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AN ALTERNATIVE DEEP TIME OF THE MEDIA

> They penetrated to the bowels of earth and dug up wealth, bad cause of all our ills.
>
> —OVID, *METAMORPHOSES*

The Submerged Cloud

The debates about the Anthropocene and electronic waste underline a necessity to engage with the geophysical stakes of media cultural infrastructure. Much of recent years' focus has been on the cloud and its promise of disappearance of hardware and the immaterial embeddedness in data. However, the cloud brings with it a demand to develop new political vocabularies that address the double bind of technical materiality and conceptual immateriality, as Seb Franklin argues.[1] The issue of the cloud extends to software cultures and their disappearance into a branch of the service industries;[2] it brandishes the importance of the hardware in new ways but seems to be limited to being the vessel of the service in attractive mobile forms, such as the investment in different sorts of tablets and smartphones evinces; it attracts the circulation of discourses of movement and immateriality, of the imaginary and dreams that fulfill the necessary gaps in the actual user experience when encountering a lack of wireless signal or some other physical disturbance. It was in a very different way that the geopolitical aspects of the physical Internet were highlighted in 2013. In the wake of revelations of NSA's spy program PRISM, the world saw images of lonely data server farms and other institutions of the geopolitical surveillance agencies—the mute monolith structures, also pictured recently in *Time* magazine (December 23, 2013) by Trevor Paglen.

But after Edward Snowden's whistle-blowing, what also surfaced was the case of seemingly random places such as Brazil: why was Brazil so much on the map of the surveillance operations of the American agency? What was so interesting about Brazil? The reason was quickly exposed: it was about the submarine cables. The paranoid surveillance mechanisms of the post-9/11 world of U.S. terror are also highlighting the extensive infrastructural arrangements of networks on the physical level. One of the main lines, Atlantis-2, connects South America to Europe and Africa,[3] allowing for a crucial interruption node to exist when *data arrive ashore,* to put it poetically. We need to look at the underground as well as at submerged realities, which are not that much different from the laying of the Atlantic cables in the mid-nineteenth century. Back then, the submerged media were escorted by an enthusiasm of interconnectedness. Now it is a secret enthusiasm for interruptedness. The grounds, ungrounds, and undergrounds of media infrastructures condition what is visible and what is invisible. Under the ground, one finds the subterranean infrastructures of modernity: telecommunications cables as much as sewage systems, metro trains, and electricity. For instance, the Parisian underground galleries became even a tourist attraction.[4] Nineteenth-century urbanization meant a move underground, whereas we seem to live a twenty-first-century move to the heavens. Yet clouds reach back to the land and sea territories and the geopolitical.[5] The earth is part of media both as a resource and as transmission. The earth conducts, also literally, forming a special part of the media and sound artistic circuitry.[6] It is the contested political earth that extends to being part of military "infrastructure": the earth hides political stakes and can be formed as part of military strategy and maneuvers.

The underground is addressed in this chapter through an investigation of deep time. Besides a geological concept, it has been adopted in media arts discussions by the German media (an)archaeologist and variantologist Siegfried Zielinski. However, in the context of the materiality of media, we need to ask, do we need more strongly to underline the geophysical aspects of this geology of media and deep time? Do we need to go underground, submerge, and dig out cables submarine and subterranean to understand further hidden depths of materiality of media?

And the Earth Screamed, Alive

What if your guide to the world of media would not be the usual suspect—an entrepreneur or evangelista from Silicon Valley or a management school scholar aspiring to catch up with the smooth crowd-sourced clouding of the network sphere? What if your guide would be Professor Challenger, the Arthur Conan Doyle character from the 1928 short story "When the World Screamed"? The story appeared in *Liberty* magazine and offered an odd insight into a mad scientist's world, with a hint of what we would nowadays call "speculative realism." Professor Challenger, whose dubious and slightly mad reputation preceded him, offered an insight into what later philosophers such as the French writing duo Gilles Deleuze and Félix Guattari happily picked up on: that the earth is alive and its crust is tingling with life. But the idea of the living earth has a long cultural history too: from antiquity, it persists as the idea of terra mater and, in the emerging mining cultures of the eighteenth and nineteenth centuries, becomes embedded as part of romantic philosophy; later, in the twentieth century, the emergence of Gaia theories brings a different connotation to the holistic life of the planet.

The narrative of geology and strata starts with a letter: an undated letter addressed to Mr. Peerless Jones, an expert in artesian drilling. The letter is a request for assistance. The nature of what is required is not specified, but the reputation of the mad scientist, the slightly volatile personality of Professor Challenger, promises that it would not be a normal operation. Escorted with suspicion and curiosity, it soon becomes evident that Mr. Jones's drilling expertise is needed. In Sussex, United Kingdom, at Hengist Down, Professor Challenger is engaged in a rather secret drilling operation, although it remains for a longer period unclear for what sort of a job the special drills are needed. Even the sort of material to be penetrated reveals only later to be different from what is usually expected when we speak of mining operations: not so much chalk or clay or the usual geological strata but more of a jellylike substance.

The professor had for a longer time drilled deeper and deeper through the earth's crust until he had finally ended up so deep so as to find a layer that pulsates like a living animal. He needed help and contacted Jones for the project that gradually had shifted from geology to something else. The earth is alive, and that this vitality can be proved with experimental means was actually the true objective of Challenger's mission. Instead of drilling and mining for petroleum, coal, copper, iron ore, and other valuables for which men usually dig holes in the ground, Challenger's mission is driven by a desire to prove a new speculative position that concerns the living depths of the earth: beyond the strata of "sallow lower chalk, the coffee-coloured Hastings beds, the lighter Ashburnham beds, the dark carboniferous clays, and . . . gleaning in the electric light, band after band of jet-black, sparkling coal alternative with the rings of clay,"[7] one finds the layers, which did not adhere to the classical geological theories of Hutton or Lyell. It seemed suddenly as if undeniable that even nonorganic matter is alive: "The throbs were not direct, but gave the impression of a gentle ripple or rhythm, which ran across the surface,"[8] Mr. Jones describes the deep surface they found. "The surface was not entirely homogenous but beneath it, seen as through ground glass, there were dim whitish patches or vacuoles, which varied constantly in shape and size."[9] The whole layers, the core and the strata, throbbed, pulsated, and animated. It should not even be necessary to go to similar lengths as Professor Challenger does, in one of the most bizarre rapelike scenes in literature, when he penetrates that jellyesque layer just to make the earth scream. This scientific sadism echoes in the ears of the audience and much further. It is the sound of "a thousand of sirens in one, paralyzing all the great multitude with its fierce insistence, and floating away through the still summer air until it went echoing along the whole South Coast and even reach our French neighbors across the Channel."[10] All this was observed and witnessed by an audience called by the professor—peers and interested international crowd, by invitation only.

The interest for "the bowels of the earth"[11] was not restricted to the writing of fiction and the vibrant language of Conan Doyle returning merely to the scientific discourse of geophysics. Professor Challenger was predated by nineteenth-century fiction characters, like Heinrich in Novalis's Heinrich von Ofterdingen (1800/1802) asking, "Is it possible that beneath our feet a world of its own is stirring in a great life?"[12] The poetic thrust toward the living, pulsating earth opened it up: for coal, for minerals, for precious material. Jules Verne's *Les Indes Noires* (1887; The Black Indies) told the story of an exhausted coal mine where, however, a new discovery is made, leading into a whole underground Coal Town.[13] Theories of the Hollow Earth might not have persisted except in popular fiction, but the idea of the underground artificial infinity—now as a seemingly infinite resource too—gained ground.[14]

The earth had become a resource. Metals and minerals were tightly linked to the emergence of modern engineering, science, and technical media. For instance, copper has been a crucial material feature of technical media culture since the nineteenth century. A lot of the early copper mines were, however, exhausted by the start of the twentieth century, leading into new demands both in terms of international reach and depth: new drills were needed for deeper mining, which was necessary to provide the materials for an increasing international need and systematic—and yet environmentally wasteful—use in wires and network culture. In addition, the increasing demand and international reach resulted in the cartelization

Figure 3. The underground became both a poetic and an engineered realm of technology, from romanticism to twentieth-century industrialization. The mines never disappeared but persist as effective geological scars even in advanced technological culture. Bingham Canyon copper mine in Utah, Rio Tinto, Kennecott Utah Copper Corp. Photograph by Spencer Musik.

of the copper business from mining to smelting.[15] Indeed, besides such contemporary contexts of mining where Challenger's madness starts to make sense, one is tempted to think of an imaginary of horrors of the underground from Lovecraft to Fritz Leiber. Leiber preempts a much more recent writer of the biopolitics of petroleum, Reza Negarestani, both highlighting the same theme: petroleum is a living subterranean life-form.[16] One should neither ignore the earth screams caused by hydraulic fracturing—fracking that, besides the promise that it might change the geopolitical balance of energy production, also points toward what is often neglected in the discourse of geopolitics, that is, *geos,* the earth, the soil, and the crust. By pumping pressurized water and chemicals underground, the procedure forces gas out from between rocks, forcing the earth to become an extended resource. Rocks fracture, benzene and formaldehyde creep in, and the planet is primed to such a condition to expose itself. Fracking is, in the words of Brett Neilson, perfectly tuned to the capitalist hyperbole of expansion beyond limits: "Whether it derives from the natural commons of earth, fire, air, and water or the networked commons of human cooperation, fracking creates an excess that can be tapped."[17]

Perhaps Professor Challenger's current versions are not found only in fiction either. Besides mining operations, such scientific missions as the Kola superdeep borehole in the ex–Soviet Union was such a hyperbolically sounding attempt that stayed true to the Challenger spirit. It held the depth record for a long while, at 12,262 meters. Scientists found in the early 1980s, after years of patiently, slowly drilling through the crust, an odd reality of geophysical phenomena, chemical surprises such as boiling hydrogen gas, and the sheer existence of water much deeper than expected in the rock minerals.[18]

Inside the earth one finds an odd chemical, rocky, and metallic reality, which feeds into metal metaphysics and digital devices. Besides the speculative stance, one can revert back to empirical material too. In short, of direct relevance to our current media technological situation is the reminder that according to year 2008 statistics, media materiality is very metallic: "36 percent of all tin, 25 percent of cobalt, 15 percent of palladium, 15 percent silver, 9 percent of gold, 2 percent of copper, and 1 percent of aluminum"[19] go annually to media technologies. We have shifted from being a society that until the mid-twentieth century was based on a very restricted list of materials ("wood, brick, iron, copper, gold, silver, and a few plastics"[20]) to the fact that even a computer chip is composed of "60 different elements."[21] Such lists of metals and materials of technology include critical materials, including rare earth minerals that are increasingly at the center of both global political controversies of tariffs and export restrictions from China. They are also related to the debates concerning the environmental damage caused by extensive open-pit mining massively reliant on chemical processes. Indeed, if the actual rock mined is likely to contain less than 1 percent of copper,[22] it means that the pressure is on the chemical processes of teasing out the Cu for further refined use in our technological devices.

The figures about metals of media seem astounding but testify to another materiality of technology that links with Conan Doyle but also with contemporary media arts discourse of the deep time of the earth. However, I will move on from Professor Challenger to Siegfried Zielinski, the German media studies professor, and his conceptualization of deep times of media art histories. In short, and what I shall elaborate in more detail soon, the figure of the deep time is for Zielinski a sort of a media archaeological gesture that, though borrowing from paleontology, actually turns out to be a riff to understanding the longer-term durations of art and science collaboration in Western and non-Western contexts. However, I want to argue that there is a need for a more literal understanding and mobilization of deep times—in terms of both depth and temporality—in media technological discourse and in relation to media art histories too. Professor Challenger is here to provide the necessary, even if slightly dubious, point about geological matter as living: this sort of a media history is of a speculative kind in terms of referring to a completely different time scale than usually engaged with in terms of our field. It borrows from the idea of dynamics of nonlinear history that Manuel Delanda so inspirationally mapped in terms of genes, language, and geology but which, in this case, can be approached even more provocatively as not just thousands but millions and billions of years of nonlinear stratified media history.[23] Media history conflates with earth history; the geological materials of metals and chemicals gets deterritorialized from their strata and reterritorialized in machines that define our technical media culture.

The extension of life to nonorganic processes follows from Deleuze and Guattari's philosophy. Life consists of dynamic patterns of variation and stratification. Stratification is a living double articulation that shows how geology is much more dynamic than just dead matter. This is obviously an allusion to the reading one finds in Deleuze and Guattari's *A Thousand Plateaus,* in which the whole philosophical stakes of this enterprise are revealed. The intensities of the earth, the flows of its dynamic unstable matter, are locked into strata. This process of locking and capture is called *stratification,* organizing the molecular nonorganic life into "molar aggregates."[24]

Hence, as a minor rhetorical question detouring via Deleuze and Guattari, what if we start our excavation of media technologies and digital culture not from Deleuze's so-well and often quoted "Postscript on the Societies of Control" text but from their joint texts on geology and stratification?[25] This is the implicit task of this chapter, with a focus on the emerging critical discourse of resource depletion, minerals, and the even harder materiality than just hardware. Hardware perspectives are not necessarily hard enough, and if we want to extend our material notions of media thoroughly toward deeper materialities and deeper times, we need to be able to talk of the nonmediatic matter that contributes to the assemblages and durations of media as technology. This comes out most clearly in two ways. First is the research and design, fabrication and standardization, of new materials that allow for mediatic and high-technology processes to emerge. This relates to history of chemistry as well as product development, aluminum and other synthetic materials that characterize modernity, alongside the work on material sciences that enabled so much of computer culture. Silicon and germanium are obvious examples of discoveries in chemistry that proved to be essential for computer culture. More recently, to take an illustrative example, the minuscule twenty-two-nanometer transistors that function without silicon are made of indium, gallium, and arsenid and demonstrate that a lot of science happens way before discursive wizardry of creative technology discourse. The MIT research project is allowing "evaporated indium, gallium, and arsenic atoms to react, forming a very thin crystal of InGaAs that will become the transistor's channel,"[26] a short quotation that suffices to narrativize that materiality of media starts much *before media become media.* Second, in a parallel fashion, we need to be able to discuss the media that are not *anymore* media. This is the other pole of media materiality that is less high tech and more defined by obsolescence:[27] the mined rare earth minerals essential to computers and in general advanced technology industries from entertainment to the military, as well as, for instance, the residue products from the processes of fabrication, like the minuscule aluminum dust residue released from polishing iPad cases to be desirably shiny for the consumer market[28] (see chapter 4).

An Ecology of Deep Time

Zielinski's notion of *Tiefenzeit,* deep time, is itself an attempt to pick up on the idea of geological times to guide the way in which we think of the humanities-focused topics of media arts and digital culture. Deep time carries a lot of conceptual gravity and is employed as a way to investigate the "Deep Time of Technical Means of Hearing and Seeing." Zielinski's approach kicks off as a critique of a teleological notion of media evolution that assumes a natural progress embedded in the narratives of the devices—a sort of a parasitical attachment, or insistence on the rationality of the machines and digital culture, that of course has had its fair share of critique in the past decades of media and cultural studies. We could call this "mythopoesis"[29] (to borrow a notion from a different context of the Ippolita group), which as a critical perspective, focuses on the narratives of and on technology as the site of political struggle. Zielinski's media archaeological and more so *anarchaeological* approach, however, hones in on geological time.

For Zielinski, earth times and geological durations become a theoretical strategy of resistance against the linear progress myths that impose a limited context for understanding technological change. They relate in parallel to the early modern discussions concerning the religious temporal order vis-à-vis the growing "evidence of immense qualitative geological changes"[30] that articulated the rift between some thousands of years of biblical time and the millions of years of earth history.

This deep temporality combined the spatial and temporal. Indeed, in James Hutton's *Theory of the Earth* from 1778, depth means time: under the layers of granite, you find further strata of slate signaling the existence of deep temporalities. Hutton is proposing a radical immensity of time, although it comes without a promise of change; all is predetermined as part of a bigger cycle of erosion and growth.[31] Despite his use of terms such as *continual succession* for time of the earth and its geological cycles discovered in its strata (the reading of strata, "stratigraphy"), time of immense durations does not, however, change in the historical fashion. More specifically, and in Hutton's words,

> the immense time necessarily required for this total destruction of the land, must not be opposed to that view of future events, which is indicated by the surest facts, and most approved principles. Time, which measures every thing in our idea, and is often deficient to our schemes, is to nature endless and as nothing; it cannot limit that by which alone it had existence; and, as the natural course of time, which to us seems infinite, cannot be bounded by any operation that may have an end, the progress of things upon this globe, that is, the course of nature, cannot be limited by time, which must proceed in a continual succession.[32]

Hutton continues to discuss and consider "the globe of this earth as a machine, constructed upon chemical as well as mechanical principles," as well as an organized body that proceeds through times of decay and repair. Hutton proposes a view and a theory of the earth as one of cycles and variations:

> His theory posited that the earth was constantly restoring itself. He based this concept on a fundamental cycle: erosion of the present land, followed by the deposition of eroded grains (or dead ocean organisms) on the sea floor, followed by the consolidation of those loose particles into sedimentary rock, followed by the raising of those rocks to form new land, followed by erosion of the new land, followed by a complete repeat of the cycle, over and over again. Hutton was also the first to recognize the profound importance of subterranean heat, the phenomenon that causes volcanoes, and he argued that it was the key to the uplifting of formerly submerged land.[33]

As becomes clear later, in Lyell's classic account of geology, this articulates a division in terms of the geological versus the historical.[34] For Lyell, Hutton's assumption of the cyclical deep times becomes a research tool to understand the radical temporality of the earth. Lyell was definitely interested in change in ways that did not pertain to Hutton,[35] but this historicity was still of a different order to that of the emerging history disciplines focused on the hermeneutic worlds of the human. The different sets of knowledge formations pertaining to the natural and to the moral are also the context for two different modes of temporal order. The time of the human concerns differs from the geological, which, however, is argued to be a radical dynamic force that affects life across the boundaries of the organic and the nonorganic. And yet it was a necessity to keep these separated, despite that modern institutions were increasingly interested in such durations that surpassed the human: geological and biological (in sciences of the evolution). In creative cultural theory, we have recently seen inspiring accounts that connect feminist ontology with

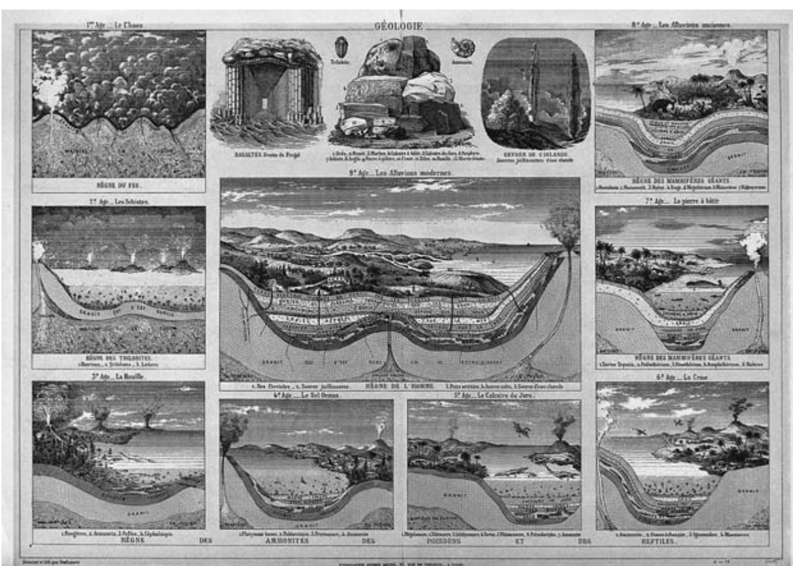

Figure 4. A lithograph featuring a visualization of geology through the ages of the earth and details of types of stone. Colored lithograph by Bethmont, 1911, after himself. Wellcome Library, London.

Charles Darwin's temporal ontology of open-ended becoming through evolution.[36]

Influential thinkers such as Rosi Braidotti have built on the Anthropocene discussions to connect it to a wider geocentric perspective, which prompts us to rethink fundamental notions of subjectivity, community, and political attachment. For Braidotti, the notion is, however, to be connected to ongoing struggles on the level of postcolonial and feminist agendas as well as avoiding technophobia and holistic, nostalgic fantasies of the earth. One could claim that some of the radicalization of the temporal ontology started with Hutton and Lyell already[37]—a time beyond biblical restrictions but tied to a view of a grand cycle that with Lyell led to the master trope of uniformitarianism.[38]

But neither Hutton's nor Lyell's theory is a stable ground for a more radical and nonlinear account of time for contemporary cultural and media theory. Indeed, it might have displaced biblical time but introduced the earth in an odd way almost as if a transcendent entity outside historical change. Hutton's worldview was deistic, and for him the world was a perfectly designed machine.[39] Hutton's geological world is also without change and difference and works in cyclical temporeality.[40] It is no wonder, then, as Simon Schaffer points out, that Hutton's account inspired Adam Smith's ideas concerning the invisible hand of capitalism in the emerging industrial system.[41] Both seemed to believe in universal laws governing the empirical world. The embedded cyclicality, of course, offers a fruitful view to erosions and renewals. For Zielinski, geological metaphors offer a way to investigate technological culture, but for Hutton, the planet *is* a machine. It is, however, one modeled according to the steam engines of his age, primarily the Newcomen engine, which, in its principles of expansion of steam, also gives the idea of elevation of the crust directly to inspire Hutton.[42] This machine is also one of organic unity and cyclical renewal, which feeds off the heat at its core.[43]

Such ideas inspired various visualizations of the deep time of the earth that machinates through the life-enabling media of the soil. The deeper strata and their remaining layers, including fossils, signal time as well: the planet is structured according to a depth of the temporal past. These layers structure animal and human life but also the industrial system of production and the technological culture of human civilization.

But this is exactly where Zielinski also departs. Paradoxically, the inspiration of Hutton (and one should remember that he was only one of the geotheorists working on this topic in his time) goes both toward the universalizing and standardizing logic of the industrial factory system and toward Zielinski's exactly opposite account of variantology that, however, finds a different tune with Stephen Jay Gould. Indeed, through Gould, Zielinski is able to carve out a more detailed account of what the geological idea affords to media art history and media analysis as variantology.

To achieve this, Zielinski has to turn from Hutton to more contemporary readings of geology and paleontology. Zielinski picks up on Gould's paleontological explanations and ideas that emphasize the notion of variation. It is in Gould's *Time's Arrow, Time's Cycle* that Zielinski finds a suitable account for a critique of progress in media culture. As a reader of Gould, Zielinski notes that the quantifying notion of deep time is itself renewed with a qualitative characteristic that produces a critique of myths of progress, which present a linear imagination of the world. Both discover the necessity to abandon divinity from the cosmological picture, whether one of the earth or the media. Instead, one has to develop such images, metaphors, and iconography that do not reproduce illusions of linear progress "from lower to higher, from simple to complex."[44] A resurging emphasis on diversity takes the place of the too neatly stacked historical layers.

Without going too much into the geologic debates, we need to understand how Gould's note itself is based on his arguments against uniformitarianism. Gould's argument for the "punctuated equilibrium" is targeted against the false assumption of continuity of a uniform evolution that persisted in the various geological and evolutionary accounts for a long time. It includes Lyell's views as much as Darwin's beliefs.[45] The series of arguments and academic discussion Gould started together with his cowriter Niles Eldredge stems from the early 1970s and included, besides a new way of approaching the fossil record, also a different sort of an understanding of the temporal ontology of geology.[46] In short, against the view that one can read a slow evolutionary change from the geological records, which at times are with gaps and missing parts, one has to approach this "archive" in a different way. This imaginary starts already in the nineteenth century: processes of transmission and recording are already present in the earth itself, a vast library waiting to be deciphered.[47] However, the idea of punctuated equilibrium suggested that instead of the constant uniform speed of change and evolution, the fossil record might show different speeds of changes: from slow to sudden jolts. The processes of speciation and variation are not necessarily one speed only but more of a multitemporal mix with singular points that punctuate the evolution in specific ways.

Already this short elaboration reveals the wider scientific stakes in Gould and Eldredge's account that was to offer a different theoretical understanding of time in geology. For Zielinski, this enabled a way to understand media archaeology as related to a notion of deep times of the ways in which we modify, manipulate, create, and re-create means of hearing and seeing. Zielinski introduces inspirational deep times of apparatuses, ideas, and solutions for mediatic desires that take inventors as the gravity point. He himself admits this approach as being even romantic and focused paradoxically on human heroes. It includes figures such as Empedocles (of four elements fame), Athanasius Kircher, and, for instance, the operatic dreams of Joseph Chudy and his early audiovisual telegraph system from the late eighteenth century (he composed a one-act opera on the topic, *The Telegraph or the Tele-Typewriter*). It also includes the opium-fueled media desires of Jan Evangelista Purkyne, a Czech from the early nineteenth century in the habit of using his own body for various drug- and electricity-based experiments to see how the body itself is a creative medium. What we encounter are variations that define an alternative deep time strata of our media culture outside the mainstream. It offers the anarchaeology of surprises and differences, of the uneven in the media cultural past revealing a different aspect of a possible future. Zielinski's project is parallel to imaginations of "archaeologies of the future"[48] that push us actively to invent other futures.

Zielinski's methodology offers a curious paradox in terms of the general paleontological framing. The deep time metaphor acts as a passage to map different times and spaces of media art history. Even the term connotes the darker underground of hidden fluxes that surface only irregularly to give a taste of the underbelly of a deep media history.[49] They offer variation in the sense Zielinski is after in media variantology: media do not progress from simple to complex, there are no blueprints for prediction, and we need to steer clear of the "psychopathia medialis" of standardization and find points of variation to promote diversity. This is not meant to signal conservation but active diversification as tactics of a living cultural heritage of technological pasts in the present-futures.[50]

In any case, though this is fascinating, I would carefully suggest picking up on the more concrete geological implications of Zielinski's metaphorics. With a theoretical hard hat on, I wonder if there is actually more to be found in this use of the notion of deep time both as temporality and geological materiality. Perhaps this renewed use is what offers a variation that attaches the concepts back to discussions concerning media materialism and the political geology of contemporary media culture reliant on the metals and minerals of the earth. Hence the earth time gradually systematized by Hutton and other geotheorists of his period sustains the media time in which we are interested. In other words, the heat engine cosmology of earth times that Hutton provides as a starting point for a media art historical theory of later times is one that also implicitly contains other aspects we need to reemphasize in the context of the Anthropocene: the machine of the earth is one that lives of its energy sources, in a similar way that our media devices and political economy of digital culture are dependent on energy (cloud computing is still to a large extent powered by carbon emission–heavy energy production[51]) and materials (metals, minerals, and a long list of refined and synthetic components). The earth is a machine of variation, and media can live off variation—but both are machines that need energy and are tied together in their dynamic feedback loop. Electronic waste is one of the examples of the ways in which media feed back to the earth history and future fossil times.

The main question that Zielinski's argument raises is this: besides the media variantological account concerning the design of apparatuses, users, desires, expressions, and different ways of processing the social order and means of seeing and hearing, there is this other deep time too. This sort of an alternative is more literal in the sense of returning to the geological stratifications and a Professor Challenger type of an excavation deeper into the living ground. The geological interest since the eighteenth and nineteenth centuries produced what was later coined "deep time," but we need to be able to understand that a new mapping of geology and the earth's resources was the political economic function of this emerging epistemology. This is where the archaeological and geological interests of knowledge reveal the other sides of the deep times as exposing the earth as part of new connections. Indeed, the knowledge of the planet through geological specimens (demonstrated, for instance, in Diderot and D'Alembert's "Mineral Loads or Veins and Their Bearings" in volume 6 of *l'Éncylopedie,* 1768) and its newly understood history meant a new relation between aesthetics and the sciences. This link is also beneficial for new ways of extracting value: "As a result of eighteenth-century archeological and antiquarian activities, the earth acquired a new perceptual depth, facilitating the conceptualization of the natural as immanent history, and of the earth's materials as resources that could be extracted just like archeological artifacts."[52]

The media theoretical deep time divides into two related directions:

1. Geology refers to the affordances that enable digital media to exist as a materially complex and politically economically mediated realm of production and process: a metallic materiality that links the earth to the media technological.
2. Temporalities such as deep time are understood in this alternative account as concretely linked to the nonhuman earth times of decay and renewal but also to the current Anthropocene of the obscenities of the ecocrisis—or to put it in one word, the *Anthrobscene.*

Deep temporalities[53] expand to media theoretical trajectories: such ideas and practices force media theory outside the usual scope of media studies to look at the wider milieu in which media materially and politically become media in the first place. This relates to Peters's speculative question about cosmology, science, and media, which turns into a short historical mapping of how astronomy and geology can be understood as media disciplines of sort.[54] Continuing Peters's idea, we can further elaborate geophysics as degree zero of media technological culture. It allows media to take place and has to carry their environmental load. Hence this geology of media perspective expands to the earth and its resources. It summons a media ecology of the nonorganic, and it picks up from Matthew Fuller's notes on "media ecology as a cascade of parasites"[55] as well as an "affordance," but itself afforded by a range of processes and techniques that involve the continuum of the biological-technological-geological.

A Media History of Matter: From Scrap Metal to Zombie Media

Throughout this book, I am interested in alternative accounts of how to talk about materiality of media technology. One aspect, with again a concrete ecological edge to it, is the acknowledgment of the growing waste problem resulting from discarded media technologies. And another aspect relates to energy and power: for example, cloud computing is still rather dependent on nonrenewable energy with heavy CO_2 emissions.[56] Indeed, what I want to map as the alternative deep time relates to geology in the fundamental sense of the Anthropocene. Crutzen's original pitch offered it as a transversal map across various domains: from nitrogen fertilizers in the soil to nitric oxide in the air; carbon dioxide and the condition of the oceans; photochemical smog to global warming. Already Crutzen had initiated the expansive way of understanding the Anthropocene to be more than about geology. In Crutzen's initiating definitions, it turned into a concept investigating the radical transformations in the living conditions of the planet.

The Anthropocene can be said to be—in the way the German media philosopher Erich Hörl suggests referring to Deleuze—a concept that maps the scope of a transdisciplinary problem. So what is the problem? Hörl's suggestion is important.[57] He elaborates the Anthropocene as a concept that responds to specific questions posed by the technological situation. It is about the environmental aspects but completely tied to the technological: the concept as well as its object are enframed by technological conditions to which we should be able to develop a further elaborated insight with the humanities tools and conceptual arsenal. Indeed, this is where a geology of media offers the necessary support as a conceptual bridge between the materials of chemical and metallic kind and the political economy and cultural impact of media technologies as part of the ongoing global digital economy discourses.

The concept of the Anthropocene becomes radically environmental. It does not mean purely a reference to "nature" but an environmentality understood and defined by the "technological condition."[58] The environmental expands from a focus on the natural ecology to an entanglement with technological questions, notions of subjectivity and agency (as a critique of a human-centered worldview), and a critique of such accounts of rationality that are unable to talk about nonhumans as constitutive of social relations. The Anthropocene is a way to demonstrate that geology does not refer exclusively to the ground under our feet. It is constitutive of social and technological relations and environmental and ecological realities. Geology is deterritorialized in the concrete ways that metal and minerals become themselves mobile, enabling technological mobility: Benjamin Bratton's words could not be any more apt when he writes how we carry small pieces of Africa in our pockets, referring to the role, for instance, of coltan in digital media technologies[59] and when the visual artist Paglen sees the geo-orbital layers of satellite debris as outer reaches of earth's geology and the Anthropocene (*The Last Pictures* project; see chapter 5).

Besides Africa, iPhones are, in the words of *mammolith,* an architectural research and design platform, "geological extracts" drawing from the planet's resources and supported by a multiplicity of infrastructures. The geological bits you carry around are not restricted to samples of Africa but include the material from Red Dog pit mine in Alaska, from where zinc ore is extracted and refined into indium in Trail, Canada. But that's only a small part of it all, and such sites where material turns gradually closer to media are "scattered across the globe in the aforementioned countries, as well as South Korea, Belgium, Russia, and Peru."[60] An analysis of dead media should also take into account this aspect of the earth and its relation to global logistics and production.

More concretely, let's focus for a while on China as a territory part of the global chains of production and abandonment of media technologies. This geopolitical China is not solely about the international politics of trade and labor, which are not to be dismissed from the picture. However, we need to be able to think about the *geos* in this geopolitics too: the soil, the earth, the waste. In a sense, we can focus on the material production of what then ends up as the massive set of consumer gadgets and the future fossil record for a robot media archaeologist (see chapter 5 on future fossils of media culture), but also as discarded waste: both electronic waste and in general scrap metals, necessary for the booming urban building projects and industrial growth.

Adam Minter's journalistic report *Junkyard Planet* offers a different story of hard metals and work and looks at the issue from the perspective of geology of scrap metals.[61] China is one of the key destinations not only for electronic waste but for scrap metals in general, offering a different insight to the circulation of what we still could call geology of technologies. China's demand for materials is huge. Part of the country's continuing major construction projects from buildings to subways to airports was the need to be able to produce—or reprocess—more metals: scrap copper, aluminum, steel, and so on:

> On the other side of the mall, in all directions, are dozens of new high-rises—all under construction—that weren't visible from the subway and my walk. Those new towers reach 20 and 30 stories, and they're covered in windows that require aluminum frames, filled with bathrooms accessorized with brass and zinc fixtures, stocked with stainless steel appliances, and—for the tech-savvy households—outfitted with iPhones and iPads assembled with aluminum backs. No surprise, China leads the world in the consumption of steel, copper, aluminum, lead, stainless steel, gold, silver, palladium, zinc, platinum, rare earth compounds, and pretty much anything else labeled "metal." But China is desperately short of metal resources of its own. For example, in 2012 China produced 5.6 million tons of copper, of which 2.75 million tons was made from scrap. Of that scrap copper, 70 percent was imported, with most coming from the United States. In other words, just under half of China's copper supply is imported as scrap metal. That's not a trivial matter: Copper, more than any other metal, is essential to modern life. It is the means by which we transmit power and information.

The wider picture of technological culture is not restricted to worried comments about the rare earth minerals essential to iPhones. The bigger picture becomes clear when we realize the extent to which, by the phase technical media end up disused, they reveal their geology. The material history of media—for instance, telecommunications—extends to the copper extracted from the wires, removing the outer covers to find this mini-mine of valuable media materials. The history of mining of copper, with its environmentally dangerous effects, is extended to the re-mining from wires for the repurposing of supposedly dead objects. One could say, following Minter's narrative, that such a technological history of materials and material history of media as matter does not really follow the logic of from life of use to death of disuse, but in places such as Foshan's Nanhai District, technologies and media materials never die: it is the place where scrap metal gets processed.[62] So despite networking infrastructure having gradually abandoned copper for materials such as extruded glass or plastic to compensate for the informationally lossy metals, the latter have not entirely disappeared in the lighter, glass-based, "transparent" cloud computing culture.

In "Zombie Media" (see the Appendix), with Garnet Hertz, we address the wider context and impact of the "dead media" that refuse to disappear from the planetary existence.[63] It's the heavier residue of metal technological communication media culture. Building on Sterling's work, we argue that there is a need to account for the undead nature of obsolete media technologies and devices in at least two ways: to be able to remember that media never die but remain as toxic waste residue, and also that we should be able to repurpose and reuse solutions in new ways, as, for instance, circuit bending and hardware hacking practices imply. The zombie media angle builds on two contexts not specific to digital media but present in such accounts as Goldberg's and the wider micropolitical stance that ties consumer desires with design practices. Planned obsolescence is one such feature art/hacking projects combining hardware hacking and circuit bending, such as Benjamin Gaulon's Recyclism, critically highlight as a persistent feature of contemporary design of technological objects and systems. Similarly, such approaches take into account the current issue of abandoned hardware, which even in functional devices reaches amounts of hundreds of millions of screens, mobiles, and electronic and computing technologies that still are not properly dealt with after their use. A couple of years' old U.S. Environmental Protection Agency statistics talk of 2.37 tons of electronics ready for their afterlife management, which represented "an increase of more than 120 percent compared to 1999."[64] The primary category is related to screen technologies, but we can safely assume that the rise of mobile technologies would soon contribute a rather big share of this dead media pile, of which only 25 percent was collected for any sort of actual management and recycling in 2009. The amount of operational electronics discarded annually is one sort of geologically significant pile that entangles first, second, and third nature:[65] the communicational vectors of advanced digital technologies come with a rather direct link to and impact on first natures, reminding that the contemporary reliance on swift communicational transactions is reliant on this aspect of hardware too. Communicational events are sustained by the broader aspects of geology of media. They include technologies abandoned and consisting of hazardous material: lead, cadmium, mercury, barium, and so on.

National, supranational, and nongovernmental organizational bodies are increasingly forced to think the future of media and information technologies as something "below the turf." This means both a focus on the policies and practices of e-waste as one of the crucial areas of concern and planning toward raw material extraction and logistics to ensure supply. As the preceding short mention of scrap metal China illustrated,

Figure 5. The April 2014 excavation in Alamogordo, New Mexico, of the 1983 abandoned and buried Atari games became a widely publicized form of "media archaeology," with connotations relating it to the much bigger problem of dumping electronic waste and the residuals of game and electronic culture in heaps of rubbish. Photograph by Taylor Hatmaker.

the usual practices of mining are not considered the only route for a future geology of media. In any case, the future geo(physical)politics of media circulate around China, Russia, Brazil, Congo, and, for instance, South Africa as key producers of raw materials. It connects to a realization that the materiality of information technology starts from the soil and the underground. Miles and miles of crust opened up in drilling. This depth marks the passage from the mediasphere to the lithosphere. An increasing amount of critical materials are found only by going down deeper into the crust or otherwise difficult-to-reach areas. Offshore oil drilling is an example, in some cases in rather peculiar circumstances and depths: the Tupi deposits of oil off the coast of Brazil, beneath one and a half miles of water and another two and a half miles of compressed salt, sand, and rock;[66] new methods of penetrating rocks, fracturing them, or of steam-assisted cavity drainage; deep sea mining by countries such as China; and the list could be continued. Corporations such as Chevron boast with mining depth records—tens of thousands of feet under the ocean bottom[67]—in search for oil and minerals. Suddenly an image comes to mind, one familiar from an earlier part of this chapter: Professor Challenger's quest to dig deeper inside the living crust that is alive.

Depth becomes not only an index of time but also a resource in the fundamental sense of Martin Heidegger's standing-reserve: technology reveals nature in ways that can turn it into a resource. For Heidegger, the writer of trees, rivers, and forest paths, the River Rhein turns from Hölderlin's poetic object into a technological construct effected in the assemblage of the new hydroelectric plant. The question of energy becomes a way of defining the river and, in Heideggerian terms, transforming it:

> The revealing that rules throughout modern technology has the character of a setting-upon, in the sense of a challenging-forth. That challenging happens in that the energy concealed in nature is unlocked, what is unlocked is transformed, what is transformed is stored up, what is stored up is, in turn, distributed, and what is distributed is switched about ever anew. Unlocking, transforming, storing, distributing, and switching about are ways of revealing.[68]

This notion of transformation becomes a central way to understand the technological assemblages in which metals and minerals are mobilized as part of technological and media contexts. Technology constructs such new pragmatic and epistemological realms where geology turns into a media resource. And similarly, geology itself transforms into a contested technologically conditioned object of research and a concept that we are able to use to understand the widespread mobilization of nature. It also transforms issues of deep times from a merely temporal question of pasts to one of futures of extinction, pollution, and resource depletion, triggering a huge chain of events and interlinked questions: the future landscape of media technological fossils (see chapter 5).

This transformation of geology of media, and media of geology/metals, works in a couple of directions. Theorists, policy makers, and even politicians are increasingly aware of the necessity of cobalt, gallium, indium, tantalum, and other metals and minerals for media technological ends, from end-user devices like mobiles and game consoles to capacitors, displays, batteries, and so forth. In short, the geophysics of media consists of examples such as the following:

cobalt: (used for) lithium-ion batteries, synthetic fuels
gallium: thin layer photovoltaics, IC, WLED
indium: displays, thin layer photovoltaics
tantalum: microcapacitors, medical technology
antimony: ATO, microcapacitors
platinum: fuel cells, catalysts
palladium: catalysts, seawater desalination
niobium: microcapacitors, ferroalloys
neodymium: permanent magnets, laser technology
germanium: fiber-optic cable, IR optical technologies[69]

Moments of deep time are exposed in such instances as Clemens Winkler's 1885–86 discovery of germanium (named, of course, after his home country) and being able to distinguish it from antimony.[70] Winkler's discovery in Freiberg sits as a part of history of chemistry and elements for sure, but it also initiates insights into computer culture, where the semiconducting capacities of this specific alloy were in tough competition with what we now consider a key part of our computer culture: silicon. But such deep times are also telling a story of the underground that is not to be confused with discourse of underground art and activism, as we so often revert back to in media art historical discourse. This new definition of media deep time is more in tune with mining and transportation, of raw material logistics and processing and refining of metals and minerals. The underground haunts the military imaginary and reality through the geography of bunkers, guerrilla trenches, and passages (such as the Vietcong) as well as the nuclear silos that are burrowed into the landscapes of the United States, for instance;[71] it haunts the technological reality of modernity. The underground has since the nineteenth century at least been the site of an imaginary of technological future, as Rosalind Williams demonstrates,[72] but it is also the actual site of technological production.

To reiterate the argument of the chapter, the extensively long historical durations of deep time in the manner introduced to media art discussions by Zielinski take place in antique times, with medieval alchemists, and in nineteenth-century science–art collaborations as exemplary events of deep time media artistic techniques and ideas. But what if we need to account for an alternative deep time that extends more deeply toward a geophysics of media culture? This is a possibility not to be missed: an alternative media history of matter. Such extends the historical interest in alchemists to contemporary mining practices, minerals, and the subsequent materialities. Would this sort of an approach be something that is comfortable to tackle with materiality below the ground level,[73] stretched into a continuum between political economy of resources and art practices (as we see in the next chapter in more detail)?

The geology of media that nods toward Zielinski but wants to extend deep times toward chemical and metal durations includes a wide range of examples of refined minerals, metals, and chemicals that are essential for media technologies to operate in the often audiovisual and often miniaturized mobile form, as we have grown to expect as end users of content. A usual focus on Understanding Media is complemented with the duration of materials as significant for media temporality. Hence media history of matter as well is in its own way another aspect of the geological deep time.[74]

The interactions of chemicals, material sciences, and technical media were never really forgotten in such accounts as Kittler's. His media historical insights were often aware that material sciences and discoveries have a grounding role in terms of enabling not only media technologies but also military operations. Hence his attention to such details as a blockade of Chilean nitrate to Germany[75] by the telegraphically effective British naval troops in World War I unravels as a story the geopolitical importance of sodium nitrate mining in Chile, the necessary substitute of synthetic ammoniac by the German chemical innovation of Haber and Bosch, needed for munitions production. Technologies are matters of war and logistics, which are ways to mobilize the particular Kittler perspective to a media history of matter:

> For over a century, wars and technologies have dreamed of being ahead of their day. In reality, however, they are forced to engage in recursions that burrow into ever deeper pasts. Lack of nitrate scuttled Alfred von Schlieffen's ingenious plan of attack. Just as up-to-date computer design is steadily closing in on the big bang, the logistics of war (irrespective of wishful ecological thinking) consume ever-older resources. The Second World War began with the switch from coal and railroads to tank oil and airplane fuel, the Pax Americana with the exploration of uranium (in Germany, the task was assigned to Hans-Martin Schleyer).[76]

In this chemical conjunction, history of fertilizers meets history of war and technological culture. The thousands of years of cultural techniques of manipulating the soil for purposes of agriculture reach one sort of a singular point by World War I but also show how histories of the Anthropocene entangle with war and technology, where only the latter have been discussed in media theory and history. But in this context, as already hinted at some points earlier, the chemical constitution of technological culture is not to be neglected. Industrialization becomes a point of synchronization of the various lineages of cultural techniques. The agricultural metaphor of "culturing" is in the scientific age part of the development of chemical means of manipulation of the soil. The soil can be made fertile, and the history of the geological impact of humans is also about the isolation of ingredients such as phosphorus (1669), nitrogen (1772), potassium (1807), and, later, nitrogen. The years constitute recent events in the nonlinear history of the earth becoming adapted to technical cultural history. The technical–scientific ties together with the Anthrobscene too:

"The arrival of industrialization, ushering in the Anthropocene, is marked by the human ability to move vast quantities of geologic material."[77]

Nation-states and their media-supported wars are themselves fueled by material explorations and, to put it simply, energy. But these are wars with a punctuated imbalance. As Sean Cubitt notes, much of contemporary geological resource hunt and energy race is conditioned by neocolonial arrangements: their targets are in territories traditionally belonging to indigenous people and "geological resources are sourced in lands previously deemed worthless and therefore earmarked as reservations for displaced indigenous peoples during the period of European imperial expansion from the 18th to the 20th centuries."[78] This is a good way of demonstrating that, in some ways, contemporary states—and corporations—are still obscenely modern in their manner of operations. Eviction, massacre, and conquering are part of the normal repository of actions allowed in guaranteeing resources, as Geoffrey Winthrop-Young writes.[79]

Oil is the usual reference point for a critical evaluation of earth fossils, modern technological culture, and the link between nation-state and corporate interests in exploiting cheap labor and seemingly cheap resources. But of course, it is not the only one. Other materials are also moved on an increasingly massive level and as an important function in the militarily secured energy regimes of the globe. Genealogies of logistics, media, and warfare are particularly "Kittlerian," even if what is missing from his media materialism is often the theme of labor. Indeed, instead of merely war, we could as justifiably track down genealogies of media materials to labor processes, exploitation, and dangerous conditions that characterize also the current persistence of *hard work* alongside persistence of *hardware*[80] (see chapter 4). Perhaps these two are better indexes of digital culture than software creativity or immaterial labor.

Conclusions: Cultural Techniques of Material Media

In Thomas Pynchon's *Against the Day* (2006), a novel set before the digital and more focused on the modulation and standardization of processes of light for the use of technical media such as photography, one gets a sense of the chemistry of media. Pynchon's status as part of a theoretical mapping of history of media and technology has become consolidated ever since *Gravity's Rainbow* (1973) tied together war, technology, and a weird narrative mix of paranoia, conspiracy, and mental states. The V-2 rocket motivated insights into technology, and science as an essential part of power relations inspired Kittler and a range of other scholars in Germany and internationally. In *Against the Day,* the theme is similar, but with a focus on light, optics, and chemistry, where especially the latter is what connects to our need to understand media history through its materials. It is an account that persists from the early histories of photography, such as geologist–photographer W. Jerome Harrison's *History of Photography* (1887), which, if you read it through the perspective of geology of media, becomes a story of chemicals instead of merely the inventor–experimenters such as Niepce, Daguerre, or Talbot: bitumen (in lithography); tin or, for instance, iodide; lactates and nitrates of silver; carbon processes; uranium nitrates; and chlorides of gold.[81] The history of technical media is constantly being reenacted in different ways in contemporary media arts. For photochemical artists, getting their hands dirty with gelatin and silver nitrates, this is part of the artistic methodology infused in chemistry: cyanotypes' aesthetic effect comes down to chemicals (ammonium iron [III] citrate and potassium ferricyanide). A film artist with a media archaeological bent knows the amount of combination needed in testing and experimenting with chemicals or materials.[82] But this knowledge is more of the sort a metallurgist might hold than a scientist: experimentation in dosage and practice-based learning of the materials' characteristics.[83]

In Pynchon's own version of media materialism and optical media, the list of objects constitutes a sort of a pre–media technological media materialism, a list of voluntary or involuntary participants in the process of technical imaging circa the nineteenth century:

> After going through all the possible silver compounds, Merle moved on to salts of gold, platinum, copper, nickel, uranium, molybdenum, and antimony, abandoning metallic compounds after a while for resins, squashed bugs, coal-tar dyes, cigar smokes, wildflower extracts, urine from various critters including himself, reinvesting what little money came in from portrait work into lenses, filters, glass plates, enlarging machines, so that soon the wagon was just a damn rolling photography lab.[84]

Besides the object worlds with which the narrative continues—a world a speculative realist might call "flat,"[85] including a litany from humans to lampposts to trolley dynamos and flush toilets—so much has already happened on the level of chemical reactions. In other words, the media devices are not the only aspects of "materialism," but we are as interested in questions of what enables and sustains media to become media.

In this sort of perspective of deep time geologies and chemistries of media, one cannot avoid at least a brief mention of the long history of alchemy. Isn't it exactly the lineage of alchemy that is of relevance here? It has meant imbuing a special force to the natural elements and their mixes, from base to precious: from realgar, sulfur, white arsenic, cinnabar, and especially mercury to gold, lead, copper, silver, and iron.[86] The history of alchemy is steeped in poetic narratives that present their own versions of sort of deep times (e.g., in pre-Christian Chinese alchemy[87]) as well as occupying a position between arts and sciences.[88] In a way, as Newman notes, alchemy prepared much of later technological culture in its own experimental way. Developers included a variety of such cases: Avicenna with his *De congelatione* (at one point mistaken for a writing by Aristotle) and scholastic writers such as Vincent of Beauvais, Albertus Magnus, and Roger Bacon are main examples of early-thirteenth-century practitioners. In Vincent's *Speculum doctrinale,* written between 1244 and 1250, one gets a sense of alchemy as a "science of minerals," a sort of practice-based excavation into their transmutational qualities. In Vincent's words, alchemy "is properly the art of transmuting mineral bodies, such as metals and the like, from their own species to others."[89]

In *Against the Day,* Pynchon presents his own condensed narrative prose lineage from alchemy to modern chemistry and technical media. According to his way of crystallizing the chemistry of technological culture, this transformation in knowledge and practices of materials corresponds to the birth of capitalism, which is characterized by a regularization of processes of material reaction and metamorphosis. In *Against the Day,* a dialogue between two characters, Merle and Webb, reveals something important about this turning point from alchemy to modern science:

> "But if you look at the history, modern chemistry only starts coming in to replace alchemy around the same time capitalism really gets going. Strange, eh? What do you make of that?"

> Webb nodded agreeably. "Maybe capitalism decided it didn't need the old magic anymore." An emphasis whose contempt was not meant to escape Merle's attention. "Why bother? Had their own magic, doin just fine, thanks, instead of turning lead into gold, they could take poor people's sweat and turn into greenbacks, and save that lead for enforcement purposes."[90]

What Pynchon brings into play in this admittedly short quotation is labor. Besides media histories of matter, such issues link up with histories of exploitation and capture of surplus value. Indeed, besides a material history of media before it becomes media, Pynchon is able to highlight the magical nature of the commodity production related to the novel forms of "alchemy": the new magic explicated by Marx as the fetish of the object hiding the material forces of its production is characteristic of this aspect, which is usually defined as the material history understood as a history of labor and political economy. However, we need also to understand the technological and the media elements in this mix, which also returns to the issue of geology, the earth.

In short, techniques of experimenting with different reactions and combinations of elements and materials are also media practices. Our screen technologies, cables, networks, technical means of seeing and hearing, are partly results of meticulous—and sometimes just purely accidental—experimentation with how materials work: what works, what doesn't, whether you are talking of materials for insulation, conduction, projection, or recording. The sciences and the arts often share this attitude of experimentation and the experiment—to make the geos expressive and transformative. The transistor-based information technology culture would not be thinkable without the various meticulous insights into the material characteristics and differences between germanium and silicon—or the energetic regimes—whether that involves the consideration of current clouds (as in server farms) or the attempts to manage power consumption inside computer architectures.[91] Issues of energy are ones of geophysics too—both in the sense of climate change accelerated by the still continuing heavy reliance on polluting forms of nonrenewable energy production and through the various chemicals, metals, and metalloids such as germanium and silicon, media cultural aftereffects of the geological strata. That is also where a deep time of the planet is inside our machines, crystallized as part of the contemporary political economy: material histories of labor and the planet are entangled in devices, which, however, unfold as part of planetary histories. Data mining might be a leading hype term for our digital age of the moment, but it is enabled only by the sort of mining that we associate with the ground and its ungrounding. Digital culture starts in the depths and deep times of the planet. Sadly, this story is most often more obscene than something to be celebrated with awe.

In the next chapter, we turn to crystallization as well as continue on the topic of aesthetics of the geophysics, or, more accurately, the psychogeophysical method of mapping relations of the earth, capitalism, and technology.