogy between body, state, and cosmos. These three levels of reality were in close correspondence, united by the energy of chi, cyclically passing through the five elements or states. The emphasis was not on causality but on *resonance* among different domains of reality. Coordinating these cosmic domains was the emperor, who maintained earthly harmony through rituals seasonally repeated and built into the forms of temples and cities. The Mandate of Heaven confirmed the emperor's rule: no catastrophes meant he was doing his job.

Zhang Heng's seismoscope contained a pendulum on a wire so sensitive it could register tremors in the earth at a great distance. When it picked up vibrations, a marble dropped out of one of the dragons' mouths and plonked into a frog's, indicating the direction of the tremor. As one story goes, one day the "ping" of one of the marbles was heard, but members of the court felt nothing; a few days later a "a runner arrived from a village 400 miles away to inform the Emperor that his area had been devastated by an earthquake" — for which the emperor had already prepared assistance. This device, like many other cosmograms, involved action at a distance in the service of an empire.[7]

5 See Joseph Needham, *Science and Civilisation in China*, vol. 4, *Physics and Physical Technology*, part 2, *Mechanical Engineering* (Cambridge: Cambridge University Press, 1965), as well as vol. 3, *Mathematics and the Sciences of the Heavens and the Earth* (Cambridge: Cambridge University Press, 1959), 624, 644; Seth Stein and Michael Wysession, *An Introduction to Seismology, Earthquakes, and Earth Structure* (New York: John Wiley & Sons, 2002).

6 See Geoffrey Lloyd and Nathan Sivin, *The Way and the Word: Science and Medicine in Early China and Greece* (New Haven, CT: Yale University Press, 2002).

7 Marilyn Shea, "Historic Beijing in Pictures 'Chinese Astronomy'," May 2007, http://hua.umf.maine.edu/China/astronomy/tianpage/0012ZhangHeng6539w.html. Does it matter that no pictures or detailed descriptions of the Han seismoscope exist in ancient sources, and that the current form is a mid-twentieth-century invention? Undoubtedly: promoting this cosmic object as a precursor to a national tradition of science is itself a cosmological intervention, to ground current visions of progress in a heralded past. On the recreating of national histories of science worldwide, see James Delbourgo, "The Knowing World: A New Global History of Science," *History of Science* 57, no. 3 (2019): 373–99; on Earth science and empire, see Deborah R. Coen, *Climate in Motion: Science, Empire, and the Problem of Scale* (Chicago: University of Chicago Press, 2018).

Fig. 3 a: *Códice Tonalámatl de Aubin* (sixteenth/seventeenth century), fol. 13. Originally composed of 20 sheets, each ca. 24 × 27 cm.

Fig. 3 b: Diego Muñoz Camargo, *Historia de Tlaxcala* (Mexico, ca. 1581–84), fol. 242r. Franciscan friars burning traditional books and clothes. The images in the fire represent the destruction of the old gods whose masks correspond to the twenty signs of the *Tonalámatl*.

II. Padrón Real

BUT THIS DOESN'T MEAN that wherever there is a cosmogram, there is cohesion and stability. On the contrary, cosmograms are often produced out of fearsome social, conceptual, and physical conflict. They may aim to unify, but they just as easily provoke disharmony or serve as the stage for deep disagreements.

At the start of the sixteenth century, imperial technologies for mapping the so-called New World and solidifying Spanish rule stirred a cosmopolitical clash in Seville. As Spain took on the Atlantic, the Casa de la Contratación de las Indias (the House of Trade of the Indies) was founded in 1503 under Queen Isabella to get a grip on overseas exploration and accumulation, and to collect taxes and duties. Navigators took an oath to report any new lands or resources they discovered and faithfully inscribe them on the Padrón Real, a secret world map. Our next exhibit is an English copy, carefully rolled out for inspection (*see fig.* 2). There was great disagreement about what the map would contain and how to assemble it. Sebastiano Cabot, the returning Pilot Major, clashed with the court cosmographers, led by Alonso de Chaves. The court cosmographers preferred astronomical methods, offering a view from above on a flattened homogeneous space. Cabot preferred portolan charts and measures based on dead reckoning, with trajectories marked by compass directions taken from various landmarks: a more practical, rule-of-thumb method, mapping from down in the midst of things.

The Padrón Real was forging a new social order within Spain, defining a geographic, legal, religious, geopolitical, intercultural space — and extending it around the planet. Yet, it was also a site for marking differences among multiple users, groups, and powers — monarchs, pilots, astronomers, God. A cosmogram may appear united while holding together opposed trajectories. The lawsuit between the pilots and the cosmographers was unresolved.[8]

The stakes of the conflict rise when our perspective shifts to New Spain itself, where the conquistadors brought the crown and cross down on entirely different cosmological orders. Mayan and Aztec cities were already arranged as maps of quite different heavens and subterranean realms; calendars, as in the Aubin *Tonalámatl*, showed the deities, plants, and animals ruling over each day and each thirteen-day period.[9] The Spanish sailors were followed by priests; Franciscans erected crosses and depicted themselves assisted by the Catholic Church and angels. Armed with blazing torches, they blasted the reigning deities, who — as this early sixteenth-century image shows — were none too happy at being swept away by fiery brooms (*see figs.* 3 *a*, *b*). While pilots and astronomers battled to draw the map of the New World in Seville, at the outer reaches of the empire, killing and enslaving the natives also meant mapping territory, and burning away their gods.

8 See Ursula Lamb, "Science by Litigation: A Cosmographic Feud," *Terrae Incognitae* 1, no. 1 (1969): 40-57; David Turnbull, *Masons, Tricksters and Cartographers* (London: Routledge, 2000); Alison Sandman, "Mirroring the World: Sea Charts, Navigation, and Territorial Claims in Sixteenth-Century Spain," in *Merchants and Marvels: Commerce, Science, and Art in Early Modern Europe*, ed. Pamela H. Smith and Paula Findlen (New York: Routledge, 2002), 83–108.

9 Serge Gruzinski, *Painting the Conquest: The Mexican Indians and the European Renaissance* (Paris: Flammarion, 1992), 98.

III. Thermoscope

The exploration of the Americas occurred at the same time as a search for ancient sources — Aristotle, Galen, Plato, Iamblichus, and Hermes Trismegistus, the "Thrice-Great" — to restore lost learning. The steps that would be called "progress" began with a return to the past. Magical and theurgical texts, emphasizing neo-Platonic graduated emanations falling in perfection from a divine source, set the agenda for court culture and solitary experiments — in Byzantium, then Italy, moving north and west. Paracelsus drew new attention to materials by rigorously testing their capacities and combinations; his readers made the alchemical laboratory a space of both concrete discovery and spiritual enlightenment. The years around 1600 saw a rediscovery of atomism and mechanical philosophy, as well as new inventions and an intense pursuit of forms of nonverbal, illuminist knowledge of the origins and workings of creation.

The cosmological images of the English physician Robert Fludd capture this moment's mixtures. His celestial monochord (*see fig. 4 a*) — an instrument he drew to connect the earthly microcosm to the astral macrocosm, tuned by the divine hand to ensure the harmonies between above and below, light and dark, heat and cold — was "the most exact symbol of the cosmic nature and the figure (*typus*) of its truth."[10] Fludd saw his images operating on the imagination to access "the internal and essential processes of Nature"[11] — while his contemporary Johannes Kepler, whose cosmological interventions were also fed by neo-Platonism, mocked Fludd's images for lacking "certain and astronomically demonstrated measures."[12]

Yet, Fludd's devices were not merely imaginary. His celestial monochord followed the soundings of a wooden one-stringed instrument. Another device he drew and built was a thermoscope (*see fig. 4 b*): a glass vial containing a liquid which rose and fell according to atmospheric heat and pressure, the changing proportions of cosmic forces. This technical apparatus, measuring a "material" Critical Zone, was written into a macrocosmic array of *spiritual* powers, linking local conditions to the harmonies of the universe.

Fludd's machine made visible the movements of a nonmechanical universe. Even though it was part of a lineage of invention and experiment which, a few decades later, would give rise to Robert Boyle's air pump — an exemplary apparatus of the "new experimental philosophy" — Fludd's thermoscope held together a very different cosmos: emanationist, animist, participatory, intuitively grasped.[13]

10 Robert Fludd, *Clavis philosophiæ et alchymiæ Fluddanæ* (Frankfurt: Fitzer, 1633), 30. Translation from the Latin taken from Christoph Lüthy, "What Does a Diagram Prove That Other Images Do Not? Images and Imagination in the Kepler-Fludd Controversy," in *Image, Imagination, and Cognition: Medieval and Early Modern Theory and Practice*, ed. Christoph Lüthy et al. (Leiden: Brill, 2018), 227–74, here 243.

11 Robert Fludd, *Veritatis proscenium […]* (Frankfurt: Erasmus Kempfer, 1621), 36. Translation from the Latin taken from Lüthy, "What Does a Diagram Prove," 262.

12 Johannes Kepler, *Harmonices mundi libri quinque* [1619], in *Gesammelte Werke*, vol. 6, *Harmonice mundi*, ed. Max Caspar (Munich: C. H. Beck'sche Verlagsbuchhandlung, 1940), 377. Translation from the Latin taken from Lüthy, "What Does a Diagram Prove," 256.

13 See D. Graham Burnett, "The Cosmogonic Experiments of Robert Fludd: A Translation with Introduction and Commentary," *Ambix* 46, no. 3 (1999): 113–70.

IV. Cell

Such universes remained active throughout the era of exploration and conquest. After seeing images and objects under lights in glass cases, we now enter a small space in a corner of our imaginary hall, with only a bed, a small table, and a prayer bench. The early moderns were supposed to have turned away from the celestial spheres toward the immediacy of this world, looking outward, filling in every corner of the globe through expeditions, discoveries, and conquests. But for millennia, large numbers of people retreated into convents and monasteries (and still do today). The cloisters remain — in monasteries and convents worldwide, and in pop-up ashrams and retreat centers — many of them arranged as figures of heavenly realms and the routes toward them.

These sites of enclosure and inwardness accessed universal visions, producing dazzling cosmograms. Hildegard von Bingen's Book of Divine Works (*Liber divinorum operum*, composed from 1163–70) depicted the cycles of the seasons and human labor, stages of sacred history, the cosmic form of the redeemer — placing an image of herself in the lower left as the artist, instrument, or vessel (*see fig. 5 a*). Monks in Tibetan lineages paint mandalas as guides and records of meditative and metaphysical states. Here the Amitayus, the Buddha of Limitless Life, is surrounded by eight others marking the earthly directions, with sacred temples and teachers pointing toward enlightenment (*see fig. 5 b*).

We find these cosmograms in our monastic cell: a remote pocket of the hall, not much larger than the size of a human body, lit by candles, its quiet occasionally broken by solemn bells and distant chanting.

V. Orrery

At this point we might be feeling a bit confused, after jumping from one of these encapsulated universes to the other. We've gone from the ritual and technical alignment of micro- and macrocosm in the Han empire, to clashes between astronomers and pilots and the Aztecs and their gods in New Spain, to Fludd's Rosicrucian devices, and back to the paradoxical topology of the vast inner universes of monasteries. But the biggest challenge is still ahead. As we approach the seventeenth century and the coronation of MeMO — the "mechanical, material, and objective" cosmology of science — we have to keep in mind all these other worlds, these ways of knowing and being, without thinking we're finally moving into "the one real world." Despite its appeals to reason, facts, and self-evidence, the scientific cosmos also needs work and action to hold it together; it needs to be built, instituted, promoted, defended, and it needs cosmograms to do so.

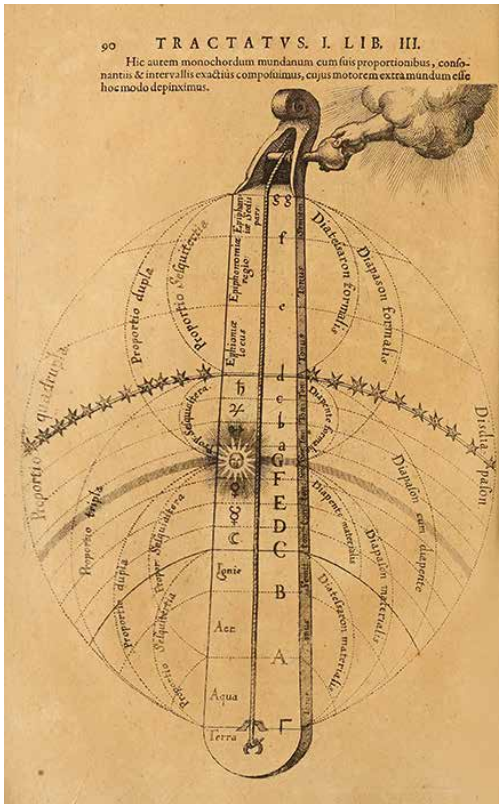


Fig. 4 a: Robert Fludd's celestial monochord in *De metaphysico macrocosmi et creaturaru[m] illius ortu* (Oppenheim, 1617), 90.

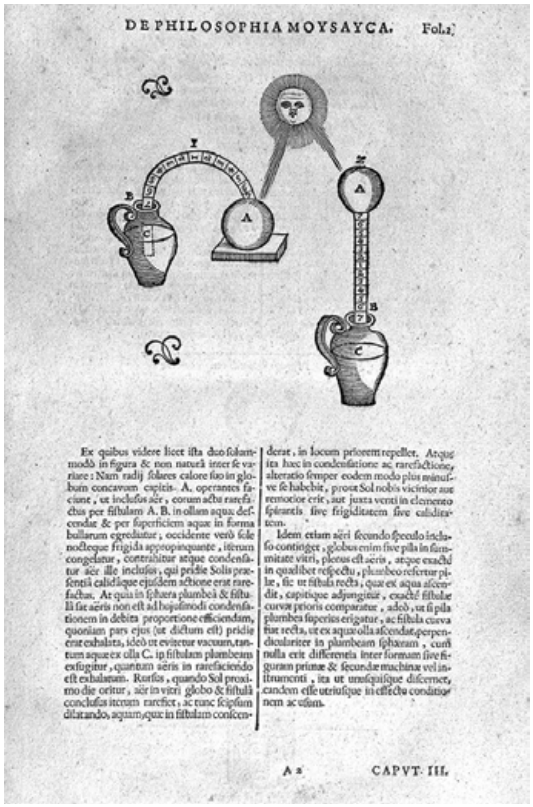


Fig. 4 b: Robert Fludd's thermoscope in *De philosophia Moysayca* (Goudae: Petrus Rammazenius, 1638), fol. 2.

Fig. 5 a: Hildegard von Bingen, *Liber divinorum operum* (early thirteenth century), fol. 38r. Hildegard von Bingen completed the first copy of the *Liber divinorum operum* in around 1173, but this illumination comes from a thirteenth-century copy known as the Lucca manuscript.

Fig. 5 b: Mandala of the Amitayus, Tibet, nineteenth century. Pigments on wood, ca. 31 × 31 × 3.8 cm.

Fig. 6: Joseph Wright of Derby, *A Philosopher Lecturing on the Orrery (in which a lamp is put in place of the sun)*, ca. 1763–65. Oil on canvas, 147.3 × 203.2 cm.

The experimental and mechanical philosophy of Robert Boyle and his seventeenth-century colleagues at the Royal Society of London began to impose itself on reality through careful theatrically staged experiments, where gentlemen offered their assent to well-documented "matters of fact." But this was just part of the story of how MeMO was enthroned. In 1687, Isaac Newton's *Principia* proposed an axiomatically argued mechanical universe. His acolytes proclaimed the system in displays of falling bodies, levers, chemical explosions, and mechanical solar systems.[14]

Joseph Wright's famous painting of popular Newtonianism, *A Philosopher Lecturing on the Orrery* (*see fig. 6*), invited emotional responses that helped make MeMO part of the furniture of bourgeois domesticity. In this dense cosmogram from 1766, on loan from the Derby Museum and Art Gallery and standing at an imposing 1.47 meters by 2.03 meters, the white-maned natural philosopher confidently expounds celestial mechanics using a desk-sized model. At left, a patriarch takes notes in a ledger; at right, a young man looks on in fascinated perplexity, while the children at center are entranced by the show.[15]

As Simon Werrett argues, another pair of paintings by Wright highlight a further aspect of MeMO's appeal (*see figs. 7 a, b*). In the two paintings, the fire from an erupting Italian volcano is visually nearly identical to the brilliant plumes of a firework display.[16] The mechanical philosophy is naturalized, *becomes nature*, by substituting an artificially produced and controlled process for one which occurs spontaneously. The explosion is the same, all things being equal, though the omniscient creator has been decisively replaced by a human technician.

VI. Earth Inside Out

FROM THE LATE eighteenth century, European engineers crisscrossed the globe, setting up frames and scaffoldings to extract the wealth of the soil, of human bodies, and of mines below the Earth's surface. Their work obeyed an aesthetics of calculated efficiency — but the early nineteenth century was injected with the *Urkraft* (primordial force) pronounced by the German philosopher Friedrich Wilhem Joseph Schelling. His

14 See Steven Shapin and Simon Schaffer, *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life* (Princeton, NJ: Princeton University Press, 1985); Simon Schaffer, "Machine Philosophy: Demonstration Devices in Georgian Mechanics," *Osiris* 9 (1994): 157–82; Stephen D. Snobelen, "On Reading Isaac Newton's *Principia* in the 18th Century," *Endeavour* 22, no. 4 (1998): 159–63.

15 See Jesse Molesworth, "The Cosmic Sublime: Wright of Derby's *A Philosopher Lecturing on the Orrery*," *Lumen: Selected Proceedings from the Canadian Society for Eighteenth-Century Studies* 34 (2015): 109–21.

16 See Simon Werrett, *Fireworks: Pyrotechnic Arts and Sciences in European History* (Chicago: University of Chicago Press, 2010); Simon Werrett, "Picturing Pyrotechnics," *Public Domain Review,* June 25, 2014, https://publicdomainreview.org/essay/picturing-pyrotechnics.

Fig. 7 a: Joseph Wright of Derby, *Vesuvius eruption with a procession in honour of St. Januarius*, 1778.
Oil on canvas, 162 × 213 cm.

Fig. 7 b: Joseph Wright of Derby, *The Annual Girandola at the Castel Sant'Angelo, Rome*, 1775–76.
Oil on canvas, 138 × 173 cm.

Fig. 8: Thomas Sopwith, Forest of Dean model, 1841, Oxford Natural History Museum. photo © Frederik Albritton Jonsson

Naturphilosophie (natural philosophy) began with an "Absolute" that was both spirit and matter, dividing and condensing itself into elements and minds, into objects and subjects — who one day would realize, in a higher state of reflection, the identity between consciousness and the world. *Naturphilosophie* was also an empirical research program, encouraging scientists to develop instruments to articulate the relations within nature.[17]

Alexander von Humboldt, patron saint of the Critical Zone, deployed his arsenal of instruments to map the relations within and between the ecological niches of the planet, driven in part by Schelling's reassurance that the Earth's endless variety was grounded in an original unity.[18] In Humboldt's famous image of Mount Chimborazo, in his *Essay on the Geography of Plants* (1805), each vertical column offered the readings from one of his geophysical instruments, like the score to a natural and human symphony performed by virtuosic instruments.

To capture and proclaim this dynamic yet instrumentalized nature, utopian reformers in Paris, the Saint-Simonians, imagined a new temple to replace Notre-Dame. A forerunner to the Statue of Liberty, this giant woman-temple would have referenced all the religions of the world and harnessed light, electricity, magnetism, and music in a spectacle of technologically extended abundance and cosmopolitan harmony through industry.[19] The slogan of this era, built into the international exhibitions, could have been: *Art is nature continued by other means*.

The scaffolds that held up new panoramas also pried open the earth for intervention and extraction. The switch to coal power required maps to put this resource at people's fingertips. They showed both abundance and limitation, as in Thomas Sopwith's beautiful model of the coal reserves beneath the Forest of Dean (*see fig. 8*).

As Fredrik Albritton Jonsson has explained, this 3-D, moveable map showed how much coal there was, and where; but it also revealed that its bounty was finite, as the Victorian engineer William Stanley Jevons warned — even as he provided the terms for analyzing economic exchanges within an endlessly growing economy.[20] By the end of the nineteenth century, fear of the Earth's limitations was expressed in the thermodynamic fantasy of the heat death of the universe, and in the desperate imperial scramble to carve up the planet.

17 See Friedrich Wilhelm Joseph Schelling, *First Outline of a System of the Philosophy of Nature*, trans. Keith Peterson (Albany: SUNY Press, 2012). Originally published in German as *Erster Entwurf eines Systems der Naturphilosophie* (Jena: Christian Ernst Gabler, 1799); Iain Hamilton Grant, *Philosophies of Nature after Schelling* (London: Continuum, 2008).

18 See Michael Dettelbach, "The Face of Nature: Precise Measurement, Mapping, and Sensibility in the Work of Alexander von Humboldt," *Studies in History and Philosophy of Science, Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 30, no. 4 (1999): 473–504.

19 See John Tresch, *The Romantic Machine: Utopian Science and Technology after Napoleon* (Chicago: University of Chicago Press, 2012).

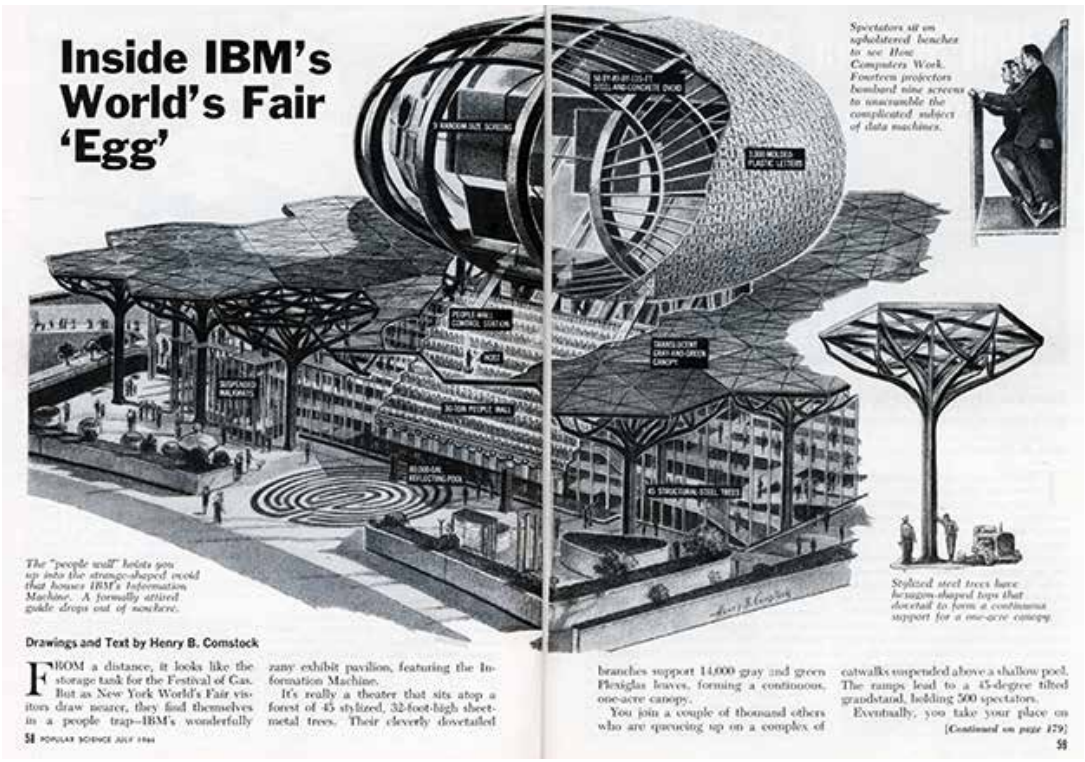


Fig. 9: Henry B. Comstock, "Inside IBM's World's Fair 'Egg,'" *Popular Science* (July 1964): 58f.

This fear also summoned utopian visions of anti-imperial harmony, with the Earth's peoples — known to Europeans by trade, war, and now "anthropology" — meeting and sharing the fruits of the Earth. The anarchist-geographer Elisée Réclus designed a gigantic globe for the 1900 World's Fair: according to his plans, viewers walking up the inner walls of a celestial egg would look with intimate proximity upon the untrammeled and developed landscapes of the finite planet they shared, fulfilling his idea that "L'Homme est la nature pregnant conscience d'elle-même" [Humanity is nature taking consciousness of itself].[21] His globe was never built.[22]

VII. World-Monitors

In twentieth-century observatories and control rooms, new means of bringing the world together appeared. Cameras, radars, and sensors transmitted signals to screens, and experts in perma-pressed shirts flipped switches and barked command sequences back into the system. The cybernetic vision of self-regulating feedback loops depended on its ontology of information, where every level of reality was signal and noise.[23]

The world eventually managed by IBM — and other "international business machines" of all sorts — also needed cosmograms. It had to be drawn, presented, made persuasive, sold. Herbert Bayer, Buckminster Fuller, Charles and Ray Eames, and Eero Saarinen drafted high-modern feedbacked visions. The Eames/Saarinen partnership, sponsored by IBM and the US government, produced in 1959 the multi-media spectacle *Glimpses of the U.S.A.* at the World's Fair in Moscow and, in 1964, in New York. The film was shown inside the "Information Machine," a cosmic egg stamped with "IBM" on its shell, located at the intersection of Commerce Avenue and the Promenade of Industry (*see fig. 9*).[24]

Inside the egg, thousands per day watched seven screens showing representative Americans going about their days, and the information technologies that made it all possible.

Such fusions of systems logic and screen-based spectacle reached an apogee with spaceflight and the

20 See Fredrik Albritton Jonsson, "Abundance and Scarcity in Geological Time, 1744–1844," *Nature, Action and the Future: Political Thought and the Environment*, ed. Katharina Forrester and Sophie Smith (Cambridge: Cambridge University Press, 2018), 70–93, with thanks for the image and helpful discussion.

21 Elisée Réclus, *L'Homme et la Terre*, vol. 1 (Paris: Librairie Universelle, 1905), 4.

22 See Soizic Alavoine-Muller, "Un globe terrestre pour l'Exposition universelle de 1900: L'utopie géographique d'Elisée Reclus," *L'Espace géographique* 32, no. 2 (2003): 156–70; Pierre Chabard, "Architects of Knowledge," in *Aesthetics of Universal Knowledge*, ed. Pasquale Galgliardi, Simon Schaffer, and John Tresch (Cham: Palgrave Macmillan, 2017), 53–76.

23 See Eden Medina, *Cybernetic Revolutionaries: Technology and Politics in Allende's Chile* (Cambridge, MA: MIT Press, 2011); Ronald R. Kline, *The Cybernetics Moment: Or Why We Call Our Age the Information Age* (Baltimore, MD: Johns Hopkins Press, 2015).

24 See Beatriz Colomina, "Enclosed by Images: The Eameses' Multimedia Architecture," *Grey Room* 2, no. 3 (2001): 6–29.

Fig. 10: Apollo 17, *The Blue Marble*, 1972.

moon launch, immortalized in the postcard sent back home: the Apollo's-eye view of the Earth seen from above. This image, *The Blue Marble* (1972), shows our uncanny home and our watchful, cloudy superego (*see fig.* 10). It becomes an object of cozy adoration on Earth Day; it is painted in terrifying red to show impending apocalyptic temperatures in climate reports. It also appears as an elusive object at last under control, the ground of a united world of technical and capitalist exploitation, as well as a fragile being we must care for, a temperamental mother to appease, and a somber, eerie alien in a void staring back.[25]

VIII. (No) Exit: You Are Here

We got up there from down here, and down here we remain. The question of how to represent our cosmos *not from outside and above* but *from below and within* is all the more pressing as we see how the detachment of MeMO and naturalism accelerate extraction and consumption, making our every action another blow against the planet, another grain on the tipping scale. How do we represent a nature that we are part of, alter by knowing it, and threaten with suffocation and catastrophe by our most trivial acts?

This is the challenge of *Critical Zones*, of Gaia 2.0: to take on board all the sciences, instruments, monitors, and relays that MeMO provides, but *without* thinking we're outside the system. How do we weave together all these temporalities and agencies in the tiny but united localities above and below the surface of the Earth? How do we also draw into our cosmogram *human agencies*, with their distracted inertias and entrenched commitments, and the *ethical incitements* and *aesthetic conversions* we will need to shake us free of our dependence on fossil fuels, and the logic of endless consumption, "growth," and predatory accumulation?

I can't answer except to exhibit the eighth object, a recent cosmogram which visualizes our immersion in a range of temporal scales while fixed on a single Critical Zone. Every page of Richard McGuire's graphic novel *Here* (2014) is an illustration of the same corner of a house in New Jersey, where the artist grew up.[26] Windows open onto a constantly shifting scenography, bringing in eras and actors from long before the house was built — and long after its disappearance (*see fig.* 11 *a*).

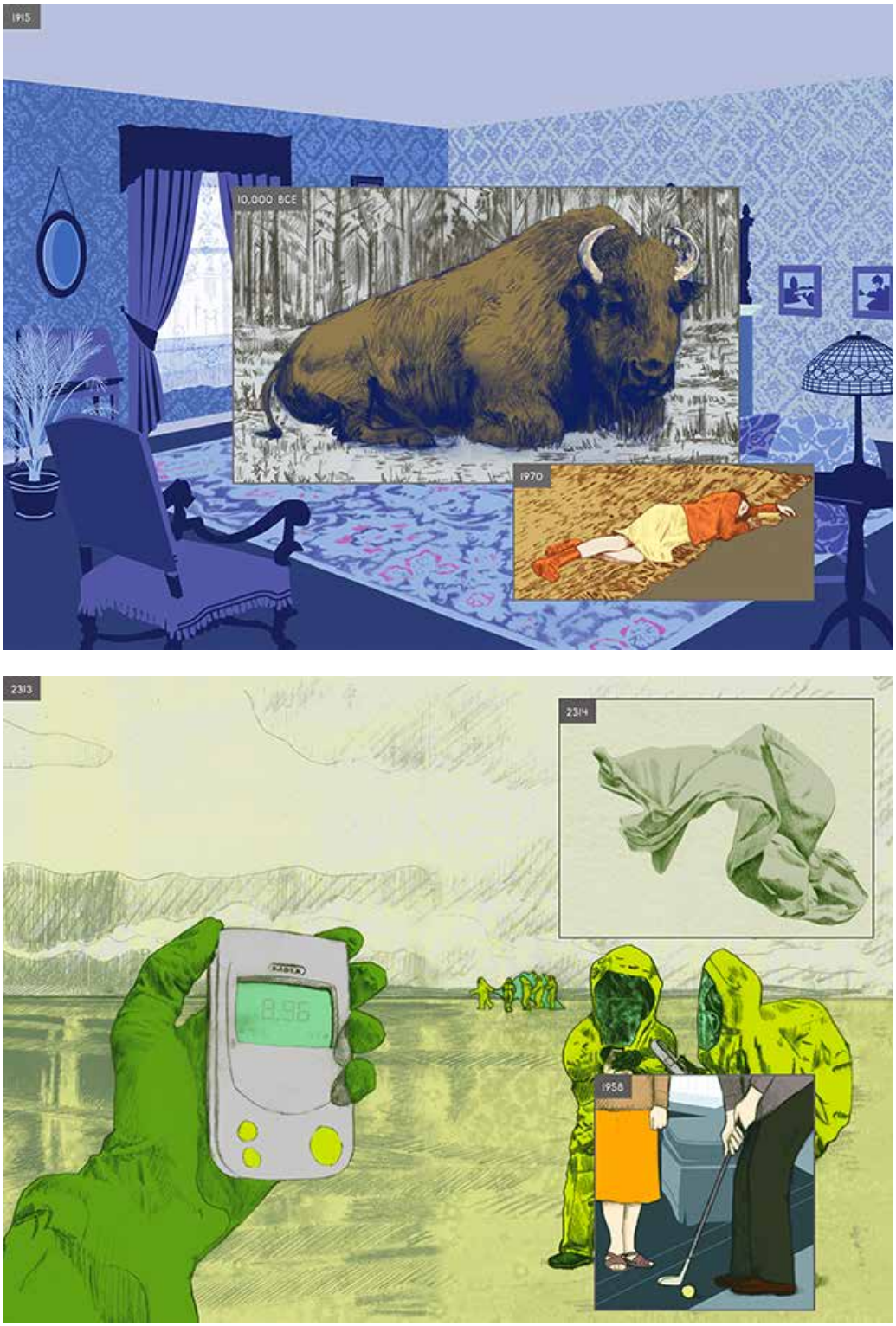
Here juxtaposes all the times and beings that briefly march through it, with numerous lines of development, echoes, repetitions, calls and responses across millennia. Gradually you realize the main protagonist is time itself. It moves slowly and quickly, backward and forward, deep and shallow — always present, always other than itself. Re-terrestrializing also means re-temporalizing. *Here* shows the many times and worlds at work within, behind, and passing through our own (*see fig.* 11 *b*).

Our tour through this hall of cosmograms for the Critical Zone has led us here. We try to build a universe while the memory, anticipation, or active presence of other worlds presses in around us. How do we grant each of them a genuine reality, a livable coherence? How do we acknowledge that we live in a pluriverse without descending into pure chaos or endless cosmo-clash? How do we position MeMO, with its powerful grips on the world, within a cosmos never fully contained in calculation, objectification, prediction, or control?

The fraught, witty serenity of *Here* makes us step back into where we are, presenting other responses to an ongoing crisis than panic and alarm. Through its windows, we glimpse ways of waiting, listening, attending to time and its movements through us as we act. Soil, rock, air, water, plants, fear, hope, and time — the stuff of which universes are made.

25 See Sebastian Vincent Grevsmühl, *La Terre vue d'en haut: L'invention de l'environnement global* (Paris: Seuil, 2014); Birgit Schneider, "Climate Model Simulation Visualization from a Visual Studies Perspective," *WIREs Climate Change* 3, no. 2 (2012): 185–93.

26 Richard McGuire, *Here* (New York: Pantheon Graphic Library, 2014).



Figs. 11 a, b: Richard McGuire, *Here* (New York: Pantheon Books, 2014), bison in 10,000 BCE and nuclear apocalypse in 2313.

An artist book disguised as a graphic novel about one location over time.