NOTES

Preface

1 Charles Lyell, *Principles of Geology* (London: John Murray, 1830), 1. Online facsimile at http://www.esp.org/books/lyell/principles/facsimile/.

2 Michael T. Klare, *The Race for What's Left: The Global Scramble for the World's Last Resources* (New York: Metropolitan Books, 2012), 29.

3 Ibid.

4 Karl Marx and Friedrich Engels, *The Communist Manifesto* (London: Pluto Press, 2008), 40.

5 Bruno Latour, *An Inquiry into Modes of Existence: An Anthropology of the Moderns,* trans. Catherine Porter (Cambridge, Mass.: Harvard University Press, 2013), 10.

6 "As we have seen, man has reacted upon organized and inorganic nature, and thereby modified, if not determined, the material structure of his earthly home. The measure of that reaction manifestly constitutes a very important element in the appreciation of the relations between mind and matter, as well as in the discussion of many purely physical problems." George Perkins Marsh, *Man and Nature: Physical Geography as Modified by Human Action* (New York: Charles Scribner, 1865), 8.

7 Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, Mass.: MIT Press, 2010).

8 Antonio Stoppani, "First Period of the Anthropozoic Era," trans. Valeria Federighi, ed. Etienne Turpin and Valeria Federighi, in *Making the Geologic Now: Responses to the Material Conditions of Contemporary Life,* ed. Elizabeth Ellsworth and Jamie Kruse (New York: Punctum, 2013), 38.

1. Materiality

1 Sean Cubitt, *The Practice of Light: A Genealogy of Visual Technologies from Prints to Pixels* (Cambridge, Mass.: MIT Press, 2014), 2. To quote Cubitt in full: "Mediation is the ground of relationship, the relationship that precedes and constructs subjects and objects. Media matter, both in the sense of giving material specificity to our descriptions of such abstract concepts as society and environment, and in the sense of the active verb: mediation comes into being as matter, its mattering constitutes the knowable, experienceable world, making possible all sensing and being sensed, knowing and being known."

2 As Geoffrey Winthrop-Young aptly notes, the term *German media theory* is an outsider construct. See Winthrop-Young, "Krautrock, Heidegger, Bogeyman: Kittler in the Anglosphere," *Thesis Eleven* 107, no. 1 (2011): 6–20.

3 Friedrich Kittler, *Discourse Networks 1800/1900,* trans. Michael Metteer with Chris Cullens (Stanford, Calif.: Stanford University Press, 1990).

4 John Durham Peters, "Space, Time and Communication Theory," *Canadian Journal of Communication* 28, no. 4 (2003), http://www.cjc-online.ca/index.php/journal/article/view/1389/1467. See also Sean Cubitt, *Digital Aesthetics* (London: Sage, 1998). Cubitt's recent book, an utterly important one, *The Practice of Light,* focuses especially on the modulations of light becoming media.

5 Douglas Kahn, *Earth Sound Earth Signal: Energies and Earth Magnitude in the Arts* (Berkeley: University of California Press, 2013), 23. See also Sean Cubitt, "Current Screens," in *Imagery in the 21st Century,* ed. Oliver Grau with Thomas Veigl, 21–35 (Cambridge, Mass.: MIT Press, 2011).

6 Klare, *Race for What's Left,* 152.

7 Robert Smithson, "A Sedimentation of the Mind: Earth Projects" (1968), in *Robert Smithson: The Collected Writings,* ed. Jack Flam (Berkeley: University of California Press, 1996), 101.

8 See also Kahn, *Earth Sound Earth Signal.*

9 The current mission of the agency is described as follows: "The [U.S. Geological Survey] serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life." http://www.usgs.gov/.

10 James Risen, "U.S. Identifies Vast Mineral Riches in Afghanistan," *New York Times,* June 13, 2010. For a short history of the U.S. Geological Survey, see

Mary C. Rabbitt, "The United States Geological Survey 1879–1989," U.S. Geological Survey Circular 1050, http://pubs.usgs.gov/circ/c1050/index.htm.

11 Siegfried Zielinski, *Deep Time of the Media,* trans. Gloria Custance (Cambridge, Mass.: MIT Press, 2006).

12 See also Timothy Morton, *Hyperobjects: Philosophy and Ecology after the End of the World* (Minneapolis: University of Minnesota Press, 2013).

13 On media archaeology, see Erkki Huhtamo and Jussi Parikka, eds., *Media Archaeology: Approaches, Applications, and Implications* (Berkeley: University of California Press, 2011). Jussi Parikka, *What Is Media Archaeology?* (Cambridge: Polity, 2012). In addition, the cultural techniques approach, pioneered by the likes of Bernhard Siegert, flags media analysis in relation to technologies of knowledge and discourse operators. Siegert, "Cultural Techniques: Or the End of the Intellectual Post War Era in German Media Theory," trans. Geoffrey-Winthrop Young, *Theory, Culture, and Society* 30, no. 6 (2013): 50.

14 Wolfgang Ernst, "From Media History to Zeitkritik," trans. Guido Schenkel, *Theory, Culture, and Society* 30, no. 6 (2013): 134–35.

15 Wolfgang Ernst, *Digital Memory and the Archive,* ed. Jussi Parikka (Minneapolis: University of Minnesota Press, 2013), 71.

16 Kittler argues that since Aristotle, there has been an ontological neglect of "media." For Aristotle, it was not part of the ontological sphere (reserved for things), which excluded "medium": *tòmetaxú* "is relegated to his theory of sensorial perception *(aisthesis).*" Friedrich Kittler, "Toward an Ontology of Media," *Theory, Culture, and Society* 26, nos. 2–3 (2009): 24.

17 Trevor Paglen, "The Last Pictures," *Journal of Visual Culture* 12, no. 3 (2013): 508–14.

18 Kahn, *Earth Sound Earth Signal,* 107, 146.

19 Friedrich Kittler, "Lightning and Series—Event and Thunder," *Theory, Culture, and Society* 23, nos. 7–8 (2006): 69.

20 "We no longer needed electronic music studios; we already had them in our brains." Oliveros, as quoted in Kahn, *Earth Sound Earth Signal,* 175.

21 Elizabeth Grosz, *Chaos, Territory, Art: Deleuze and the Framing of the Earth* (New York: University of Columbia Press, 2008).

22 Kahn, *Earth Sound Earth Signal,* 177.

23 Theodore Ziolkowski, *German Romanticism and Its Institutions* (Princeton, N.J.: Princeton University Press, 1990), 28–29.

24 Fortey, as quoted in Ian W. D. Dalel, "Vestiges of a Beginning and the Prospect of an End," in *James Hutton—Present and Future,* ed. G. Y. Craig and J. H. Hull (London: Geological Society Special Publications, 1999), 150.

25 Dalel, "Vestiges of a Beginning," 122–23.

26 John Shimkus, "Mining Helium-3 Will Transform the Dark Side of the Moon," May 9, 2011, http://www.energydigital.com/global_mining/mining-helium-3-will-transform-dark-side-of-the-moon.

27 "Russia will begin Moon colonization in 2030—a draft space program," May 9, 2013, http://rt.com/news/157800-russia-moon-colonization-plan/.

28 Cubitt, *Digital Aesthetics,* 45–49.

29 Bruce Clarke, "Gaia Matters," *Electronic Book Review,* November 30, 2006, http://www.electronicbookreview.com/thread/criticalecologies/looped.

30 Martin Heidegger, *The Question Concerning Technology and Other Essays,* trans. William Lovitt (New York: Garland, 1977), 17.

31 Samih Al Rawashdeh and Bassam Saleh et Mufeed Hamzah, "The Use of Remote Sensing Technology in Geological Investigation and Mineral Detection in El Azraq-Jordan," *Cybergeo–European Journal of Geography,* October 23, 2006, http://cybergeo.revues.org/2856.

32 Eyal Weizman, Heather Davis, and Etienne Turpin, "Matters of Calculation: Eyal Weizman in Conversation with Heather Davis and Etienne Turpin," in *Architecture in the Anthropocene: Encounters among Design, Deep Time, Science, and Philosophy,* ed. Etienne Turpin (Ann Arbor, Mich.: Open Humanities Press, 2013), 64.

33 See Edwards, *Vast Machine.*

34 Kahn, *Earth Sound Earth Signal,* 157.

35 For Kittler, the phonograph and in general the technical media of sound recording tap into the Lacanian Real. See Friedrich Kittler, *Gramophone, Film, Typewriter,* trans. Geoffrey Winthrop-Young and Michael Wutz (Stanford, Calif.: Stanford University Press, 1999).

36 Donna Haraway draws from the work of ethnographer Marilyn Strathern in this formulation that resonates with the emphasis on cross-species connections across a range of micropractices, interfaces, relationality: "Marilyn Strathern, drawing on decades of study of Papua New Guinean histories and politics, as well as on her investigation of English kin reckoning habits, taught us why conceiving of 'nature' and 'culture' as either polar opposites or universal categories is foolish. An ethnographer of relational categories, she showed how to think in other topologies. Instead of opposites, we get the whole sketchpad of the modern geometrician's fevered brain with which to draw relationality. Strathern thinks in terms of 'partial connections'; i.e., patterns within which the players are neither wholes nor parts. I call these the relations of significant otherness. To think of Strathern as an ethnographer of naturecultures; she will not mind if I invite her into the kennel for a

cross-species conversation." Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Otherness* (Chicago: Prickly Paradigm Press, 2003), 9. On "medianatures," see also Jussi Parikka, "Media Zoology and Waste Management: Animal Energies and Medianatures," *Necsus–European Journal of Media Studies,* no. 4 (2013), http://www.necsus-ejms.org/.

37 Haraway, *Companion Species Manifesto,* 12.

38 Rick Dolphjin and Iris van der Tuin, *New Materialism: Interviews and Cartographies* (Ann Arbor, Mich.: Open Humanities Press, 2012), 90. Of course, one can argue, to quote Scott McQuire, that "defining the technological activates the border between nature and culture." McQuire, "Technology," *Theory, Culture, and Society* 23, nos. 2–3 (2006): 252. And at the same time, technology also is based on the crossing of the border between the two.

39 Sean Cubitt, interviewed by Simon Mills, *Framed,* http://www.ada.net.nz/library/framed-sean-cubitt/.

40 See Colin Dickey, "Review of *Why Hell Stinks of Sulfur: Mythology and Geology of the Underworld,*" *Los Angeles Review of Books,* July 14, 2013, https://lareviewofbooks.org/.

41 See Rosalind Williams, *Notes on the Underground: Essays on Technology, Society, and the Imagination,* new ed. (Cambridge, Mass.: MIT Press, 2008).

42 Tarde's short novel was originally published in 1904 as *Fragment d'histoire future* (Fragment of a history of future).

43 Williams, *Notes on the Underground,* 81.

44 Lewis Mumford, *Technics and Civilization* (1934; reprint, Chicago: University of Chicago Press, 2010), 228–29.

45 Paul J. Crutzen, "Geology of Mankind: The Anthropocene," *Nature* 415, no. 3 (2002): 23.

46 The International Commission on Stratigraphy should reach a decision on the formal acceptance of the designation by 2016.

47 The "obscenity" of the Anthropocene can be read as an ethical qualification of the term to underline the role of corporations and nation-states in a systemic exploitation of work and natural resources. The Anthrobscene is executed through engineered, scientific, and, for example, legislative means. But it has also implicit connotations to the ontological shift that Jean Baudrillard writes as the *ob-scene.* Even if the link to Baudrillard is not the engine for this concept, there is an element of obscene exposure and exploitative visuality that produces nature as a resource. On Baudrillard, see Paul Taylor, "Baudrillard's Resistance to the Ob-Scene as the Mis-en-Scene (Or, Refusing to Think Like a Lap-Dancer's Client)," *International Journal of Baudrillard Studies* 5, no. 2 (2008), http://www.ubishops.ca/baudrillardstudies/vol-5_2/

v5–2-taylor.html. In *The Geology of Media,* however, this implosion happens on the level of the material ob-scene: the myths of immateriality support the engineered depletion of crucial resources, energy crisis, and the corporate mobilization of the earth as part of the circuit of medianatures. The *pornographic* is evident primarily in the manner in which nature–ecology is viewed as a corporate resource, exposed down to its molecular intensities. The obscene is both a mode of exploitation and an epistemological framework. However, I want to underline that there should be no nostalgic longing for a connection of the earth in the mythological or Heideggerian sense but rather in a different sense of ecosophic relation across the spheres of economic, social, and environmental engineering and production.

48 Will Steffen, Paul J. Crutzen, and John R. McNeill, "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?," *Ambio* 36, no. 8 (2007): 615.

49 See Mumford, *Technics and Civilization,* 232–33.

50 Steffen et al., "The Anthropocene," 616.

51 Crutzen, "Geology of Mankind," 23.

52 John McNeill, *Something New under the Sun: An Environmental History of the Twentieth-Century World* (New York: W. W. Norton, 2000), 52.

53 Steffen et al., "The Anthropocene," 616.

54 McNeill, *Something New under the Sun.*

55 Dipesh Chakrabarty, "The Climate of History: Four Theses," *Critical Inquiry* 35 (Winter 2009): 206–7.

56 Ibid., 219.

57 In the manner Félix Guattari uses and introduces the terms alongside "mixed semiotics" of material intensities and signifying structures entangled. For an elaboration, see Gary Genosko, *Félix Guattari: An Aberrant Introduction* (London: Continuum, 2002), 169–71.

58 A crisis demands a temporal framework that is able to premediate futures, even changing them: modeling climate change, for instance, is based on the hope that if we take such predictions seriously, we might be able to stop them from becoming true, to paraphrase Wendy Hui Kyong Chun. Chun, "Crisis, Crisis, Crisis, or Sovereignty and Networks," *Theory, Culture, and Society* 28, no. 6 (2011): 107.

59 See Mieke Bal, *Travelling Concepts in the Humanities* (Toronto: Toronto University Press, 2002).

60 See also Rosi Braidotti, *The Posthuman* (Cambridge: Polity, 2013).

61 Gilles Deleuze and Félix Guattari, *A Thousand Plateaus,* trans. Brian Massumi (Minneapolis: University of Minnesota Press, 1987), especially chapter 3.

Eric Alliez, *The Signature of the World: What Is Deleuze and Guattari's Philosophy?,* trans. Eliot Ross Albert and Alberto Toscano (New York: Continuum, 2004), 25.

62 Gilles Deleuze and Félix Guattari, *What Is Philosophy?,* trans. Hugh Tomlinson and Graham Burchell (London: Verso, 2009), 85.

63 See Matthew Fuller, *Media Ecologies: Materialist Energies in Art and Technoculture* (Cambridge, Mass.: MIT Press, 2005). See also Michael Goddard and Jussi Parikka, eds., "Unnatural Ecologies," special issue, *Fibreculture,* no. 17 (2011), http://seventeen.fibreculturejournal.org/.

64 Asko Nivala, "The Chemical Age: Presenting History with Metaphors," in *They Do Things Differently There: Essays on Cultural History,* ed. Bruce Johnson and Harri Kiiskinen, 81–108 (Turku: Turku, 2011).

65 Theodore Ziolkowski, *German Romanticism and Its Institutions* (Princeton, N.J.: Princeton University Press, 1990). See chapter 2 on mining in that book.

66 Ben Woodard, *On an Ungrounded Earth: Towards a New Geophilosophy* (New York: Punctum Books, 2013). Iain Hamilton Grant, *Philosophies of Nature after Schelling* (London: Continuum, 2006). Reza Negarestani, "Undercover Softness: An Introduction to the Architecture and Politics of Decay," *COLLAPSE VI: Geo/Philosophy,* January 2010, 382.

67 Iain Hamilton Grant, "Mining Conditions," in *The Speculative Turn: Continental Materialism and Realism,* ed. Levi Bryant, Nick Srnicek, and Graham Harman (Melbourne: re.press, 2010), 44.

68 This ungrounding and constituent exhumation is picked up by Reza Negarestani too: "If archeologists, cultists, worms and crawling entities almost always undertake an act of exhumation (surfaces, tombs, cosmic comers, dreams, etc.), it is because exhumation is equal to ungrounding, incapacitating surfaces ability to operate according to topologies of the whole, or on a mereotopological level. In exhumation, the distribution of surfaces is thoroughly undermined and the movements associated with them are derailed; the edge no longer belongs to the periphery, anterior surfaces come after all other surfaces, layers of strata are displaced and perforated, peripheries and the last protecting surfaces become the very conductors of invasion. Exhumation is defined as a collapse and trauma introduced to the solid part by vermiculate activities; it is the body of solidity replaced by the full body of trauma. As in disinterment—scarring the hot and cold surfaces of a grave—exhumation proliferates surfaces through each other. Exhumation transmutes architectures into excessive scarring processes, fibroses of tissues, membranes and surfaces of the solid body." Negarestani, *Cyclonopedia: Complicity with Anonymous Materials* (Melbourne: re.press, 2008), 51–52. It would

be interesting to extend and develop Zielinski's methodology of deep time and variantology of media in connection with such notes by geophilosophers from Woodard to Grant to Negarestani.

69 Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham, N.C.: Duke University Press, 2010). Manuel Delanda, *Deleuze: History and Science* (New York: Atropos Press, 2010). Dolphjin and van der Tuin, *New Materialism.*

70 Deleuze and Guattari, *A Thousand Plateaus,* 372. "*There are itinerant, ambulant sciences that consist in following a flow in a vectorial field across which singularities are scattered like so many 'accidents.'*"

71 Bennett, *Vibrant Matter,* 58–60.

72 Ibid., 60.

73 Andrew Blum, *Tubes: A Journey to the Center of the Internet* (New York: HarperCollins, 2012), 258.

74 Ibid., 260.

75 Ibid.

76 Ibid., 259.

77 Mumford, *Technics and Civilization,* 229.

78 Ibid., 231.

79 And also increasingly an artistic and curatorial mapping. A good example is *The Oil Show* exhibition at HKMW, Dortmund (November 12, 2011, to February 19, 2012), curated by Inke Arns. See also Mumford, *Technics and Civilization,* 232–33.

80 For a good journalistic mapping of the issues of resources and geopolitics, see Klare, *Race for What's Left.*

81 Sean Cubitt's work-in-progress book project *Ecomediations* addresses these issues in detail. See also Cubitt, "Electric Light and Energy," *Theory, Culture, and Society* 30, nos. 7–8 (2013): 309–23.

2. An Alternative Deep Time of the Media

1 Seb Franklin, "Cloud Control, or the Network as a Medium," *Cultural Politics* 8, no. 3 (2012): 443–64.

2 See Ippolita, *The Dark Side of Google,* trans. Patrice Riemens (Amsterdam: Institute of Network Cultures), 2013, http://networkcultures.org/wpmu/portal/publication/no-13-the-dark-side-of-google-ippolita/.

3 "What the N.S.A. Wants in Brazil," *The New Yorker,* July 24, 2013, http://www.newyorker.com/online/blogs/newsdesk/2013/07/why-the-nsa-really-cares-about-brazil.html.

4 Williams, *Notes on the Underground,* 72.

5 On sea cables and infrastructural (in)visibility, see Nicole Starosielski, "'Warning: Do Not Dig': Negotiating the Visibility of Critical Infrastructures," *Journal of Visual Culture* 11, no. 1 (2012): 38–57. See also Ryan Bishop, "Project 'Transparent Earth' and the Autoscope of Aerial Targeting: The Visual Geopolitics of the Underground," *Theory, Culture, and Society* 28, nos. 7–8 (2011): 270–86. Williams, *Notes on the Underground.*

6 Kahn, *Earth Sound Earth Signal.*

7 Arthur Conan Doyle, "When the World Screamed," 1928, http://www.classic-literature.co.uk/scottish-authors/arthur-conan-doyle/when-the-world-screamed/ebook-page-10.asp.

8 Ibid. The idea of a living earth was part of an imaginary of the earth and technology, but one has to note that far until the late nineteenth century, the nature of the earth's interior was much debated. As Williams argues, the likes of prominent geologists such as Archibald Geikie listed various possibilities of what lies under the crust; the theories of the Hollow Earth might have been discarded a long time ago, but whether there is a liquid substratum under the crust was still left as a possibility. Williams, *Notes on the Underground,* 14.

9 Doyle, "When the World Screamed."

10 Ibid. The allusion to rape is made even more obvious when considering the long-term mythological articulation of the earth with the female. The gendered interior of the earth is one of valuable richness. Steven Connor, *Dumbstruck: A Cultural History of Ventriloquism* (Oxford: Oxford University Press, 2000), 52.

11 Doyle, "When the World Screamed."

12 Novalis, as quoted in Ziolkowski, *German Romanticism and Its Institutions,* 31.

13 Williams, *Notes on the Underground,* 11. As I won't deal with literature and geology in a systematic way in this short book, I want to point readers interested in the narrativization of geology in the nineteenth century to Adelene Buckland, *Novel Science: Fiction and the Invention of Nineteenth Century Geology* (Chicago: University of Chicago Press, 2013).

14 Williams, *Notes on the Underground,* 90–91.

15 Richard Maxwell and Toby Miller, *Greening the Media* (Oxford: Oxford University Press, 2012), 55.

16 Fritz Leiber, "The Black Gondolier," in *The Black Gondolier and Other Stories* (n.p., 2002). Negarestani, *Cyclonopedia.* Eugene Thacker, "Black Infinity, or, Oil Discovers Humans," in *Leper Creativity,* 173–80 (New York: Punctum, 2012).

17 Brett Neilson, "Fracking," in *Depletion Design,* ed. Carolin Wiedemann and Soenke Zehle (Amsterdam: Institute of Network Cultures and xm:lab, 2012), 85.

18 Kola superdeep borehole, http://en.wikipedia.org/wiki/Kola_Superdeep_Borehole. Larry Gedney, "The World's Deepest Hole," *Alaska Science Forum,* July 15, 1985, http://www2.gi.alaska.edu/ScienceForum/ASF7/725.html. The drilling operation proved some geophysical theories from the 1920s inaccurate and discovered other oddities in old ages of depth: "The Kola well has now penetrated about halfway through the crust of the Baltic continental shield, exposing rocks 2.7 billion years old at the bottom (for comparison, the Vishnu schist at the bottom of the Grand Canyon dates to about 2 billion years—the earth itself is about 4.6 billion years old). To scientists, one of the more fascinating findings to emerge from this well is that the change in seismic velocities was not found at a boundary marking Jeffreys' hypothetical transition from granite to basalt; it was at the bottom of a layer of metamorphic rock (rock which has been intensively reworked by heat and pressure) that extended from about 3 to about 6 miles beneath the surface. This rock had been thoroughly fractured and was saturated with water, and free water should not be found at these depths! This could only mean that water which had originally been a part of the chemical composition of the rock minerals themselves (as contrasted with ground water) had been forced out of the crystals and prevented from rising by an overlying cap of impermeable rock. This has never been observed anywhere else."

19 Maxwell and Miller, *Greening the Media,* 93.

20 T. E. Graedel, E. M. Harper, N. T. Nassar, and Barbara K. Reck, "On the Materials Basis of Modern Society," *PNAS,* October 2013, Early Edition, 1.

21 Ibid. See also Akshat Raksi, "The Metals in Your Smartphone May Be Irreplaceable," *Ars Technica,* December 5, 2013, http://arstechnica.com/science/2013/12/the-metals-in-your-smartphone-may-be-irreplaceable/.

22 Brett Milligan, "Space-Time Vertigo," in *Making the Geologic Now: Responses to the Material Conditions of Contemporary Life,* ed. Elizabeth Ellsworth and Jamie Kruse (New York: Punctum, 2013), 124.

23 Manuel Delanda, *A Thousand Years of Nonlinear History* (New York: Swerve/MIT Press, 2000). Delanda's argument for a geological approach to human history stems from an understanding of self-organization as the general drive on how matter and energy are distributed. In this way, he is able to argue provocatively that "human societies are very much like lava flows" (55), referring to the certain nonlinear patterns of organization. In addition, he does a good job illuminating the historical character in which there is an

extensive continuum between geological formations and what we tend to call human history, for instance, of urbanity. Indeed, the processes of mineralization some five hundred million years ago give rise to the endoskeleton and materiality of the bone affecting the processes crucial for the birth of humans (and a range of other specific types of bony organic life), as well as later affording a range of other processes. Indeed, Delanda talks of the exoskeleton of urban cities as being afforded by this same process and tracks how metals play their part in the formation of urban centralization and clustering. We could in this vein argue that the processes of mineralization extend to the current computer age too, in terms of how the sedimented but deterritorializing layers of geological time are affording a further exoskeleton—an argument that has its implicit resonances with the way in which, for instance, Bernard Stiegler has pitched the various externalizations of human memory, leaning on Husserl and Simondon.

24 Deleuze and Guattari, *A Thousand Plateaus,* 40. They are adamant in emphasizing that this is not about substance and form (the hylomorphic model persistent in philosophy), the dualism usually haunting the linguistically modeled idea of meaning. Instead, they want to introduce a geologically driven idea of the materiality of signification, including asignifying elements. The double nature of the articulation is expressed as follows: "The first articulation chooses or deducts, from unstable particle-flows, metastable molecular or quasi-molecular units *(substances)* upon which it imposes a statistical order of connections and successions *(forms).* The second articulation establishes functional, compact, stable structures *(forms),* and constructs the molar compounds in which these structures are simultaneously actualized *(substances).* In a geological stratum, for example, the first articulation is the process of 'sedimentation,' which deposits units of cyclic sediment according to a statistical order: flysch, with its succession of sandstone and schist. The second articulation is the 'folding' that sets up a stable functional structure and effects the passage from sediment to sedimentary rock" (40–41). A good and necessary philosophical reading of the geological is Ben Woodard's *On an Ungrounded Earth.* It offers a critique and expansion of the Deleuze–Guattari perspective.

25 In short, in *A Thousand Plateaus,* Deleuze and Guattari pitch the idea of a geology of morals (a reference to Nietzsche) as illuminating an idea of stratification as a double articulation. The previous endnote clarified this aspect. Such a process is not, however, restricted to geology, but it allows Deleuze and Guattari to talk of a geology of morals. In my further development, geology of media is besides a philosophical figure and a nod toward *A Thousand*

Plateaus, an emerging perspective of the careful selection and sedimentation of certain material elements necessary for the consolidation of functional media technologies. Such technologies express continua between nature and culture, or what I have called *medianatures,* which often signal themselves through ecological implications or, to be frank, problems—energy production, waste, and so forth. For Delanda, the Deleuze and Guattari geological model provides a new materialism of stratification that as an abstract machine runs across various materialities: "sedimentary rocks, species and social classes (and other institutionalized hierarchies) are all historical constructions, the product of definite structure-generating processes that take as their starting point a heterogeneous collection of raw materials (pebbles, genes, roles), homogenize them through a sorting operation, and then consolidate the resulting uniform groupings into a more permanent state." Delanda, *A Thousand Years of Nonlinear History,* 62. Furthermore, the link between Smithson's in other places in this book mentioned "abstract geology" and Deleuze and Guattari's thought (including Bateson) is an interesting theme to elaborate, but it is out of my reach in this short book.

26 Sebastian Anthony, "MIT Creates Tiny, 22nm Transistor without Silicon," *Extremetech,* December 11, 2012, http://www.extremetech.com/extreme/143024-mit-creates-tiny-22nm-transistor-without-silicon.

27 See Wiedemann and Zehle, eds., *Depletion Design* (Amsterdam: Institute of Network Cultures and xm:lab, 2012).

28 Jussi Parikka, "Dust and Exhaustion: The Labor of Media Materialism," *Ctheory,* October 2, 2013, http://www.ctheory.net/articles.aspx?id=726.

29 Ippolita and Tiziana Mancinelli, "The Facebook Aquarium: Freedom in a Profile," in *Unlike Us Reader: Social Media Monopolies and Their Alternatives,* ed. Geert Lovink and Miriam Rasch (Amsterdam: Institute of Network Cultures, 2013), 164.

30 Zielinski, *Deep Time of the Media,* 3.

31 Stephen Jay Gould, *Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time* (Cambridge, Mass.: Harvard University Press, 1987), 86–91.

32 James Hutton, *Theory of the Earth,* e-version on Project Gutenberg, (1792) 2004, http://www.gutenberg.org/files/12861/12861-h/12861-h.htm.

33 Jack Repchek, *The Man Who Invented Time: James Hutton and the Discovery of Earth's Antiquity* (New York: Basic Books, 2009), 8.

34 Charles Lyell, *Principles of Geology* (London: John Murray, 1830), 1–4. Online facsimile at http://www.esp.org/books/lyell/principles/facsimile/.

35 Gould, *Time's Arrow, Time's Cycle,* 167, 150–55.

36 Elizabeth Grosz, *Becoming Undone: Darwinian Reflections on Life, Politics, and Art* (Durham, N.C.: Duke University Press, 2011).

37 See Repchek, *Man Who Invented Time.* Repchek's account posits Hutton as an important discoverer, but some of this discourse focusing on the originality of Hutton neglects earlier geological research that is not always pertaining to a Christian worldview of limited biblical proportions. Furthermore, the invention of modern time in historiography follows slightly differing paths, opening up the idea of an open, radically different future. See Reinhart Koselleck, *Futures Past: On the Semantics of Historical Time,* trans. Keith Tribe (New York: Columbia University Press, 2004), 240–43.

38 Gould, *Time's Arrow, Time's Cycle.*

39 Martin J. S. Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: University of Chicago Press, 2005), 160. Hutton's world does not allow for the accidental but remains in the natural theological view of an orderly universe.

40 Gould, *Time's Arrow, Time's Cycle,* 87.

41 Simon Schaffer, "Babbage's Intelligence," http://www.imaginaryfutures.net/2007/04/16/babbages-intelligence-by-simon-schaffer/.

42 Rudwick, *Bursting the Limits of Time,* 161.

43 Ibid., 159–62.

44 Zielinski, *Deep Time of the Media,* 5.

45 Stephen Jay Gould, *Punctuated Equilibrium* (Cambridge, Mass.: Harvard University Press, 2007), 10.

46 Niles Eldredge and Stephen Jay Gould, "Punctuated Equilibria: An Alternative to Phyletic Gradualism," in *Models in Paleobiology,* ed. T. J. M. Schopf (San Francisco: Freeman Cooper, 1972), 82–115.

47 Peters, "Space, Time, and Communication Theory."

48 Fredric Jameson, *Archaeologies of the Future* (London: Verso, 2005).

49 See Alexander R. Galloway, Eugene Thacker, and McKenzie Wark, *Excommunication: Three Inquiries in Media and Mediation* (Chicago: Chicago University Press, 2013), 139.

50 Zielinski has continued these discussions in the Variantology book series as well as in the recently translated *[. . . After the Media],* trans. Gloria Custance (Minneapolis, Minn.: Univocal, 2013).

51 The figures as to exactly how much network computing and data centers consume varies a lot, as does the dependence on carbon emission–heavy energy. Peter W. Huber, "Dig More Coal, the PCs Are Coming," *Forbes,* May 31, 1999. Duncan Clark and Mike Berners-Lee, "What's the Carbon Footprint

of . . . the Internet?," *The Guardian,* August 12, 2010, http://www.theguardian.com/. Seán O' Halloran, "The Internet Power Drain," *Business Spectator,* September 6, 2012, http://www.businessspectator.com.au/article/2012/9/6/technology/internet-power-drain.

52 Amy Catania Kulper, "Architecture's Lapidarium," in *Architecture in the Anthropocene: Encounters among Design, Deep Time, Science, and Philosophy,* ed. Etienne Turpin (Ann Arbor, Mich.: Open Humanities Press, 2013), 100. Lewis Mumford's technological reading of mines is also important; it underlines them as the site of crystallization of a specific early phase of modern technology. "*The mine is nothing less in fact than the concrete model of the conceptual world which was built up by the physicists of the seventeenth century.*" Quoted in Williams, *Notes on the Underground,* 22.

53 Recent media and cultural theory has, in most interesting ways, picked up the notion of temporality again. In media archaeology, such a desire has resonated with a non-narrative- and non-human-based understanding of temporalities—for instance, microtemporality (Wolfgang Ernst). For Ernst, microtemporalities define the ontological basis of how media as reality production works in speeds inaccessible by the human senses. See Wolfgang Ernst, *Chronopoetik: Zeitweisen und Zeitgaben technischer Medien* (Berlin: Kadmos, 2013). See also Ernst, "From Media History to Zeitkritik," trans. Guido Schenkel, *Theory, Culture, and Society* 30, no. 6 (2013): 132–46. Similarly Mark Hansen's recent work has flagged the need to embed media theoretical vocabulary in a different regime of sensation than the conscious perception. In Hansen's Whitehead-inspired perspective, the limitations of phenomenology are explicated so as to find a sufficiently developed approach that helps to address the current ubiquitous digital media culture and the speeds at which it folds as part of the human, without being accessible through human senses. See Mark B. N. Hansen, *Feed Forward: On the Future of the Twenty-First Century Media* (Chicago: University of Chicago Press, 2014). At the other scale, the duration of climatic and geological time scales has to be addressed. Besides this book on geology, see, for instance, Claire Colebrook on extinction and the weird temporalities of nature and knowledge of nature. Colebrook, "Framing the End of Species," in *Extinction: Living Books about Life* (Ann Arbor, Mich.: Open Humanities Press, 2011), http://www.livingbooksaboutlife.org/books/Extinction/Introduction.

54 Peters, "Space, Time, and Communication Theory."

55 Fuller, *Media Ecologies,* 174.

56 Sean Cubitt, Robert Hassan, and Ingrid Volkmer, "Does Cloud Computing Have a Silver Lining?," *Media, Culture, and Society* 33 (2011): 149–58.

57 Paul Feigelfeld, "From the Anthropocene to the Neo-Cybernetic Underground: An Conversation with Erich Hörl," *Modern Weekly,* Fall/Winter 2013, online English version at http://www.60pages.com/from-the-anthropocene-to-the-neo-cybernetic-underground-a-conversation-with-erich-horl-2/.

58 Ibid.

59 Benjamin Bratton, *The Stack* (Cambridge, Mass.: MIT Press, forthcoming); Michael Nest, *Coltan* (Cambridge: Polity, 2011).

60 Rob Holmes, "A Preliminary Atlas of Gizmo Landscapes," *Mammolith,* April 1, 2010, http://m.ammoth.us/blog/2010/04/a-preliminary-atlas-of-gizmo-landscapes/.

61 For a specific focus on scrap metals, technology, and China, see Adam Minter, "How China Profits from Our Junk," *The Atlantic,* November 1, 2013, http://www.theatlantic.com/china/archive/2013/11/how-china-profits-from-our-junk/281044/. On the life cycle of metals as part of technological society, see Graedel et al., "On the Materials Basis of Modern Society."

62 Ibid.

63 Garnet Hertz and Jussi Parikka, "Zombie Media: Circuit Bending Media Archaeology into an Art Method," *Leonardo* 45, no. 5 (2012): 424–30.

64 U.S. Environmental Protection Agency, "Statistics on the Management of Used and End-of-Life Electronics," 2009, http://www.epa.gov/osw/conserve/materials/ecycling/manage.htm.

65 McKenzie Wark, "Escape from the Dual Empire," *Rhizomes* 6 (Spring 2003), http://www.rhizomes.net/issue6/wark.htm.

66 Klare, *Race for What's Left,* 12.

67 "Chevron Announces Discovery in the Deepest Well Drilled in the U.S. Gulf of Mexico," press release, December 20, 2005, http://investor.chevron.com/. Currently the deepest wells are located on the Al Shaheen Oil Field, offshore in the middle of the Persian Gulf (12,290 meters) and offshore the Sakhalin Island, on the Okhotsk Sea, reaching the depth of 12,376 meters. The latter project was executed by Exxon Neftegas Ltd.

68 Heidegger, *Question Concerning Technology,* 16.

69 European Union Critical Raw Materials Analysis, by the European Commission Raw Materials Supply Group, July 30, 2010, executive summary by Swiss Metal Assets, October 1, 2011, http://www.swissmetalassets.com.

70 Clemens Winkler, "Germanium, Ge, ein neues, nichtmetallisches Element," *Berichte der deutschen chemischen Gesellschaft* 19 (1886): 210–11.

71 See Ryan Bishop, "Project 'Transparent Earth' and the Autoscopy of Aerial Targeting: The Visual Geopolitics of the Underground," *Theory, Culture, and Society* 28, nos. 7–8 (2011): 270–86.

72 Williams, *Notes on the Underground.*

73 One could speculate that such theory is definitely "*low* theory," to refer to McKenzie Wark's notion in *Telesthesia: Communication, Culture, and Class* (Cambridge: Polity, 2012), 12.

74 Jonathan Sterne has also raised the need for a deep time perspective, without using those terms: "if the span of media history in human history amounts to approximately 40,000 years, we have yet to really seriously reconsider the first 39,400 years." Jonathan Sterne, "The Times of Communication History," presented at Connections: The Future of Media Studies, University of Virginia, April 4, 2009.

75 Friedrich Kittler, "Of States and Their Terrorists," *Cultural Politics* 8, no. 3 (2012): 388. See also the University of Brighton project "Traces of Nitrate: Mining History and Photography between Britain and Chile," funded by the AHRC. Online at http://arts.brighton.ac.uk/projects/traces-of-nitrate.

76 Kittler, "Of States and Their Terrorists," 394.

77 Chris Taylor, "Fertilising Earthworks," in Ellsworth and Kruse, *Making the Geologic Now,* 130.

78 Sean Cubitt, "Integral Waste," presented at the transmediale 2014 Afterglow festival, Berlin, February 1, 2014.

79 Geoffrey Winthrop-Young, "Hunting a Whale of a State: Kittler and His Terrorists," *Cultural Politics* 8, no. 3 (2012): 406. He continues with a reference to Pynchon's words about World War II in *Gravity's Rainbow* (New York: Viking, 1973), perhaps a relevant guideline to the wider issue of media, materiality, ideology, and wars: "This War was never political at all, the politics was all theatre, all just to keep the people distracted . . . secretly, it was being dictated instead by the needs of technology. . . . The real crises were crises of allocation and priority, not among firms—it was only staged to look that way—but among the different Technologies, Plastics, Electronics, Aircraft, and their needs which are understood only by the ruling elite." Ibid., 407.

80 iMine game, http://i-mine.org/. See also Parikka, "Dust and Exhaustion."

81 William Jerome Harrison, *History of Photography* (New York: Scovill Manufacturing Company, 1887). What makes Harrison even more interesting for our purposes is his career in geology. See Adam Bobbette, "Episodes from the History of Scalelessness: William Jerome Harrison and Geological Photography," in Turpin, *Architecture in the Anthropocene,* 45–58.

82 Thank you to Kelly Egan for sharing the autoethnographic account of her artistic practice with films and chemicals.

83 Jane Bennett uses this conceptual figure, borrowed from Deleuze and Guattari, as well. See Bennett, *Vibrant Matter,* 58–60.

84 Thomas Pynchon, *Against the Day* (London: Vintage Books, 2007), 72.

85 See Paul Caplan, "JPEG: The Quadruple Object," PhD thesis, Birkbeck College, University of London, 2013.

86 Homer H. Dubs, "The Beginnings of Alchemy," *Isis* 38, nos. 1–2 (1947): 73.

87 "When the effluvia from the cow lands ascend to the dark heavens, the dark heavens in six hundred years' give birth to black whetstones, black whetstones in six hundred years give birth to black quicksilver, black quicksilver in six hundred years gives birth to black metal (iron), and black metal in a thousand years gives birth to a black dragon. Where the black dragon enters into [permanent] hibernation, it gives birth to the Black Springs." Quoted in ibid., 72–73.

88 William Newman, "Technology and Alchemic Debate in the Late Middle Ages," *Isis* 80, no. 3 (1989): 426.

89 Vincent of Beauvais's *Speculum doctrinale,* quoted in Newman, "Technology and Alchemic Debate," 430.

90 Pynchon, *Against the Day,* 88.

91 Cubitt et al., "Does Cloud Computing Have a Silver Lining?" See also Michael Riordan and Lillian Hoddeson, *Crystal Fire: The Invention of the Transistor and the Birth of the Information Age* (New York: W. W. Norton, 1997).

3. Psychogeophysics of Technology

1 Rachel Armstrong, "Why Synthetic Soil Holds the Key to a Sustainable Future," *Guardian Professional,* January 17, 2014, http://www.theguardian.com/.

2 Rudwick, *Bursting the Limits of Time,* 162.

3 Delanda, *Deleuze: History and Science,* 78.

4 See Chun, "Crisis, Crisis, Crisis." Edwards, *Vast Machine.* In more general terms, one could relate this to the discourse of cultural techniques too and to consider media technologies as cultural techniques: "namely, to relate the concept of media/mediums historically to ontological and aesthetic operations that process distinctions (and the blurring of distinctions) which are basic to the sense production of any specific culture." From this anthropological definition by Bernhard Siegert, one can move on to a more ecological sense in which media technologies operate. The quotation is from Siegert, "The Map Is the Territory," *Radical Philosophy* 169 (September/October 2011): 14. This connection is not fully explored in this book and is left more as a hint of an alternative route that can be picked up in the future in more detail and consistency.

5 Afterglow was the transmediale 2014 festival theme.

6 McKenzie Wark, *The Beach beneath the Street: Everyday Life and the Glorious Times of the Situationist International* (London: Verso, 2011). Wark, *The Spectacle of Disintegration: Situationist Passages out of the 20th Century* (London: Verso, 2013).

7 The London Psychogeophysics Summit, "What Is Psychogeophysics?," *Mute,* August 4, 2010, http://www.metamute.org/.

8 Indeed, for Friedrich Kittler and others, this marked a radical epistemic threshold from the psychological subject to the physiological object of measurement: physiology instead of the interior experience, scientific measurability of reaction thresholds and speeds instead of "feeling." See Kittler, *Gramophone, Film, Typewriter,* 188. Cf. Sybille Krämer, "The Cultural Techniques of Time-Axis Manipulation: Friedrich Kittler's Conception of Media," *Theory, Culture, and Society* 23, nos. 7–8 (2006): 93–109. On Helmholtz, see also Henning Schmidgen, *Helmholtz Curves: Tracing Lost Time,* trans. Nils F. Schott (New York: Fordham University Press, 2014).

9 This claim can be best understood through A. N. Whitehead's philosophy. See Steven Shaviro, *Without Criteria: Kant, Whitehead, Deleuze, and Aesthetics* (Cambridge, Mass.: MIT Press, 2009).

10 Quoted in Ziolkowski, *German Romanticism and Its Institutions,* 33.

11 John Durham Peters, "Space, Time, and Communication Theory."

12 Marina Warner, "The Writing of Stones," *Cabinet*, no. 29 (Spring 2008), http://cabinetmagazine.org/issues/29/warner.php.

13 Roger Caillois, *The Writing of Stones,* trans. Barbara Bray (Charlottesville: University Press of Virginia, 1985), 4–6.

14 This is a variation on the Deleuze and Guattari idea of metallurgy (as a minor science), found in *A Thousand Plateaus* and in a vital materialist way mobilized by Jane Bennett: "The desire of the craftsperson to see what a metal can do, rather than the desire of the scientist to know what a metal is, enabled the former to discern a life in metal and thus, eventually, to collaborate more productively with it." Bennett, *Vibrant Matter,* 60.

15 Bennett, *Vibrant Matter,* 115.

16 Matthew Fuller, "Art for Animals," *Journal of Visual Art Practice* 9, no. 1 (2010): 17–33.

17 Rosi Braidotti, *The Posthuman* (Cambridge: Polity, 2013), 81.

18 Morton, *Hyperobjects.*

19 See the introduction to Jussi Parikka, ed., *Medianatures: The Materiality of Information Technology and Electronic Waste* (Ann Arbor, Mich.: Open Humanities Press, 2011). Online at http://www.livingbooksaboutlife.org/.

20 Workshop description of the London Geophysics Summit, August 2–7,

2010, http://turbulence.org/blog/2010/06/21/the-london-psychogeophysics-summit-london/.

21 Of course, in philosophical discourse as well as in mythology, the invisible underground (or caves, the preempting of the much later German romanticist focus on mines) has a long history. This relates to the differentiation of the senses and the rational mind, the work of perception versus the operations of reason. It also has a topology that comes out in Plato's differentiation that is besides philosophical, also related to the grounds and undergrounds that can be only reached by the mind, not the body: "The visible is accessible to the senses, while the invisible can only be grasped by the reasoning of the mind. By referring to the invisible as το αιδες, Plato sets up the identification of the invisible world proper to the soul with the traditional mythic idea of the realm of Hades, Αιδου. This connection of Hades and the unseen is part of the mythic tradition at least as early as Homer, and Plato refers to it in the Cratylus as well, where he makes the etymology of Hades not from αειδες (not-visible) but rather from ειδεναι (to know) (404b, cp. 403a)." Radcliffe Guest Edmonds, *Myths of the Underworld Journey: Plato, Aristophanes, and the "Orphic" Gold Tablets* (Cambridge: Cambridge University Press, 2004), 179.

22 Guy Debord, "Introduction to the Critique of Urban Geography," trans. Ken Knabb, in *Critical Geographies: A Collection of Readings,* ed. Harald Bauder and Salvatore Engel-Di Mauro (Kelowna: Praxis (e)press, 2008), 23. Originally: "Introduction à une critique de la géographie urbaine," *Les Lèvres Nues,* no. 6 (September 1955).

23 Wark, *Beach beneath the Streets,* 28.

24 The term and the collective work behind it have many layers. The text in *Mute* magazine is primarily by Wilfred Hou Je Bek, even if the concept was most probably coined by Oswald Berthold and Martin Howse. The term became more defined in the research group and project *Topology of a Future City* for the transmediale 2010 festival, even if one can justifiably say that some of the work of people involved and active in the research and projects, including Jonathan Kemp, goes back to the 2008 xxxxx-Peenemünde-project (with its strong Pynchon–Kittler connotations). More information on the history and layers of the term are on the wikipage http://www.psychogeophysics.org/wiki/doku.php?id=wikipedia. Thanks also to Jonathan Kemp, whom J. P. interviewed via e-mail about the term and its history in January 2014.

25 The London Psychogeophysics Summit, "What Is Psychogeophysics?"

26 Ibid.

27 Robert Smithson, "A Sedimentation of the Mind: Earth Projects," in *Robert Smithson: The Collected Writings,* ed. Jack Flam (1968; repr. Berkeley: University of California Press, 1996), 100–113. See Etienne Turpin, "Robert Smithson's Abstract Geology: Revisiting the Premonitory Politics of the Triassic," in *Making the Geologic Now: Responses to the Material Conditions of Contemporary Life,* ed. Elizabeth Ellsworth and Jamie Kruse (New York: Punctum, 2013), 174.

28 The London Psychogeophysics Summit, "What Is Psychogeophysics?"

29 Gary Genosko, "The New Fundamental Elements of a Contested Planet," talk at the Earth, Air, Water: Matter and Meaning in Rituals conference, Victoria College, University of Toronto, June 2013.

30 See, e.g., Cary Wolfe, *What Is Posthumanism?* (Minneapolis: University of Minnesota Press, 2009). Kari Weil, *Thinking Animals: Why Animal Studies Now?* (New York: Columbia University Press, 2012). Nicole Shukin, *Animal Capital: Rendering Life in Biocapital Times* (Minneapolis: University of Minnesota Press, 2009). Matthew Calarco, *Zoographies: The Question of the Animal from Heidegger to Derrida* (New York: Columbia University Press, 2008). See also Dominic Pettman, *Human Error: Species-Being and Media Machines* (Minneapolis: University of Minnesota Press, 2011).

31 Ellsworth and Kruse, *Making the Geologic Now.*

32 Ziolkowski, *German Romanticism and Its Institutions,* 18–22. There is unfortunately no space to go into the Kantian questions of the beautiful and the sublime. Partly this has resurfaced in the recent Whitehead-based aesthetic discourse of philosophy, especially in Shaviro, *Without Criteria.* The themes of what we might now call "geopoetics" might be seen as part of Kant's focus on the sublime, as much as it uses notions referring to the natural—from mountains to the sea. But for Kant, this aspect of the sublime actually points inward, toward the mind: "This also shows that true sublimity must be sought only in the mind of the judging person, not in the natural object the judging of which prompts this mental attunement. Indeed, who would want to call sublime such things as shapeless mountain masses piled on one another in wild disarray, with their pyramids of ice, or the gloomy raging sea? But the mind feels elevated in its own judgment of itself when it contemplates these without concern for their form and abandons itself to the imagination and to a reason that has come to be connected with it—though quite without a determinate purpose, and merely expanding it—and finds all the might of the imagination still inadequate to reason's ideas." Immanuel Kant, *Critique of Judgment,* trans. Werner S. Pluhar (1790; reprint, Indianapolis, Ind.: Hackett, 1987), §26, "On Estimating the Magnitude of

Natural Things, as We Must for the Idea of the Sublime," 257. Hence, in this context, consider Shaviro's argument concerning the beautiful and the Whitehead perspective to the inorganic as perhaps hinting at some aspects relevant to our geocentric argument.

33 Williams, *Notes on the Underground,* 17.

34 Tate Britain's exhibition *Ruin Lust* in London (March 4–May 18, 2014) was a well-curated collection of this modern imaginary of the ruins in visual arts.

35 Kenneth White, as quoted in Matt Baker and John Gordon, "Unconformities, Schisms and Sutures: Geology and the Art of Mythology in Scotland," in Ellsworth and Kruse, *Making the Geologic Now,* 163–69. For some notes on the emergence of the concept by White in the 1970s and its theoretical influences from Heidegger to Deleuze and Guattari and onward to some more cosmological dimensions, see Kenneth White, "Elements of Geopoetics," *Edinburgh Review 88* (1992): 163–78. See also the Scottish Centre for Geopoetics, http://www.geopoetics.org.uk/.

36 Richard Grusin, *Culture, Technology, and the Creation of America's National Parks* (Cambridge: Cambridge University Press, 2004).

37 Ibid., 131. Clarence E. Dutton, *Tertiary History of the Grand Cañon District , with Atlas,* in *Monographs of the United States Geological Survey,* vol. 2 (Washington, D.C.: Government Printing Office, 1882).

38 Dutton, *Tertiary History,* 39.

39 Williams, *Notes on the Underground,* 88.

40 Deleuze and Guattari, *A Thousand Plateaus,* 361–74.

41 "Vatnajökull (the sound of)," Katie Paterson, project description, http://www.katiepaterson.org/vatnajokull/.

42 "We call it the Cretaceous acoustic effect, because ocean acidification forced by global warming appears to be leading us back to the similar ocean acoustic conditions as those that existed 110 million years ago, during the Age of Dinosaurs." "Dinosaur-Era Acoustics: Global Warming May Give Oceans the 'Sound' of the Cretaceous," *Science Daily,* October 18, 2012, http://www.sciencedaily.com/.

43 See Florian Dombois, homepage, for project information, http://www.florianandombois.net/.

44 For Wolfgang Ernst, time-critical media are able to measure events of such time scales not necessarily directly perceptible to the human being. However, time-critical media themselves also operate in such ways. In Ernst's words, "with techno-mathematical computing where minimal temporal moments become critical for the success of the whole process of internal calculation and human-machine communication ('interrupt'), time-criticality becomes

a new object of epistemological attention in the economy of knowledge. When culture is rather counted than narrated, time-criticality needs to be focussed by process-oriented (thus dynamic) media archaeology." Jussi Parikka, "Ernst on Time-Critical Media: A Mini-Interview," blog post, *Machinology,* March 18, 2013, http://jussiparikka.net/2013/03/18/ernst-on-microtemporality-a-mini-interview/. See also Wolfgang Ernst, "From Media History to Zeitkritik," trans. Guido Schenkel, *Theory, Culture, and Society* 30, no. 6 (2013): 132–46.

45 This resonates with Lynn Margulis's understanding of Gaia theory. Also, for an extended discussion of related issues concerning Deleuze's shortcomings in the context of a geophilosophy, see Woodard, *On an Ungrounded Earth.* Leaning on Grant, Woodard points out the possible somaphilia lurking in Deleuze's account of the earth, as well as the dangers of other sorts of stabilizing moves that do not go far enough in terms of granting a vital agency to the earth: "This is to say nothing of Husserl's ark-ization of the earth (the earth as the 'original ark,' where the Earth is flung back in time to its pre-Copernican state as merely the bounds of experience), as over-romanticized ground *(Boden),* or of what Heidegger would call *Offenheit,* or openness, as Meleau-Ponty *[sic]* shows. It is such images of Earth as both dead body and mute cradle that we set out to destroy with digging machines, massive energy weapons, and total ecological collapse. These images perform a dual criminal function: one, to stabilize thinking, and two, to give gravity to anthropocentric thinking and being" (6).

46 Kahn, *Earth Sound Earth Signal.*

47 A lot of Kahn's arguments regarding the epistemological function of early technological media devices are also present in Wolfgang Ernst's media archaeology. See Ernst, *Digital Memory and the Archive.*

48 Kahn, *Earth Sound Earth Signal,* 255.

49 "An *earth circuit* was open to the sounds of the earth and to other, non-natural sounds, whereas a *metallic circuit* was closed onto its own technological loop. Most often the sounds in an open circuit were thought of as noises, but they were also listened to aesthetically and observed and measured as scientific phenomena." Kahn, *Earth Sound Earth Signal,* 256.

50 Bruno Latour, *What Is the Style of Matters of Concern?* (Amsterdam: Van Gorcum, 2008).

51 Transmediale/Resource: Residency project Critical Infrastructure, http://www.transmediale.de/resource/residency-project.

52 The project was initiated by Jonathan Kemp and then co-organized by Kemp, Jordan, and Howse. http://crystalworld.org.uk/.

53 Delanda, *Deleuze: History and Science,* 87. See also Matthew Fuller, "The Garden of Earthly Delights," *Mute,* September 19, 2012, http://www.metamute.org/editorial/articles/garden-earthly-delights.

54 The_crystal_world:space:publicity project, http://crystal.xxn.org.uk/wiki/doku.php?id=the_crystal_world:space:publicity.

55 Fuller, "Garden of Earthly Delights."

56 Martin Howse, "The Earthcodes Project: Substract/Shifting the Site of Execution," microresearchlab, http://www.1010.co.uk/org/earthcode.html.

57 *Encyclopædia Britannica,* s.v. "Earth Current." Among such mentioned pioneers were Barlow and Walker, interested in diurnal variations and, for instance, the influence of the ground in earth currents.

58 See Friedrich Kittler, "Dracula's Legacy," in *Literature, Media, Information Systems,* ed. John Johnston, 50–84 (Amsterdam: G+B Arts International, 1997).

59 Howse, "The Earthcodes Project." Importantly, soil also has a history. Gradually, during the nineteenth century, in geology, the discussions that saw it only as residue of rocks gave way to alternative versions that granted soil a status, life, and history of its own. One can approach this by reading the transformations in soil science and geology. The soil becomes a heterogeneous assemblage itself. See Denizen, "Three Holes in the Geological Present," in *Architecture in the Anthropocene: Encounters among Design, Deep Time, Science, and Philosophy,* ed. Etienne Turpin, 35–43 (Ann Arbor, Mich.: Open Humanities Press, 2013).

60 Cf. Jussi Parikka, *Digital Contagions: A Media Archaeology of Computer Viruses* (New York: Peter Lang, 2007).

61 Smithson, "A Sedimentation of the Mind," 106.

62 Ibid.

63 Manuel Delanda speaks of "metallic affects" pointing to the role of metals as catalysts of chemical reactions. To paraphrase Delanda, the metallic affect refers to the molecular potential for change in the real composition of chemical interactions. Catalysts themselves are useful for that purpose because they don't change in those reactions. What's more is how the metallic is infused with life more generally. This new materialist perspective promises to extend the list of material entities that usually counted (labor, space, clothes, food) into a molecular level of reactions. Indeed, the metals in our bodies and brains are conductive elements as much as they are in technological assemblages, cutting through a range of different level phenomena. Methodologically, this relates to the new materialist assemblage theory that is interested in reality of entities and their processes irrespective of scale,

aiming to correct the human-centered focus of earlier material philosophies. Delanda, *Deleuze: History and Science,* 78.

64 Wark, *Beach beneath the Street,* 29.

65 Paul Lloyd Sargent, "Landscapes of Erasure: The Removal—and Persistence—of Place," in Ellsworth and Kruse, *Making the Geologic Now,* 108. Also discussions in architecture and the Anthropocene are forcing us to rethink cities and geology: "The image of the city, in particular, as a thing that is made *of* geology or *on* geology, increasingly has to contend with the idea of the city as a thing that *makes* geology, in the forms of nuclear fuel, dammed rivers, atmospheric carbon, and other metabolic products of urbanization whose impacts will stretch into future epochs." Denizen, "Three Holes in the Geological Present," 29.

66 Ibid.

67 See Sargent, "Landscapes of Erasure," 109. "Over time in urban, rural, and even 'wild' space, rivers are diverted, ponds drained, malls constructed, casinos imploded, forests burned, crops grown, oceans polluted, reservoirs created, clouds seeded, cathedrals erected, villages sacked, neighborhoods gentrified, libraries filled, satellites launched, histories forgotten, immigrants deported, businesses turned over, invasive species introduced, indigenous people displaced, and landmarks renamed."

68 Debord, as quoted in Wark, *Beach beneath the Street,* 28.

69 Wark, *Beach beneath the Street,* 28.

70 Pynchon, *The Crying of Lot 49* (New York: Harper and Row, 1966), 181–82.

71 In the sense used by Félix Guattari.

72 Cf. Eugene Thacker on Fritz Leiber and the theme of the unhuman. Thacker, "Black Infinity," 173–80.

73 Cf. Jane Bennett's proposal to see vital matter as parallel to historical materialism in *Vibrant Matter,* 63.

4. Dust and the Exhausted Life

1 Christian Neal MilNeil, "Inner-City Glaciers," in Ellsworth and Kruse, *Making the Geologic Now,* 79–81.

2 Ibid., 79.

3 Negarestani, *Cyclonopedia.* See Gary Genosko, "The New Fundamental Elements of a Contested Planet," talk presented at the Earth, Air, Water: Matter and Meaning in Rituals conference, Victoria College, University of Toronto, June 2013. A case to underline this argument: Cold War nuclear testing culture was tightly linked with climate research. The radioactive fallout from nuclear tests sometimes penetrated the stratosphere, and tracking the

aftereffects of the blast was instrumental to understanding the global circulation of microparticles, including carbon-14. The earth traces of, for instance, carbon became agents through which to understand the global dynamics of the planet, rather ironically through the assistance of nuclear detonations, themselves made possible by advanced computing. See Edwards, *Vast Machine,* 209.

4 "Today, African dust carries with it metals and microbes, persistent organic pollutants and pesticides, and these contaminants fall onto the declining reefs of the Caribbean Ocean. A pathogenic fungus, known to cause sea fan disease and coral mortality in these warm pale waters, originated from Sahel soil in Mali." GinaRae LaCerva, "The History of Dust," *Feedback* blog, http://openhumanitiespress.org/feedback/newecologies/dust/.

5 James P. Sterba, "In Coral Layers Scientists Find a History of the World," *New York Times,* August 10, 1982.

6 Colby Chamberlain, "Something in the Air," *Cabinet* 35 (Fall 2009), http://cabinetmagazine.org/issues/35/chamberlain.php.

7 Steven Connor, "Pulverulence," *Cabinet* 35 (Fall 2009), http://cabinetmagazine.org/issues/35/connor.php.

8 The fictional Dr. Hamid Parsani, in Negarestani, *Cyclonopedia.*

9 Susan Sontag, *Illness as Metaphor* (New York: Farrar, Straus, Giroux, 1977), 13.

10 Jennifer Gabrys, "Telepathically Urban," in *Circulation and the City: Essays on Urban Culture,* ed. Alexandra Boutros and Will Straw (Montreal: McGill-Queen's University Press, 2008), 49.

11 Jonathan M. Bloom, *Paper before Print: The History and Impact of Paper in the Islamic World* (New Haven, Conn.: Yale University Press, 2001), 129.

12 Ned Rossiter, "Dirt Research," in *Depletion Design: A Glossary of Network Ecologies,* ed. Carolin Wiedemann and Soenke Zehle (Amsterdam: Institute of Network Cultures, 2012), 44.

13 See Peter Sloterdijk, *Bubbles. Spheres Volume I: Microspherology,* trans. Wieland Hoban (Los Angeles, Calif.: Semiotext(e), 2011).

14 Connor, "Pulverulence."

15 Ibid.

16 http://phonestory.org/.

17 The iPhone 5 launch and shipping of millions of phones in the first days was accompanied by strikes at the Foxconn factories in Zhengzhou and earlier clashes in Taiyuan. See Adam Gabbatt, "Foxconn Workers on iPhone 5 Line Strike in China, Rights Group Says," *The Guardian,* October 5, 2012, http://www.guardian.co.uk/. Such problems in production are cleaned away from Apple's immaculately polished marketing material that emphasizes the human-sized ergonomics of its products.

18 See Graham Harwood's texts and in general YoHa's 2008 project *Aluminium,* http://www.yoha.co.uk/aluminium. Modern industrialism and its fascist aesthetics (referring to futurism as a sort of an archaeology of the political resonances of the chemical) are distributed as part of the everyday: "Aluminium xmas trees, pots and pans, door and window frames, wall cladding, roofing, awnings, high tension power lines, wires, cables, components for television, radios, computers, refrigerators and air-conditioner, cans, bottle tops, foil wrap, foil semi-rigid containers, kettles and saucepans, propellers, aeroplane, gearboxes, motor parts, tennis racquets and Zepplins [*sic*]." A key scholarly work on aluminum is Mimi Sheller, *Aluminum Dreams: The Making of Light Modernity* (Cambridge, Mass.: MIT Press, 2014).

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26 See Pasi Väliaho, *Mapping the Moving Image: Gesture, Thought, and Cinema circa 1900* (Amsterdam: Amsterdam University Press, 2010).

27 Daniel Paul Schreber, *Memoirs of My Nervous Illness,* trans. Ida Macalpine and Richard Hunter (London: W. M. Dawson, 1955).

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32 See John McNeill, *Something New under the Sun.*

33 Maxwell and Miller, *Greening the Media,* 46–47.

34 Ibid., 47.

35 Ibid., 53.

36 See also Jussi Parikka, *What Is Media Archaeology?* (Cambridge: Polity, 2012), 163–64.

37 Manuel Delanda interviewed in Dolphjin and van der Tuin, *New Materialism,* 41.

38 Jason W. Moore, "Crisis: Ecological or World-Ecological?," in Wiedemann and Zehle, *Depletion Design,* 73–76.

39 Yann Moulier Boutang, *Cognitive Capitalism,* trans. Ed Emery (Cambridge: Polity, 2012), 19.

40 The estimates about "peak oil" vary, demonstrating the complex epistemologies and trouble in measuring such geologic data but also the economic stakes in the question. According to some worst-case estimates, also in recent research, peak oil could be reached even before 2020. Besides the fact that we need to be aware of the wider energy contexts of media technologies, of course, the dependence on oil has major consequences across sectors where it is hard to play the game of which one is the most important to worry about. The report identified that "major industrial sectors were at risk, including food and food processing, primary agriculture, metals and metals processing, and transport." Hence it is no wonder that a recent report suggests not only the reduction of movement of people and things but also a different sort of fertilizer agriculture, more reliant on organic farming. In general, what is suggested is a lifestyle change that is more about localities and decentralization, to paraphrase the text. Nafeez Ahmed, "Imminent Peak Oil Could Burst US, Global Economic Bubble—Study," *The Guardian,* November 19, 2013, http://www.theguardian.com/.

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42 Genosko, "New Fundamental Elements of a Contested Planet."

43 YoHa, *Coal Fired Computers* project, http://yoha.co.uk/cfc.

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50 Raqs, with Respect to Residue, 2005, quoted on the Aluminium project web page, http://www.yoha.co.uk/node/536. On the "residual" in media, see also Charles R. Acland, ed., *Residual Media* (Minneapolis: University of Minnesota Press, 2007).

51 See, e.g., Huhtamo and Parikka, *Media Archaeology.* Parikka, *What Is Media Archaeology?*

52 Negarestani, *Cyclonopedia,* 88.

53 Consider also smart dust, important not least for emerging military applications, on which I won't go into detail here. Smart dust is not, however, restricted to military applications—all the talk of smart cities demonstrates how the possibility of equipping urban environments in such smartness presents a new paradigm of controlled environments. If smart dust is the marker of the creative informational city—in that it joins together creative brains and the city itself (thus the city becomes brainy, communicative)—then we also need to remember the dumb dust that entangles itself with information and creativity: it is partly the residue of information technology smartness, yet we still need to be aware of its qualities as creative, effective matter (to follow Negarestani's philosophical idea). See Brendan I. Koerner, "What Is Smart Dust Anyway?," *Wired,* June 2003, and Gabrys's excellent historical insight into smart dust and cities, "Telepathically Urban."

54 See Dolphjin and van der Tuin, *New Materialism.* See also, e.g., Milla Tiainen, "Revisiting the Voice in Media and as Medium: New Materialist Propositions," *Necsus,* no. 4 (Autumn 2013), http://www.necsus-ejms.org/revisiting-the-voice-in-media-and-as-medium-new-materialist-propositions/.

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57 Fuller, "Pits to Bits."

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5. Fossil Futures

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14 Goldberg, "Hardware Is Dead."
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20 Gabrys, *Digital Rubbish,* 5. Gabrys on Benjamin: "Benjamin, in his practice of natural history, at once drew on but departed from the usual, more scientific practice of natural history. While he was fascinated by nineteenth-century depictions of and obsessions with natural history and fossil hunting, he interpreted these historical records of the earth's deep time as a renewed temporal vantage point from which to assess practices of consumption. Obsolete objects returned to a kind of prehistory when they fell out of circulation, at which time they could be examined as resonant material residues—fossils—of economic practices. He reflected on the progress narratives that were woven through Victorian natural histories (and economies) and effectively inverted these progress narratives in order to demonstrate the contingency and transience of commodity worlds" (6). See also the chapter on "Natural History: Fossils" in Susan Buck-Morss, *The Dialectics of Seeing: Walter Benjamin and the Arcades Project,* 58–77 (Cambridge, Mass.: MIT Press, 1991).

21 Gabrys, *Digital Rubbish,* 7.

22 Peters, "Space, Time, and Communication Theory."

23 Charles Lyell, *Principles of Geology* (London: John Murray, 1830), 1. Online facsimile at http://www.esp.org/books/lyell/principles/facsimile/. The monument is the crucial figure in Michel Foucault's archaeology, differentiating it from the historiographical tracking of stories. For Foucault, it is the persistence of the past in the present as a concrete monument that is of interest to the archaeologist. This idea is picked up by Wolfgang Ernst in his media archaeology, which tries to follow this nondiscursive line offered by Foucault. Ernst: "Like the media analyst, who gazes at objects in the same way as the ethnologist records the practices of a remote society, the antiquarian intends to achieve a *monumental* relation to the past. This method aims to avoid prematurely interpreting archival or archaeological evidence as documents of history but rather isolates this data into discrete series in order to rearrange them and open them for different configurations." Ernst, *Digital Memory and the Archive,* 44.

24 Ilana Halperin, "Autobiographical Trace Fossils," in Ellsworth and Kruse, *Making the Geologic Now,* 154.

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28 Paul Virilio, *Bunker Archaeology,* trans. George Collins (New York: Princeton Architectural Press, 1994), 56.

29 Williams, *Notes on the Underground,* 43.

30 Stoppani, "First Period of the Anthropozoic Era," 40. "A new era has then begun with man. Let us admit, though eccentric it might be, the supposition that a strange intelligence should come to study the Earth in a day when human progeny, such as populated ancient worlds, has disappeared completely. Could he study our epoch's geology on the basis of which the splendid edifice of gone worlds' science was built? Could he, from the pattern of floods, from the distribution of animals and plants, from the traces left by the free forces of nature, deduct the true, natural conditions of the world? Maybe he could; but always and only by putting in all his calculations this new element, human spirit. At this condition, as we, for instance, explain the mounds of terrestrial animals' bones in the deep of the sea, he, too, could explain the mounds of sea shells that savage prehistoric men built on the coasts that they inhabited. But if current geology, to understand finished epochs, has to study nature irrespective of man, future geology, to understand our own epoch, should study man irrespective of nature. So that future geologist, wishing to study our epoch's geology, would end up narrating the history of human intelligence. That is why I believe the epoch of man should be given dignity of a separate new era" (40).

31 Gould, *Time's Arrow, Time's Cycle,* 175–76.

32 "By second nature I mean the space of the material transformation of nature by collective labor. Second nature is a space of fragmentation, alienation, class struggle. In many ways, the space of the vector really is a third nature, from which the second nature of our built environments can be managed and organized, as a standing reserve, just as second nature treats nature as its standing reserve." Wark, "Escape from the Dual Empire."

33 Wark, *Telesthesia,* 34–35.

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35 Manuel Delanda, *War in the Age of Intelligent Machines* (New York: Zone Books, 1991), 2–3.

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43 See Zielinski, *[. . . After the Media].*

44 Paul Virilio, *Grey Ecology,* trans. Drew Burk, ed. Hubertus von Amelunxen (New York: Atropos Press, 2009).

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46 Parks, "Media Fixes."

47 Brooke Belisle, "Trevor Paglen's Frontier Photography," in Ellsworth and Kruse, *Making the Geologic Now,* 147.

48 Paglen, "The Last Pictures."

49 Ryan Bishop, "How to Talk to a Heavenly Body," talk presented at transmediale 2013, February 2013, Berlin.

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52 Understood in the sense suggested by Paul Virilio: a move from the geographically fixed local times to global times of accelerated technological speeds

surpassing the affective and cognitive coordinates of the human. Paul Virilio, *Open Sky,* trans. Julie Rose (London: Verso, 1997). Richard G. Smith, "Escape Velocity," in *The Virilio Dictionary,* ed. John Armitage (Edinburgh: Edinburgh University Press, 2013), 79–80.

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58 Belisle, "Trevor Paglen's Frontier Photography," 145–49.

59 Bishop, "Project 'Transparent Earth.'"

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62 Herschel, as quoted in Peters, "Space, Time, and Communication Theory." As Belisle notes, regarding early pioneers such as Herschel, "echoing with contemporaneous geological arguments, his view unsettled notions of a fixed and perfect universe, arguing it was unimaginably old and vast, and still changing." Belisle, "Trevor Paglen's Frontier Photography."

63 Meillassoux, *After Finitude,* 10.

64 Ibid.

65 Ibid., 14.

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67 Tim Morton, "Zero Landscapes in the Time of Hyperobjects," quoted in Ellsworth and Kruse, *Making the Geologic Now,* 221.

68 See Ernst, *Digital Memory and the Archive.* In general, my use of the notion of "temporeality" is in debt to Ernst.

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Afterword

1 Steffen et al., "The Anthropocene," 616.

2 See Nest, *Coltan,* 8–9.

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4 Huber, "Dig More Coal."

5 Caillois, as quoted in the introduction by Marguerite Yourcenar to *The Writing of Stones,* trans. Barbara Bray (Charlottesville: University Press of Virginia, 1985), xvi.

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Appendix

1 The authors would like to thank Amelia Guimarin, Tony D. Sampson, Lesley Walters, and the three referees for their valuable feedback. Garnet Hertz would like to thank Mark Poster, Peter Krapp, Cécile Whiting, and Robert Nideffer for feedback on earlier versions on this essay. Hertz is supported by the National Science Foundation grant 0808783 and the following organizations at UC Irvine: the Center for Computer Games and Virtual Worlds, the Institute for Software Research, and the California Institute for Telecommunications and Information Technology. No endorsement implied. Jussi Parikka

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16 Wolfgang Ernst, *Digital Memory and the Archive,* ed. Jussi Parikka (Minneapolis: University of Minnesota Press, 2013), 37–54.

17 See Eric Kluitenberg, ed., *The Book of Imaginary Media* (Rotterdam: Nai, 2006); Eric Kluitenberg, "On the Archaeology of Imaginary Media," in *Media Archaeology: Approaches, Applications, Implications,* ed. Erkki Huhtamo and Jussi Parikka, 48–69 (Berkeley: University of California Press, 2011).

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