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ITERATIONS

HISTORICAL FUTURES

FOSSILIZATION, OR THE MATTER OF HISTORICAL FUTURES*

THE LIFETIMES RESEARCH COLLECTIVE**

ABSTRACT

In this contribution to the "Historical Futures" project, the Lifetimes Research Collective adds to the geological turn currently underway in historiography by presenting a theory of fossils and fossilizations as a way of rethinking the concept of "historical futures." We proceed by addressing two pivotal speech acts in Western historiography, in the broad sense: the "fossil question," which was first raised in the middle of the seventeenth century, about how a solid can end up inside another solid and the nineteenth-century Marxist slogan for the modern world, "all that is solid melts into air." Transported into the early twenty-first century and faced with the challenges of the Anthropocene, both take on new meanings and perform new tasks. In this article, we experiment with different ways of thinking and writing fossils into more general questions of historiography and historical theory by investigating how they affect conceptualizations of historical time. Furthermore, we demonstrate how fossilizations indicate possible trajectories for new materialist speculations, distributing agency to various matters, physical and virtual, in the Earth's crust as well as in museums and video games. Finally, we ask how a theory of fossilization can be seen to decenter the human subject by exploring the processes of decomposition and solidification taking place in the human body. In this way, the arrangements of timescales and lifescales that have given rise to disciplines like history, geology, and biology are destabilized in favor of open-ended historical knowledge ventures that transgress temporal and epistemological borders.

Keywords: geology, stratigraphy, fossils, fossilization, new materialism

What is the stuff that futures are made of? This riff on the well-known quote from Shakespeare's *The Tempest* seems fitting enough, even for a study of futures that can be qualified as "historical."[1] In their introduction to the "Historical Futures"

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1. "We are such stuff / As dreams are made on, and our little life / Is rounded with a sleep" (Shakespeare, *The Tempest*, 4.1.156-58).

project, Zoltán Boldizsár Simon and Marek Tamm define "historical futures" as "the plurality of transitional relations between apprehensions of the past and anticipated futures."[2] In addition to apprehensions and anticipations, the stuff of futures involves a long list of abstractions and projections: hopes, fears, utopias, imaginations, speculations, scenarios, plans, promises, prognoses, and prophecies. Phenomenologically as well as practically, many of these "modalities," as Simon and Tamm call them, take on material forms as technologies, texts, mediations, and visualizations.[3] Nevertheless, the purchase they have on the future lies to a large extent in their ability to overcome the material limitations of the now—whether biological, institutional, infrastructural, mediational, or technological.[4] This seems even more evident for what Simon and Tamm call "disconnective futures," when "the future ceases to be made of the same matter as the past."[5] In this article, we discuss one way in which the past and the future, by mediation of the present, are indeed connected by matter—or, rather, by a specific form of materiality and materialization.

The following attempt at thinking about historical futures by way of rocks, minerals, strata, and sediments takes inspiration from the *geological turn* currently underway in historiography and other forms of cultural theory, heralded by scholars like Dipesh Chakrabarty, Bruno Latour, and Kathryn Yusoff.[6] However, whereas Chakrabarty and Latour argue for the need to scale up, to the planetary level, in order to reconnect "human-centered and planet-centered thinking"[7] or discover new forms of agency in a common "geostory,"[8] our discussion sticks closer to the matters at hand, literally speaking. In this sense, we have more in common with Yusoff's theorization of "geosocial strata,"[9] although we take on a less structural and stratigraphic, more processual and materialist approach, giving primary attention to the formation and existence of singular rocks of a specific kind. This is what we term a geomaterialist approach to historical futures.

At the center of attention stands the *fossil*, which was first made the object of systematic scientific inquiry in seventeenth-century natural history—that is, the field of knowledge and practice that gave meaning to European scholars'

2. Zoltán Boldizsár Simon and Marek Tamm, "Historical Futures," *History and Theory* 60, no. 1 (2021), 5.

3. Ibid.

4. See, for example, Karen Barad's assertion that "there is an important sense in which the only thing that doesn't seem to matter anymore is matter" (*Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* [Durham: Duke University Press 2007], 132).

5. Déborah Danowski and Eduardo Viveiros de Castro, *The Ends of the World* (Cambridge: Polity, 2016), 26, quoted in Simon and Tamm, "Historical Futures," 8.

6. See also Patrice Maniglier, "How Many Earths? The Geological Turn in Anthropology," *The Otherwise* 1 (2020), 61-75, http://www.theotherwise.net/files/issue1/TheOtherwise_Maniglier.pdf.

7. Dipesh Chakrabarty, "Anthropocene Time," *History and Theory* 57, no. 1 (2018), 6. See also Chakrabarty, "The Climate of History: Four Theses," *Critical Inquiry* 35, no. 2 (2009), 197-222.

8. Bruno Latour, "Agency at the Time of the Anthropocene," *New Literary History* 45, no. 1 (2014), 3.

9. Kathryn Yusoff, "Geosocial Strata," *Theory, Culture & Society* 34, no. 2–3 (2017), 105-27. See also Yusoff, "Geologic Life: Prehistory, Climate, Futures in the Anthropocene," *Environment and Planning D: Society and Space* 31, no. 5 (2013), 779-95.

explorations of their natural environment.[10] "Fossil" is derived from the Latin term *fossilis*, a grammatical inflection of *fodere*—to dig, or dig up. What was dug up, or simply collected from the ground by natural historians and mineralogists all over Europe, was a special kind of rock—a rock that had once been something else, something organic, but had then lost all its organic properties, except for the shape that still reminded of its past existence as part of a plant or an animal.[11]

From the seventeenth century on, fossils began to change the way scholars thought about history. Can they do it again now, at the beginning of the twenty-first century? This is the question we raise in this experimental, collectively written, explorative piece, which heeds Simon and Tamm's call for contributions that adopt an "experimental attitude and openness toward . . . forms of collaboration."[12] More specifically, we direct our collective investigations of historical futures—their "*transitions*," "*anticipatory practices*," and "*registers*"—at one kind of stuff, one kind of matter, *fossils*, as well as the processes that bring them about, *fossilizations*.[13] Our suggestion, however, is not that historical theory should become a form of geology or paleontology; rather, and much more humbly, we suggest a change of vantage point. By shifting the perspective from the abstract stuff of hopes, fears, plans, and anticipations, of which historical futures are usually made, to the material, solid stuff of fossils, we want to complement the "modalities" of the future that Simon and Tamm point to in their prompt.

The article has three parts. In the first part, we explore the possibilities for a materialist theory of historical futures, proceeding from the inversion of Marx and Engels's claim about modernity. Furthermore, we ask how such a theory can be brought to the fore by again asking the seventeenth-century "fossil question" as our point of departure for explorations into twenty-first-century historical theory. Then, in the second, more experimental part, we perform these explorations, taking fossils and fossilization as the basis for a new theory of historical futures. We advance from a well-versed form of geomaterialistic historiographies, in which the past is shaped according to the multilayered formations of stratigraphy, taken over from geology and reworked into historical theory. Then, we explore the historiographic implications of other geomaterialisms, in which both human and nonhuman futures are indeed predicated on the existence of fossils and fossilization. Finally, in the third and concluding part, we sketch a possible framework for a geomaterialist theory of historical futures. Being an interdisciplinary research collective, in which people have different styles of thinking and writing, we have kept

10. See, for example, *Cultures of Natural History*, ed. N. Jardine, J. A. Secord, and E. C. Spary (Cambridge: Cambridge University Press, 1996).

11. See, for example, Rhoda Rappaport, *When Geologists Were Historians, 1665–1750* (Ithaca, NY: Cornell University Press, 1997); Martin J. S. Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: University of Chicago Press, 2005); and Rudwick, *Earth's Deep History: How It Was Discovered and Why It Matters* (Chicago: University of Chicago Press, 2014).

12. Simon and Tamm, "Historical Futures," 5.

13. Ibid., 5, 6.

the prose in an explorative, tentative mode without ironing out all the differences of style and argument—that is, as long as they contribute to the general arguments of the article.

WHAT REMAINS—WHEN ALL THAT IS SOLID HAS MELTED INTO AIR?

We begin our discussion about the materiality of "historical futures" by inversing Marx and Engels's famous claim in their 1848 *Communist Manifesto*: "All that is solid melts into air."[14] Samuel Moore's rather loose 1888 translation of the German original—*Alles Ständische und Stehende verdampft*—went on to become a slogan for modernity, epitomized by Marshall Berman in his bestselling book about European urbanist modernism.[15] Marx and Engels coined the phrase in order to grasp the "constant revolutionizing of production" as well as the "uninterrupted disturbance of all social conditions" that characterize "the bourgeois epoch."[16] Even outside of Marxist historical dialectics, the idea that, in modernity, everything becomes increasingly more volatile, transient, and ungraspable—indeed, like air—has informed studies of history and culture, even more so during the most recent phases of globalization and digitization.

At the beginning of the twenty-first century, however, the Marxist claim about modernist futures no longer seems to hold because the proliferation of human geological agency handily illustrated by the array of graphs that make up "The Great Acceleration,"[17] as well as the longevity of anthropogenic climate change, confronts us with the likelihood that even our transient lives, even our most airy ideas—even the capitalist mode of production, however unsustainable—may endure, materially and ecologically, in multiple temporalities of long durations.

For this article, we turn the slogan around and raise the inverse question: Out of everything that modern global culture has turned into air, made light, invisible, ungraspable, and transient, from fossil fuels to all kinds of plastic gadgets, what will solidify, petrify, ossify, turn heavy, turn to stone, fossilize? What does it mean to investigate the future not as the result of something accelerating and dissolving, like Marx and Engels proclaimed in *The Communist Manifesto*, but as a result of something slowing down, settling like sediments at the bottom of slow-running rivers or at river outlets? After they have settled in layers of sand and clay, materials start to petrify—or, with a term that entered European languages in the

14. Karl Marx and Frederick Engels, *Manifesto of the Communist Party*, transl. Samuel Moore (with Frederick Engels) (1888), in *Marx/Engels Selected Works*, vol. 1 (Moscow: Progress Publishers, 1969), https://www.marxists.org/archive/marx/works/download/pdf/Manifesto.pdf.

15. Marshall Berman, *All That Is Solid Melts into Air: The Experience of Modernity* (London: Verso, 1982).

16. Marx and Engels, *Manifesto of the Communist Party*.

17. See Will Steffen, Wendy Broadgate, Lisa Deutsch, Owen Gaffney, and Cornelia Ludwig, "The Trajectory of the Anthropocene: The Great Acceleration," *Anthropocene Review* 2, no. 1 (2015), 81-98, and J. R. McNeill and Peter Engelke, *The Great Acceleration: An Environmental History of the Anthropocene since 1945* (Cambridge, MA: Harvard University Press, 2016). For a critique of this periodization, see Christophe Bonneuil and Jean-Baptiste Fressoz, *The Shock of the Anthropocene: The Earth, History and Us*, transl. David Fernbach (New York: Verso, 2016).

seventeenth century and by the next century had become indispensable in the new science of geology, *fossilize*. Fossil *fuels* are fossils too; they are the transformed biological residue of long-dead beings—bodies of the ancient dead, plants, animals, biomass rendered as combustible organic deposits: a tar-like energetic surplus refined over millions of years, as the earth shifted and stirred, churning the bodies. "All that is solid melts into air," Marx and Engels wrote, and carbon is a solid, but it does not melt—it burns. Smoke spirals, whirling from the chimneys with the force of a broken seal as the combustible organic deposits catch fire in the rolling wave of this planetary conflagration, this epochal rupture in which even the dead are not safe. What remains? What of the trace, the accreting solidity, the mark that will not be erased? "All that is solid melts into air, all that is holy is profaned."[18] In what follows, we discuss historical futures in terms of processes of fossilization, in a broad, inclusive sense: that is to say, we look at instances of solidification, petrification, calcification—instances when, instead of melting into air, things start to solidify. And we probe the meaning of these processes.

Understanding historical futures from the perspective of fossilization raises ontological and epistemological issues. In *The Marvelous Clouds*, John Durham Peters claims that "ontology . . . is usually just forgotten infrastructure."[19] In some cases, we add in this article, this infrastructure has been forgotten for so long that it has become petrified, fossilized. Where does that leave our notion of ontology? In the same way, ideas of knowledge and epistemology will have to be revised if we shift our gaze from progress or development to fossilization as the dominant temporal form. How do we gain knowledge about something that is either no longer there (the organic matter that has become fossilized) or has not yet been excavated (fossils of the future)? Furthermore, fossilization invites us to rethink the relationship—and, indeed, in the words of Simon and Tamm, the "transition"—between past, present, and future.[20]

THE FOSSIL QUESTION—THEN AND NOW

The most condensed version of the "fossil question" appeared in the writings of the Danish natural historian Nicolaus Steno, originally Niels Stensen, who, in his 1669 treatise, asked how it could be that one solid ended up inside another solid, *solido intra solidum*.[21] Steno, who lived in Tuscany, had arrived at the question after the Grand Duke of Tuscany, Ferdinando II de' Medici, had ordered that the head of a huge female shark caught near the town of Livorno be sent to him. Dissecting it, the Danish scholar noted that the shark's teeth bore a striking resemblance to certain stony objects that had been found embedded within rock formations and that his contemporaries referred to as *glossopetrae*, or

18. Marx and Engels, *Manifesto of the Communist Party*.

19. John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago: University of Chicago Press, 2015), 38.

20. Simon and Tamm, "Historical Futures," 4.

21. Nicolaus Steno, *The Prodromus of Nicolaus Steno's Dissertation concerning a Solid Body Enclosed by Process of Nature within a Solid*, transl. John Garrett Winter (New York: Macmillan, 1916). See also Rappaport, *When Geologists Were Historians*, 105-35.

"tongue stones."[22] In its simplest form, the "fossil question" asks: what are these objects, where do they come from, and—both in a theological and natural-historical sense—what do they mean?

At the time, explanations ranged from Pliny the Elder's suggestion that these stones had fallen from the sky to more recent ones, such as Athanasius Kircher's proposal that the formation of fossils is an inherent characteristic of the Earth.[23] Steno, by contrast, developed a theory of how the shark's teeth had been embedded in layers of sand at the bottom of the ocean, petrified over time, and turned into what was now known as *glossopetrae*. Somewhat later, the emerging science of geology gave these solids, which were once organic parts of the plant or animal kingdoms, the generic name "fossils." By 1764, Joshua Platt self-consciously stated in the *Philosophical Transactions* of the Royal Society that "it may indeed be thought unnecessary at this time, to say any thing of the origin of extraneous Fossils in general; all our modern naturalists being fully convinced, that they are the exuviæ or remains of animals and vegetables, and the greater part of them of marine production."[24] Since then, the "fossil question" has figured as a question with a solution, presented here according to the general, popularized *Oxford English Dictionary* definition:

> Fossils are typically hard parts, such as bones, teeth, shells, or wood, which have been rapidly buried in sediment. This is followed by the petrifaction of their constituent materials (or the replacement or recrystallization of mineral components, as in fossil shells), or the preservation of a mould or cast of the organism's exterior or interior form as the surrounding material turns to rock. Trace fossils represent remnants of the activity of living organisms, such as burrows or footprints. Rarely, fossils of such insubstantial organisms as jellyfish are preserved in fine-grained rocks such as shales, or entire organisms may be preserved frozen, or embedded in amber or tar.[25]

However, stating that fossils are the remains of organic material covered by layers of sand and then petrified does not really solve the fossil question—not then, not now. What intrigued and, indeed, worried seventeenth- and eighteenth-century scholars was the amount of time needed to complete this process of transforming material substance from organic tissue to minerals and rocks.[26] The close to 6,000 years from Creation to the present day that the Irish bishop James Ussher calculated were not sufficient to account for these kinds of material transformations, by which the world changed and evolved in a way that appeared to belie God's omnipotent agency. Even today, fossilization activates timeframes that vastly outscale traditional anthropocentric historiography, which still finds itself

22. Ibid., 211-12.

23. Stephen Jay Gould, "Father Athanasius on the Isthmus of a Middle State: Understanding Kircher's Paleontology," in *Athanasius Kircher: The Last Man Who Knew Everything*, ed. Paula Findlen (New York: Routledge, 2004), 207-39.

24. Joshua Platt, "An Attempt to Account for the Origin and the Formation of the Extraneous Fossil Commonly Called the *Belemnite*," *Philosophical Transactions* 54 (1764), 39.

25. *Oxford English Dictionary*, s.v. "fossil (*n*.2b)," www.oed.com/view/Entry/73829.

26. Steno, *The Prodromus*, 261. For a discussion of the role of time in Steno, see Rudwick, *Earth's Deep History*, 45-49.

"in the grip of sacred history," to use a formulation by Daniel Lord Smail.[27] The term "fossil" is conventionally reserved for remains older than 10,000 years, from before the end of the last glacial period. In other words, fossils and fossilization can reveal much about the past, although about pasts that outscale the pasts that we usually refer to as "history" or "historical" by hundreds of thousands, even millions, of years. To make sense of these pasts, we have the habit of moving them into another timescale, one labeled "geological." Fossils make important contributions to the time-work of geology, providing evidence for the accurate dating of rock strata as well as information for the present subdivisions of the geological timescale.

What, however, can fossils and fossilization tell us about the future? To conceptualize history and the future in terms of fossilization radically challenges our concepts of change and continuity. On the one hand, fossilization presupposes continuity, since it preserves elements of the present into the deep future, but, on the other hand, it involves radical change, since what is preserved changes material and ontological status, from organic to inorganic, from tissue to rock. Multiple, innumerous lifetimes are assembled into one: the lifetime of a rock or a mineral, or maybe another solid object. Some fossils keep their shapes, functioning as visual remnants of what they once were, while others change radically. Is the time of fossilization really a homogenous, uniform time, or does it also divide into different rhythms, speeds, and durations? To the extent that the newly solidified solid—whatever it is—is preserved within something else (a *solido intra solidum*, as in Steno's case), it can disappear and become invisible for centuries, even millions of years, until it is rediscovered. As what? How does it help us to think about deep historical futures?

FOSSILIZATION AND THE ANTHROPOCENE

The context for this specific, inverted reiteration of the fossil question is the historical moment, or epoch, that trades under the shorthand name of the "Anthropocene," when humankind emerges as a geological agent, affecting the planet, its climate, and its ecosystems in irreversible ways.[28] As David Farrier points out in *Footprints: In Search of Future Fossils*, the fossils of the future will be human and, more precisely, anthropogenic—that is, fossilized remnants of human existence and activity.[29] Per definition, fossils are the preserved remains of plants and animals, which make up the world's natural biomass, presently at 1.1 terratonnes. In a recent article, a group of scientists from the Weizmann Institute in Israel claim that the Earth—in the year 2020 (±6)—encountered the crossover point

27. Daniel Lord Smail, "In the Grip of Sacred History," *American Historical Review* 110, no. 5 (2005), 1337-61. See also Andrew Shryock and Daniel Lord Smail, introduction to *Deep History: The Architecture of Past and Present*, ed. Andrew Shryock and Daniel Lord Smail (Berkeley: University of California Press, 2011), 3-20.

28. Paul J. Crutzen and Eugene F. Stoermer, "The 'Anthropocene,'" *Global Change Newsletter* 41 (May 2000), 17.

29. David Farrier, *Footprints: In Search of Future Fossils* (London: Farrar, Straus and Giroux, 2020).

where anthropogenic mass, which has recently doubled roughly every twenty years, will surpass all global living biomass.[30] In other words, the biomass that will be preserved in sediments of sand and mud and will gradually turn to stone will be predominantly anthropogenic, and that is before we start thinking about the millions of pieces of plastic as well as the concrete and glass from crushed megacities.[31] Some scientists take the dominance of anthropogenic biomass as a "quantitative and symbolic characterization of the human-induced epoch of the Anthropocene."[32] However, it also invites us to speculate about the fossils of the future and about how the sharp increase in anthropogenic biomass, relative to all other organic lifeforms, will be represented in rock layers and geological strata.

Farrier takes the fossil question, projected into a far future, as an occasion to speculate about future societies, human or otherwise, and to consider how, based on the petrified traces found in the ground, future fossil collectors will look back at the current moment in Earth's history. In his book, he lets a microbiologist speculate about a commune of evolved bees that encourage their bee-scientists to study the Anthropocene as a warning for all hive-kind. The minimum 10,000 years involved in producing a fossil, according to current geological definitions, can be used to project a far future, one that exists beyond the timescale within which history usually operates. However, processes of fossilization, taken as a generic term for different kinds of solidification, petrification, and ossification, involve not only future time but also past and present time. In this article, fossilization is restored to its place alongside other concepts of movement and transformation, like development, evolution, and progress.

This brings us to another aspect of the Anthropocene that can serve as a context for thinking about historical futures. Thinking history across disciplines is, in itself, nothing new. In the 1960s and 1970s, social history bridged the gap between sociology and political science,[33] and in the 1980s and 1990s, cultural history brought onboard theories and methods from linguistics, literature, and cultural anthropology.[34] In the face of climate emergency and framed by geological periodization, the already multifaceted discipline of history faces a new, similar task: to reconnect with the historical disciplines among the natural sciences (mainly geology, biology, and cosmology),[35] which conceive of their objects of study as continuously changing across shorter or longer, and sometimes extremely long, periods of time. In earlier phases, the historical disciplines borrowed their concepts from sociological analysis or literary theory (for example, "class" and "signifier"). To these we would like to add the geological concepts of "fossil" and "fossilization," thus staking out another possible trajectory for the exchanges

30. Emily Elhacham, Liad Ben-Uri, Jonathan Grozovski, Yinon M. Bar-On, and Ron Milo, "Global Human-Made Mass Exceeds All Living Biomass," *Nature* 588 (2020), 442-44.

31. Farrier, *Footprints*, 3-26.

32. Elhacham, Ben-Uri, Grozovski, Bar-On, and Milo, "Global Human-Made Mass," 442.

33. See, for example, Geoff Eley, "Memories of Under-Development: Social History in Germany," *Social History* 2, no. 6 (1977), 785-91.

34. See, for example, the essays in *The New Cultural History*, ed. Lynn Hunt (Berkeley: University of California Press, 1989).

35. See, for example, Julia Adeney Thomas, "History and Biology in the Anthropocene: Problems of Scale, Problems of Value," *American Historical Review* 119, no. 5 (2014), 1587-1607.

between geological and human histories, in addition to the shared vocabulary of "strata" and "stratification," "layers," "sediments," "organic" and "inorganic," "petrification," et cetera, which we return to later in this article.

To break down the barriers between human and natural sciences, and specifically between human and natural histories, we need to go beyond disciplinary terminologies to discuss time in a non-discipline-specific way. Our term "lifetimes" applies to times inherent in—and, indeed, embodied by—different forms of life, organic and otherwise. Furthermore, concepts of "timescales" and "lifescales" help us to move back and forth across the human-nature divide. In this sense, human time is a specific timescale, spanning from seconds to centuries, even millennia. To move between human and geological history means to move up and down—or, indeed, back and forth—on a timescale, which now also includes millions and billions of years, as illustrated by the concept of the Anthropocene. Similarly, lifescales—in terms of the Aristotelian *scala naturans*—create continuities between different lifeforms, as illustrated by Geoffrey West's 2017 book, which moves gradually through many levels of complexity, from insects to modern metropoles.[36]

Fossils and fossilization mark an interface between timescales and lifescales. In the next step of the argument, we ask to what extent and in what ways the theory of fossilization, handed down from seventeenth- and eighteenth-century natural history to the modern science of the geology (which, alongside meteorology and Earth System Science, constitutes one of the master sciences of the Anthropocene), can offer an alternative analytics of history and of historical futures specifically.

AN ANALYTICS OF SOLIDIFICATION, OR WHEN IS THE FOSSIL?

At the most general level, "fossilization" belongs to a group of words that describes how something metamorphoses from mutable and organic to solid and inorganic. Paradoxically, to ask what solidifies is to make it clear that there never were "immutables" in the first place.[37] The fact that solidification is a process destabilizes the dichotomy between "solid" and "melting into air" by insisting that even a solid has a lifetime, a before and an after. The only thing that is certain is that solids are subject to change, never quite immutable. A heightened attention to solidifications is not about entrenching what endures as matter; it is about tending to *how* the process may occur and alert us to the lifetimes of solids. The basic move is to disaggregate the senses in which something solidifies: to learn what distinguishes petrification from ossification or calcification; to question the meanings of these terms as descriptors of a world that was not coproduced by humans; and to figure out the complicated meanings they may acquire in the trails of variously human actions—be these material, virtual, or metaphorical senses of

36. Geoffrey West, *Scale: The Universal Laws of Growth, Innovation, Sustainability, and the Pace of Life, in Organisms, Cities, Economies, and Companies* (New York: Penguin, 2017).

37. See Latour's "immutable mobiles" ("Visualisation and Cognition: Drawing Things Together," *Knowledge and Society: Studies in the Sociology of Culture Past and Present* 6 [1986], 1-40).

the terms. Examples of such anthropogenic meanings could be to set in stone; to simulate the "weathering" of stones;[38] to socially stratify, to imprint a mode of production onto the face of the Earth, to accumulate into archeological layers; to conceive genealogies of knowledge; to forge new constellations of kin.

Furthermore, we will need to elucidate the entangled nature of real-life solidifications. If the Anthropocene is marked by temporal clashes, a critical way they become evident, tangible, and contestable is through what has solidified and what gets to be solid.[39] One example of this is living beings perishing, decomposing over millions of years, being extracted from the fossil layer, and being turned into fuel so they can be consumed by a sudden intervention so momentous that it will change the climatological conditions that may once be detected on the stratum of our time. Another example: volcanic eruptions increase in frequency as a result of the very same warming; in such events, the Earth's melted-down innards gush over its face, a nonhuman remix of the Earth's temporal layers[40] that, nowadays, can be broadcast as an uncanny live-video stream (as in the case of the Gelingadalir eruption)[41] and endures in the archives of media, new media, research labs, and governmental agencies. On a living planet, solids do not melt into air; their melting is a generative moment in the coming together of a multitude of entangled lifetimes.

Attention to solidifications brings the question of situation in time, and of vantage points on temporality, to a head. To achieve this, we also need to shift the questions of time from the realm of mathematical, physical, and phenomenological abstractions to the material existence of objects and beings. In other words, we need to address not a Newtonian homogenous time "independent of anything external" but an embodied, heterogeneous, and multiple time, one that is inherent to things and lives.[42] When is the fossil? How do we gain knowledge about something that is either no longer there (for example, organic matter that has become fossilized) or has not yet arrived (fossils of the future)? There are modes of exploring positions that are incipient at best—roughly orbiting around the speculative[43]

38. Rachel Douglas-Jones, John J. Hughes, Siân Jones, and Thomas Yarrow, "Science, Value and Material Decay in the Conservation of Historic Environments," *Journal of Cultural Heritage* 21 (September–October 2016), 824.

39. See the discussions of "chronocenosis" in *Power and Time: Temporalities in Conflict and the Making of History*, ed. Dan Edelstein, Stefanos Geroulanos, and Natasha Wheatley (Chicago: University of Chicago Press, 2020) and Helge Jordheim, "In Sync/Out of Sync," forthcoming in *Historical Understanding: Past, Present and Future*, ed. Zoltán Boldizsár Simon and Lars Deile (London: Bloomsbury Academic, 2022).

40. Using a different dynamic geological medium, Alexis Rider has argued that ice geologies challenge the neat stratification model of geological time ("Glitch Geology: Ice Sheets and the Unconformities of Deep Time" [presentation, 2nd International Temporal Belongings Conference, 17 March 2021]).

41. "Live from the volcano in Geldingadalir, seen from Langihryggur, Iceland," RÚV, streamed live on 22 March 2021, YouTube video, https://www.youtube.com/watch?v=BA-9QzIcr3c. Thanks to Anders Ekström for bringing this to our attention.

42. Isaac Newton, *The Mathematical Principles of Natural Philosophy*, vol. 1, transl. Andrew Motte (London: Benjamin Motte, 1729), 9.

43. Martin Savransky, Alex Wilkie, and Marsha Rosengarten, "The Lure of Possible Futures: On Speculative Research," in *Speculative Research: The Lure of Possible Futures*, ed. Alex Wilkie, Martin Savransky, and Marsha Rosengarten (London: Routledge, 2017), 1-17.

and the probable.[44] What is more, the forms and the depths of time available to scientific inquiry is ever increasing,[45] a crucial precondition for the understanding of the planet as a multiple, living sphere of coexistence that is prevalent today.[46]

In the next part of the article, we look at how fossilization interpellates various aspects of historical thinking and theory. The first and probably most obvious candidate is stratigraphy, the structural principles of layers and layering that, for more than half a century, has marked a productive interface between natural and human history. From there, we proceed into a less structuralist, more materialist aspect of fossilization when we discuss how organic matter is transformed into rocks and minerals. This includes the human body. Finally, we look into how processes of fossilization also take place outside of what we usually consider to belong to geology, though still involving something that settles, hardens, and acquires another kind of duration and durability.

SEDIMENTATION AND HISTORICAL TIME

Sedimentation and the transformation of sediments into rock is, in most cases, a prerequisite for fossilization. Fossils are mainly found in sedimentary rocks, and for fossilization to happen, organic material needs to be covered up and left in an especially favorable "environment." This covering up of what has been a living organism in many ways decelerates history. Life turns into structure—that is, it becomes part of slow geological processes. Fossilization is about altering the speed of change; it is about slowing down processes, changing things slowly. Thus, fossilization can be understood as a (re)structuralization of organic time inside slow-moving material layers of rock time. Not all fossils are turned into stone, though. Neontology (the study of living organisms) defines "living fossils" as organisms that look basically the same as ancestral species that are known only from found fossils. These organisms, then, are also a form of nonhistory: they basically have not changed—on the species level, that is.[47]

Materially, sediments are made up of either bedrock, earth strata, or organic matter that has been broken down through erosion or weathering. Water, air, or ice have moved the solid materials and deposited them in a new location. Geologists distinguish between several forms of sediments, which can be classified by different criteria. Through diagenesis (which is caused, for instance, by microbial

44. A good example from contemporary governance is Louise Amoore, *The Politics of Possibility: Risk and Security Beyond Probability* (Durham: Duke University Press, 2013).

45. For a survey, see Sverker Sörlin, "Environmental Times: Synchronizing Human-Earth Temporalities from *Annales* to Anthropocene, 1920s to 2020s," forthcoming in *Times of History, Times of Nature: Temporalization and the Limits of Modern Knowledge*, ed. Anders Ekström and Staffan Bergwik (New York: Berghahn, 2022).

46. See, for example, Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015).

47. For Stephen Jay Gould's tongue-in-cheek definition of "neontology," as used by paleontologists, see Ethan E. Cochrane, "Evolutionary Explanation and the Record of Interest: Using Evolutionary Archaeology and Dual Inheritance Theory to Explain the Archaeological Record," in *Pattern and Process in Cultural Evolution*, ed. Stephen Shennan (Berkeley: University of California Press, 2009), 115.

activity, water-rock interactions, or compacting processes), sediments can change physically and chemically into solid rock or—if it is organic matter—into coal, oil, or gas. The process of diagenesis transforming masses into solid rock can be divided in two phases. The first phase is petrification, where the sediments gradually turn into solid rock because of overlaying and younger sediments pushing the older sediments together so that water exudes. In the second phase, increasing pressure and temperature caused by the solid rock's movement further down into the Earth's crust make chemical processes happen, transforming the rock further. If the rock is superimposed even more, the process of diagenesis turns into a more radical metamorphosis.[48]

According to the *Oxford English Dictionary*, "stratigraphy" refers to a "branch of geology that is concerned with the order and relative position of the strata of the earth's crust."[49] "Strata," on the other hand, is the plural of the Latin word *stratum*, which originally referred to something spread or laid down, such as a piece of bedding, coverlet, bed or couch, saddlecloth, horse-blanket, level floor, or platform, but which, in the second half of the seventeenth century, took on another kind of meaning, which we today identify as geological: "a natural layer or bed of sediment or rock having a consistent composition and representing a more or less continuous period of deposition."[50] The theory of stratigraphy was first developed by Steno in his *De solido intra solidum*, which was published in 1669.[51] In this book, geologists find the first draft of what will become the framework of modern geology, including the law of superposition, the principle of original horizontality, and the principle of lateral continuity.[52] For Steno, the materiality of history consists of rock strata and formations. In his attempt to explain how one solid body (such as a tooth, a crystal, a diamond, an animal, or a plant) can be contained within another solid (that is, within a layer of rock), Steno argues that all solid bodies have been produced from fluids by way of sedimentation, thus creating the strata of the Earth. The position of the strata, above and underneath each other, is entirely a question of time. Thus, when Steno formulates what is later referred to as "the law of superposition," it all depends on when—at what time—the different strata in the Earth's crust were formed.

Three centuries after the geological term "stratigraphy" was coined, the Polish-French philosopher and cultural historian Krzysztof Pomian took it upon himself to introduce the concepts of strata and stratigraphy in human historiography and theory of history. In his groundbreaking, but often overlooked, work *L'ordre du temps*, which was published 1984, he launches his conception—or, in his own words, "preconception"—for what he calls a "stratigraphy of time and history."[53] According to Pomian, the phrase marks a shift from a "diachronic" to a "purely

48. Stephen Marshak, *Essentials of Geology*, 4th ed. (New York: Norton, 2013), 150-93.

49. *Oxford English Dictionary*, s.v. "stratigraphy (*n*.1)," www.oed.com/view/Entry/191335.

50. *Oxford English Dictionary*, s.v. "stratum (*n*.2a)," www.oed.com/view/Entry/191350.

51. For discussions of Steno as the first to present the theory of stratigraphy, including the laws of superposition, see Rudwick's *Bursting the Limits of Time*, 97, and *Earth's Deep History*, 39-49.

52. Rudwick, *Bursting the Limits of Time*, 97. For a criticism of Rudwick's reading of Steno as a predecessor, see Jakob Bek-Thomsen, "From Flesh to Fossils—Nicolaus Steno's Anatomy of the Earth," *Geological Society, London, Special Publications* 375 (January 2013), 289-305.

53. Krzysztof Pomian, *L'ordre du temps* (Paris: Gallimard, 1984), 334-35.

synchronic analysis" of historical events in order to understand "the fundamental reasons for the polysemic nature of the word 'time.'"[54] In many ways, thinking of time, and history, as strata seems like a suitable approach for trying to understand human history and its conditions. However, the metaphor does not always fit: how do different strata interact or clash? The strata model helps us to visualize overlaying strata pushing down or resting on others, and it enables understandings of historical processes moving at different speeds.[55] Historical times, however, are entangled in mysterious ways. This is why we must ask the fossil question: how can it be that one solid ends up inside another solid, *solido intra solidum*? What happens if we consider the slow-changing sedimentary rocks unhurriedly moving toward a different geological future, with their pockets of captured organic time transforming into structure, as the actual historical actors?

Sedimentation and stratigraphy have also made their way into human history in the works of historians like Fernand Braudel and Reinhart Koselleck. Braudel's theory of the three temporal orders operating at different historical depths is well known.[56] For Koselleck, on the other hand, history unfolds in *Zeitschichten*, "strata/layers of time" (or "sediments of time," as the most recent English translation of his concept will have it[57]), that move at different speeds. In "Structures of Repetition in Language and History," Koselleck is interested in the conditions for possible histories—that is, "how we can analyze and represent the sediments and mixtures of both repetition and innovation."[58] For Koselleck, a historian of human life and experience, sedimentation manifests itself in "structures of repetition" that exist at varying depths.[59] He lists five such depths:

> (a) extrahuman conditions of our experiences; (b) the biological preconditions of life we share with animals; (c) structures of repetition unique to humankind, that is, institutions; (d) structures of repetition embodied in singularly occurring sequences of events; and (e) linguistic structures of repetition, within which all previously named repetitions or repeatabilities were generated and recognized, and within which they are still generated and discovered.[60]

Koselleck's layers or strata of time make up the conditions not only of possible histories but of history itself: it is a theory of historical time that leads into multiple futures. The possible future histories conditioned by the different layers of time forming and folding a historical crust on which events happens are all histories

54. Ibid., 335.

55. For a discussion of why historical time cannot be analyzed via stratigraphic models, see Chris Lorenz, "Probing the Limits of Metaphor: On the Stratigraphic Model in History and Geology," forthcoming in Simon and Deile, *Historical Understanding*.

56. Fernand Braudel, "Historie et Sciences sociales: La longue durée," *Annales* 13, no. 4 (1958), 725-53.

57. Reinhart Koselleck, *Sediments of Time: On Possible Histories*, transl. Sean Franzel and Stefan-Ludwig Hoffmann (Stanford: Stanford University Press, 2018). For a discussion of this translation, see Helge Jordheim, "Sattel, Schicht, Schwelle, Schleuse: Kosellecks paradoxe Sprachbildlichkeit der pluralen Zeiten," in *Reinhart Koselleck und das Bild*, ed. Bettina Brandt and Britta Hochkirchen (Bielefeld: Bielefeld University Press, 2021), 217-43.

58. Koselleck, "Structures of Repetition in Language and History," in *Sediments of Time*, 160.

59. Ibid., 162.

60. Ibid.

of human experience. However, if we are to radically challenge our concepts of change and continuity, we must turn Koselleck's *Zeitschichten* upside down: what if sedimentation, diagenesis, metamorphosis, and fossilization are what makes up history? Then, every event, every human action, every organic being and their interactions, either between themselves or with the nonorganic environment, will *not* be history in the emphatic, agential sense; instead, they will only be conditions for possible "geostories,"[61] where fossilization writes history through the pocketing of asynchronicities in layers of sedimentary rocks. The only way for organic life, and maybe also *products* of organic life, to become history, then, is to get covered up and pocketed in rock time.

In this way, the theory of sedimentation and stratigraphy, pioneered by Steno in the seventeenth century and introduced into the broader field of history by Braudel, Koselleck, and Pomian, sets the scene for a different form of historiography, decentering the human from the geohistorical narrative and replacing it with a specific kind of matter, the fossil. Fossilization invites a new materialist rethinking of history and historical futures, which we explore in more detail below.

FOSSILIZATION IN NEW MATERIALIST FUTURES

By blurring and questioning the Cartesian distinction between *res extensa* and *res cogitans*, historians proceeding in the wake of the work of Karen Barad, Donna Haraway, Bruno Latour, and others restore agency and performativity to matter.[62] "Matter is . . . a doing," Karen Barad puts it.[63] Matter is active, agentive, an actant (to use a term from Actor Network Theory), taking part in networks with other human and nonhuman actants. As we have already seen, thinking about historical futures in terms of fossilization puts matter at the center of various forms of historical change and continuity and invests it with meaning and, indeed, agency. In other words, fossilization (as a perspective on history) has obvious interfaces with new materialist historiographies. Fossils appear as ideal objects for exploring new materialist rethinking of history. In the following section, we trace the steps of new materialist thinking into different futures of the culture of fossils, in which rocks, museum objects, and video games gain material agency.

One possible way to proceed is to imagine the world and retell geological processes from the perspective of a fossil, thus investing metamorphoses unfolding in the Earth's crust with agency, even subjectivity and intentionality, and blurring the borders between organic and inorganic, human and nonhuman. If you want to become a fossil, you will have to die, and the mode of your death matters.[64] You

61. Latour, "Agency at the Time of the Anthropocene," 3.

62. Hans Schouwenburg, "Back to the Future? History, Material Culture and New Materialism," *International Journal for History, Culture and Modernity* 3, no. 1 (2015), 59-72. See also Timothy J. LeCain, *The Matter of History: How Things Create the Past* (Cambridge: Cambridge University Press, 2017).

63. Barad, *Meeting the Universe Halfway*, 151.

64. A good overview of the fossilization processes discussed in this section appears in Keith Thomson, *Fossils: A Very Short Introduction* (Oxford: Oxford University Press, 2005), 51-71.

will want to die, ideally, in a way that buries you quickly, at the right depth, and in an oxygen-poor environment. A key to successful fossilization is to arrest decomposition, and for most of us, the most important decomposers are aerobic—that is, bacteria and organisms that require oxygen to do their work. For a classic, durable fossilization, you will want a stable, sealed environment that is quiet, anoxic, and gently irrigated by mineral-rich water. Sedimentary deposits such as sand, clay, and ash are particularly useful for this. The loose material will bury you and, over the millennia, as pressure and time transform it into harder rock types (limestone, say), encase your body, sealing it in.

From here, there are several mechanisms by which you may achieve a more lasting fossilization. One is recrystallization, in which time and pressure act on the crystalline parts of your body, resettling their chemical components into different, more durable configurations. An aragonite shell may transform into calcite, for example, and continue to grow—because the crystalline elements possess a life and a time of their own, outlasting the biological matrix of your body and continuing to grow and transform after your death. Another path you may take is permineralization. This is what you will need the mineral-rich water for. As it seeps through, irrigating your body, the water will deposit its minerals into the pores and hollow spaces. Over time, the precipitate will crystallize and harden, eventually filling your hollows and preserving your likeness in a heavier, more durable form. When this results in a complete substitution, when all tissues are replaced, it is known as petrification. Some parts of you may simply remain as they are, of course. Teeth are often the hardest parts of a body; they are durable mineral structures that may survive for a very long time, even millions of years, without undergoing alteration. The groundwater flowing through the space may also dissolve your physical body entirely. But if you were buried in a sedimentary layer, the hardened rock may still have captured your form, creating a mold or cast fossil from the negative space your body used to occupy.

As time passes, your slowly fossilizing body will move with the strata that surround you. It is important that you find your way out of the "taphonomically active zone"[65] and into the deeper strata, where you can rest as the fossilization process continues to do its work. Avoid tectonic fault lines, eruptions, and other areas of intense geological activity. For the first few tens of thousands of years, your body is also still residually organic, made up of tissues from the original body—a "subfossil." During this time, you will want to avoid disturbances, like being bored through by a tunneller: perforation will disrupt your structural integrity, and more importantly, oxygen will enter and the decomposers will go to work. When the time comes, finally, the trace that was made from you must be exhumed—pulled from the earth into the light and the air, extracted. The surfacing may be accidental or intentional, by human hands or otherwise: the specific modality of the exhumation matters less than the fact that it occurs—and perhaps,

65. This refers to the "dynamic [stratigraphic] interval where postmortem alteration of biological remains takes place" (Sandro Monticelli Petró, Matias Do Nascimento Ritter, María Alejandra Gómez Pivel, and João Carlos Coimbra, "Surviving in the Water Column: Defining the Taphonomically Active Zone in Pelagic Systems," *Palaios* 33, no. 3 [2018], 85).

also, that it is observed, witnessed by someone who sees you and recognizes the fossil you became.

From the ground, some fossils make it into human hands—and in your hand, a fossil possesses a kind of aura, a thing-power that is not the aura of the corpse. It is not animate, at least not on a human timescale, although geochemical processes continue to unfold in the captured intricacy of its postbiological folds, in the luminous density of its no-longer-flesh. It is a thing that lived and was buried, and now it keeps a different time—a time that it might help us think, make thinkable, keep open. The ammonite lineage, for example, emerged initially during the Devonian period, some 400 million years ago. The last of them perished with the Chicxulub impact, over 300 million years later—in the vast planetary extinction that marked the end of the Cretaceous. The time-depth that separates fossilized ammonite from living humans transcends imagination, and yet there is the fossil—concrete metaphor, metonymic proxy, image of time. Holding it, you come face-to-face with the immensity of the aftermath, the sheer time-depth of the no-longer-biological. "Remember, I was once like you," the ammonite seems to say—speaking as one of the dead for whom time has almost ceased to pass, as one of those who are now held in the slow, quiet hum of growing crystals, of mineral precipitates that, over the millennia, deposit themselves in the slow tectonic pulse of the Earth itself. Across the dark abyss of time, the echo of shared flesh provokes an empathic leap. Or does it? This is such an easy, convenient narrative: the fossil as *memento mori*,[66] keepsake and reminder of finitude, transience, extinction, a higher order of death. But death is such an overworked analytic these days, now, here, in the Anthropocene. The discourse is exhausting, as are its affects: theorists elaborate an endless succession of epochal neologisms as the "lullaby of finitude"[67] drones on—banal, monotonous, incessant. Other registers, other modes of relation and engagement with deep time, are not just possible but urgently, desperately needed: care, affection, respect, obligation, kinship, awe, wonder, recognition.[68]

Some of these registers can be cultivated in museums of natural history, where fossils and ancient artifacts continue to evoke in many visitors a delight in the transformative power and beauty of the Earth's deep past. Heritage and museum practices struggle to accommodate the material and the immaterial as well as the entanglements of cultural and natural phenomena. Objects and material remains are conserved and salvaged, but without the "living traditions," the "immaterial heritage," their "ecosystems," the *Umwelt* where they thrived and became obsolete or died. In heritage practices, things are turned into fossils and given the task of narrating other cultures, other natures, other times. They meet our eyes

66. Ben Dibley, "The Technofossil: A *Memento Mori*," *Journal of Contemporary Archaeology* 5, no. 1 (2018), 44-52.

67. Elizabeth Povinelli, "On Biopolitics and the Anthropocene: Elizabeth Povinelli, interviewed by Kathryn Yusoff and Mat Coleman," *Society and Space*, 7 March 2014, https://www.societyandspace.org/articles/on-biopolitics-and-the-anthropocene.

68. See, for example, Christina Fredengren, "Unexpected Encounters with Deep Time Enchantment: Bog Bodies, Crannogs and 'Otherworldly' Sites," *World Archaeology* 48, no. 4 (2016), 482-99.

as out-of-context things, performing as "museum nature"[69] and museum culture. The fossilization processes of natures and cultures that have tried to keep the past alive in heritage contexts are now under pressure. Today, asking the fossil question opens up to the possibility that we need to care for the past and for history in new and hitherto unknown ways.[70] Are we to keep things for eternity, as the rationale for modern preservation and conservation practices would hold? Or are the caring practices we need "to let things go,"[71] to let fossilization practices unfold?

In their battles against the forces of deterioration while also managing a difficult politics of accessibility, museums increasingly turn to 3D scanning. The Smithsonian, for example, has started digitizing its collection, allowing anyone who is interested to handle their artifacts virtually.[72] As data objects, they can then be easily imported in augmented reality (AR) apps that superimpose them on the world seen through a phone's camera.[73] Thus, you can project the fossilized skeleton of a woolly mammoth on your lawn in true scale, engineering an impressive encounter with deep time. The 2020 videogame *I Am Dead* offers a playful exploration of the inside/outside dynamic that animated the fossil question, and it forwards another digital means of engaging with fossils.[74] In the game, the player interacts as the deceased caretaker of the Shelmerston Museum, which is located on a little fossil-rich island off the southwest coast of England. The story involves trying to stop a nearby volcano from erupting and engulfing the island; to do this, the player must recruit custodian spirits from among a number of recently deceased individuals in an attempt to mediate between the island and the life it supports. To conjure these spirits, the player must collect and use objects to uncover memories that were relevant to the other spirits' lives. Fortunately, being dead comes with certain privileges, one of which is that the player can move through and see inside objects without having to open them (in the same way that ghosts can move through walls). One of the player's very first test objects is an unbroken geode on a desk at the Shelmerston Museum (the crystals inside are turquoise). Throughout the rest of the game, however, all kinds of contemporary, everyday objects are subject to the same slicing gaze: boots, bags, cabins, water tanks, display cases, funerary mounds, and even the preserved Bronze Age corpse of Aggi, the Shelmerston bog woman. Fossils are often presented in relief, poking out of their stone graves just slightly.

I Am Dead allows players to see commonplace objects sliced through in a similar manner, revealing artifacts inside, like a pair of slippers. Owing to this gaze, the

69. Samuel J. M. M. Alberti, "Constructing Nature behind Glass," *Museum and Society* 6, no. 2 (2008), 73-97.

70. For the development of these perspectives, see Rodney Harrison et al., *Heritage Futures: Comparative Approaches to Natural and Cultural Heritage Practices* (London: UCL Press, 2020).

71. See this developed in Caitlin DeSilvey, *Curated Decay: Heritage beyond Saving* (Minneapolis: University of Minnesota Press, 2017) and Caitlin DeSilvey and Rodney Harrison, "Anticipating Loss: Rethinking Endangerment in Heritage Futures," *International Journal of Heritage Studies* 26, no. 1 (2020), 1-7.

72. Smithsonian 3D Digitization (website), accessed October 2021, https://3d.si.edu/.

73. Jamie Cope, "Voyager + AR," 24 November 2020, Smithsonian Digitization Program Office, accessed October 2021, https://dpo.si.edu/blog/voyager-ar.

74. *I Am Dead* (Annapurna Interactive, 2020), PC game.

game encourages players to consider the objects around them as potential future fossils, raising questions about the impact of our material legacy, especially since the threat of volcanic eruption reminds us of the ancient cities of Pompeii and Herculaneum, which were buried under lava and ashes and were thus preserved. The interface that allows the player to slice through and fondle the different objects in the game so freely mimics the one used in 3D digitization projects, such as the one at the Smithsonian. Objects are isolated from their contexts and float around in space, and players can zoom in, zoom out, and turn them over to their hearts' content. In *I Am Dead*, the ghostly touch of digitization promises to keep the artifacts and fossils intact, fostering a sense of care and intimacy. More generally, the game emphasizes that fossils and other objects are "storied matter," accruing relationships to other things and other beings over the course of their lifetimes.[75] In *I Am Dead*, as the local museum's caretaker (and, ultimately, the island's custodian spirit), the player must unveil these relationships among humans, creatures, spirits, objects, and geological forces (like the nearby volcano).

Have we reached the end of the lifetime of a fossil? What was once alive has become stone, and what was stone may be rendered into bits and bytes. It may seem that way, but we must be careful not to overstate the virtuality of digital processes. Digital processes, too, are grounded in material infrastructures. Videogames are played on computers that are made up of rare metals, and they are reliant on server farms and power plants. Moreover, although most contemporary games are purchased and downloaded online, it was not so long ago that they were sold as physical copies. These physical copies themselves have afterlives that attest to the material legacy of the entertainment industry. Among the Smithsonian's more unusual artifacts (and not yet 3D-scanned) is a copy of the 1982 videogame *E.T. the Extra-Terrestrial* that ended up in a landfill in New Mexico in 1984, after the crash of the American videogame industry.[76] The game was unearthed in 2014, when the burial had become something of an urban legend, symbolic of the unsustainability of the 1980s videogame boom. It makes for an unlikely fossil, but then most things in your direct vicinity would require some effort to speculatively fossilize. A more playful engagement with objects of natural and cultural history, as shown in *I Am Dead*, can help us jump more freely between different timescales, enabling us to trace lifetimes into the deep future. Matter is indeed a doing.

HUMAN FOSSILS AND FOSSILIZED HUMANS

If the subjects and agents of geohistorical narrative are the fossils as well as the formations in which they find themselves embedded, what happens to the autonomous, intentionally or affectively guided, presumed exceptional human of

75. Serenella Iovino, "The Living Diffractions of Matter and Text: Narrative Agency, Strategic Anthropomorphism, and How Interpretation Works," *Anglia* 133, no. 1 (2015), 81.

76. Video Game Cartridge, E.T. the Extra-Terrestrial, National Museum of American History, Smithsonian, accessed September 2021, https://www.si.edu/object/video-game-cartridge-et-extra-terrestrial%3Anmah_1519322.

historiography?[77] The theory of fossilization conceives of human agency in a very different way, distributed through dynamic materialities that exist beyond human intention and control, such as the physical, chemical, and biological properties of the human body, enmeshed in larger ecosystems. When it comes to fossilization, the human body is no different from other organic beings.[78] Humans have hard skeletons and they are comparably large; thus, our bones are more likely to make it into a fossil than, for instance, the body of a jellyfish or a spider would. Some components of the human body are more solid than others. There are numerous ongoing processes that turn the soft parts into solids, which are more resistant to decomposition after death than other parts of the body. Calcification is one of these processes. It occurs when calcium salts accumulate in the body tissue, such as in bone or teeth formation. Calcium salts can also build up in soft tissue, causing it to harden and disrupt normal body processes. For instance, calcification can lead to hardening of the arterial walls, resulting in atherosclerosis of the heart valves (which makes the heart pump less flexible and efficient) or of the joint and tendons (which causes arthrosis with difficulties and pain in walking); calcification can also lead to the formation of stones in the kidney, bladder, or gallbladder.[79]

Above we described the conditions under which a body can fossilize. Some of the soft parts—including the heart, the lungs, the intestines, and the inside of the brain—decompose first, contributing to the ever-present recycling of nutrients. The soft tissues decay and then dry, exposing the solid parts, such as the bones (including the skeleton) and the different calcifications. When all the soft tissues have been eliminated, only disarticulated bones are left. In a temperate climate, this process can take from three weeks to several years, depending on factors such as temperature, humidity, and the number of insects.[80] The so-called bog bodies are an exception to this rule.[81] A bog body is a human cadaver that, due to special conditions in the peat bog where it ended up, never decomposed completely but was naturally mummified. The oldest known bog body is the Koelbjørn Man from Denmark, who lived more than 10,000 years ago during the Mesolithic period. Bog bodies often have skins and internal organs that are more or less well

77. For a useful discussion of what happens to the category of the human after the geological turn in history, see Marek Tamm and Zoltán Boldizsár Simon, "Historical Thinking and the Human: Introduction," *Journal of the Philosophy of History* 14, no. 3 (2020), 285-309.

78. Note that we can make this assertion without committing a cybernetics-style analogy between humans and nonhumans; rather, it is the antecedent quality of fossils that means the identity of the originator does not matter. A way of thinking about this may be found in John Dewey, *The Public and Its Problems* (New York: Henry Holt and Company, 1927), 3-26, in which Dewey pointed out that the "consequences" of human actions had a materiality.

79. See Moeen Abedin, Yin Tintut, and Linda L. Demer, "Vascular Calcification: Mechanisms and Clinical Ramifications," *Arteriosclerosis, Thrombosis, and Vascular Biology* 24, no. 7 (2004), 1161-70, and Linda L. Demer and Yin Tintut, "Vascular Calcification: Pathobiology of a Multifaceted Disease," *Circulation* 117, no. 22 (2008), 2938-48.

80. See Gulnaz T. Javan et al., "An Interdisciplinary Review of the Thanatomicrobiome in Human Decomposition," *Forensic Science, Medicine and Pathology* 15, no. 1 (2019), 75-83, and David O. Carter, David Yellowlees, and Mark Tibbett, "Cadaver Decomposition in Terrestrial Ecosystems," *Naturwissenschaften* 94, no. 1 (2007), 12-24.

81. For an excellent discussion of this topic, see Karin Sanders, *Bodies in the Bog and the Archaeological Imagination* (Chicago: University of Chicago Press, 2009).

preserved. High acidic water, low temperature, and lack of oxygen allows for the preservation of skin, hair, and nails. The bones, in contrast, have most often dissolved due to the high level of acidity. For all other bodies, the process of decomposition leaves only bones and cartilage, which is further broken down and has its chemical composition changed by other microorganisms. Acids in fertile soils (for instance, in cemeteries) can dissolve a skeleton in about twenty years. If the skeleton is situated in a pH-neutral environment, the process of disintegration can be delayed by hundreds of years. A tiny percentage of these bones can, if they dwell in particularly suitable soils (those that are devoid of oxygen, contain salts, or are mildly alkaline), convert into stone so that they may persist indefinitely—that is, they undergo fossilization. Bone is a highly porous material because it contains bone marrow and other tissues. These pore spaces may be filled with minerals, changing bone to stone.

How fossilization changes the position of the human in history can be illustrated by considering the other way that humans are turned into stone—or, in some cases, into bronze—in the form of statues adorning public spaces. Whereas fossilization is rare (less than 0.1% of all the animal species that ever lived have turned into fossils), the immortalization of historical actors, mostly after they are dead, via stone replicas mounted on pedestals is even rarer. Most statues are of the same small collection of so-called Great Men. Furthermore, whereas fossilization is based on the laws of geology, among them the law of superposition, the erection of statues and memorials commemorating mostly white men and their deeds correspond to the Great Man theory of history. Finally, as discussed above, fossilization happens gradually over the course of thousands of years, whereas it mostly takes only a few years, often even less, from when the idea of a statue to commemorate a historical person is conceived to when the statue is erected, effectively demonstrating the difference of duration and rhythm between traditional historical narratives and "geostories."

Recently, however, the humans turned to stone and placed on plinths have again been exposed to more sudden, shorter-term historical changes in the wake of the Black Lives Matter movement and the Decolonizing initiatives. As heroizing statues of slave owners and imperialist war criminals have been rejected, revisited, and, in some cases, even torn down in recent years, the peculiar status of solidifications in political struggles has erupted into public with great complexity.[82] It is as if all parties sense that allying power with rocks is to move beyond the contestation of the present.[83] Conversely, the graffiti, the denigrations, and the dismountings—the throwing into the ocean—make it clear that memorializing petrifications always live at the mercy of the polities that have to live with them.

82. See Victoria Fareld, "Coming to Terms with the Present: Exploring the Chrononormativity of Historical Time," in *Rethinking Historical Time: New Approaches to Presentism*, ed. Marek Tamm and Laurent Olivier (London: Bloomsbury Academic, 2019), 50-70.

83. This is by no means to neglect that memorialization emerges from the often anachronistic concerns of a present struggle. Most Confederate statues in the US South were erected after the 1920s in an effort to shore up the authority of the Jim Crow South. See "Rahul Rao: 'Statues are more about our present than our past,'" BBC Newsnight, YouTube video, 21 August 2017, https://www.youtube.com/watch?v=TmOqzoClAe4. Rao is also working on a book about controversial statues.

What is set in stone needs to be conserved, maintained, protected: a statue can only stand if it is granted a minimum of consent from every generation that coexists with it.

All the more reason to note, however, that toppling a statue or even throwing it into the ocean is rarely the end of it: such are the powers of elemental media. The bronze Edward Colston statue that was toppled in Bristol, for instance, was fished out of the ocean and taken to a secret location for conservation, after which it is expected to find a new home in a museum, according to the BBC.[84] Besides creating a heart-shaped hole in the back and causing some structural damage to one foot, the protesters only gave the statue some "scrapes and scuffs."[85] Meanwhile, the toppling presented the conservationists with the complications of preserving the layer that the protesters added to the story (that is, the event of controversy) and of making the disjunctures between historical and present moral economies clear. Fran Coles, Bristol's conservation manager, told the BBC that the conservationists' "main concern is making sure that we can conserve the paint, the graffiti that's on him now, because that's actually become the most fragile part of the sculpture."[86] What will likely be discarded, on the other hand, is the urban marine ecology the statue was thrown into: after only four days in the water, the statue still came out of the water full of mud and sediment and with an old bike tire hanging from it. If it had been left where it was, it might have turned into a specific kind of second-degree fossil: the solidification by geological processes of something that had already been solidified by human practices—a true fossil of anthropogenic futures. Another version of statues turned second-degree fossils can be witnessed in Memento Park in Budapest, Hungary, where toppled memorials to Lenin, Stalin, and Hungarian Communist leaders have been collected and are exhibited as tourist attractions, as *solido inter* (not *intra*) *solidum*, having been assembled in a park instead of in a layer of rock.

CONCLUSION: TOWARD A THEORY OF GEOMATERIALIST HISTORIOGRAPHY

The stage for this intervention in the ongoing discussion about "historical futures," prompted by Simon and Tamm's provocation, was set by two historiographical markers that span almost half a millennium: the reiteration of the "fossil question," which was first raised in the middle of the seventeenth century, about the *solido intra solidum* and the inversion of the nineteenth-century Marxist slogan for the modern world, "all that is solid melts into air," to formulate a discussion of which solids remain when everything else has evaporated. Transported into the early twenty-first century and into a very different kind of periodization than the early and high modernities in which they originated—indeed, into the Anthropocene—both speech acts take on different meanings and perform different tasks than their originals. For the fossil question, the temporal framework is

84. "Edward Colston statue graffiti will be preserved," *BBC News*, 17 June 2020, https://www.bbc.com/news/uk-england-bristol-53083939.

85. Ibid.

86. Ibid.

expanded, gaining a futurist dimension that it did not have in the seventeenth century. The question itself is redirected from the past to the future, thus opening up another kind of temporal imagination and horizon—not only what fossils tell us about the deep past (the lives, durations, and rhythms) but also how ongoing processes of fossilization force us to rethink our own deep, or not-so-deep, futures.

The question "what remains?" is recontextualized from an anthropocentric, more or less collectivistic theory of history to a theory of sedimentation and solidification that encompasses human and nonhuman, organic and nonorganic, remains. Historical futures are futures in which something solidifies, whereas other things decompose and disappear—they "melt into air," as Marx and Engels would have it. This inversion of Marxist modernism ushers in another kind of materialism, one that differs from nineteenth- and twentieth-century dialectical materialism in the way it conceives of matter and materiality beyond the means and relations of production. Solidification and fossilization form the basis of a truly geomaterialist theory of historical futures, in which attention is shifted from the hopes, fears, and anticipations to that which might or might not remain: the solids of the future, both *intra* and *extra solidum*.

Asking the "fossil question" today means asking how human history conditions possible fossilizations. In the introduction, we asked what elements of the present will solidify into fossils of the future and what this process of fossilization looks like. Fossilized futures are futures in which something endures, not by growth, evolution, and reproduction but by solidification and petrification, trading in its ability for organic change for solidity while at the same time becoming a coveted resource for human consumption. In this article, we have given examples of how past-present-future transitions transform when we study them in terms of fossilization rather than as progress, evolution, and growth—when we look for petrified remnants rather than renewals, transformations, and revolutions and, similarly, when we approach the present moment by asking about what will fossilize and thus remain. Furthermore, we have analyzed the specific historicity of processes of fossilization by mapping out the hermeneutic distance between two iterations of the "fossil question": the seventeenth-century question about fossils of the past and the twenty-first-century, Anthropocenic questions about fossils of the future. In so doing, we discovered a set of modalities, ranging from conflicting times via auratic objectifications to proleptic grief, for rethinking historical futures.

To think with fossilization is to insist on history as a geological process. In general parlance, fossils are dead and petrified; they are what cannot change—obsolete languages, traditions, or people out of date. Reintroducing the actual matter of fossils into history can help us to interrogate the timescales and lifescales of human and more-than-human history. The aim of this collectively written piece has been to experiment with different ways of thinking and writing fossils into more general questions of historiography and historical theory by investigating how they affect conceptualizations of historical time. Furthermore, we have attempted to illustrate how fossils and fossilization indicate possible trajectories for new materialist speculations, distributing agency to various matters, physical

and virtual, in the Earth's crust as well as in museums and video games. We have also experimented with how a theory of fossilization can be seen to decenter the human subject by exploring the processes of decomposition and putrefaction, as well as calcification and solidification, taking place in human bodies and by contrasting them with other forms of solidification, like the making of stone and bronze statues. In this way, we have lined up a series of nonexclusive, parallel, and entangled historical futures that do not rest on or come into being through anticipatory practices but instead emerge through the persistence, transformation, and metamorphoses of certain materials. By consequence, the stable—indeed, solidified—arrangements of timescales and lifescales that have given rise to disciplines like history, geology, and biology are destabilized in favor of open-ended historical knowledge ventures that meander in and out of temporal frameworks and ontological separations of life from non-life, human from nonhuman.

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