ARCHIVES OF THE ANTHROPOCENE

VISUAL GRAMMARS OF DEEP TIME

YURIKO FURUHATA

ARCHIVES OF THE
ANTHROPOCENE

ELEMENTS *A series edited by Stacy Alaimo and Nicole Starosielski*

DUKE UNIVERSITY PRESS

ARCHIVES OF THE ANTHROPOCENE

VISUAL GRAMMARS OF DEEP TIME

YURIKO FURUHATA

DUKE UNIVERSITY PRESS Durham and London 2026

Printed in the United States of America on acid-free paper ∞
Project Editor: Ihsan Taylor
Cover design by Courtney Leigh Richardson
Typeset in Chaparral Pro and Knockout
by Westchester Publishing Services

Library of Congress Cataloging-in-Publication Data
Names: Furuhata, Yuriko, [date] author
Title: Archives of the anthropocene : visual grammars of deep time / Yuriko Furuhata.
Other titles: Elements (Duke University Press)
Description: Durham : Duke University Press, 2026. | Series: Elements | Includes bibliographical references and index.
Identifiers: LCCN 2025048899 (print)
LCCN 2025048900 (ebook)
ISBN 9781478038948 paperback
ISBN 9781478033592 hardcover
ISBN 9781478062530 ebook
Subjects: LCSH: Geology, Stratigraphic—Anthropocene—Philosophy | Human ecology | Nature—Effect of human beings on | Settler colonialism—Pacific Area | Natural resources—Political aspects | Imperialism—History—20th century | Geopolitics | Mass media and the environment
Classification: LCC GF75 .F856 2026 (print) | LCC GF75 (ebook) | DDC 304.2—dc23/eng/20260507
LC record available at https://lccn.loc.gov/2025048899
LC ebook record available at https://lccn.loc.gov/2025048900

Cover art: (*Collage of images, top to bottom*): cover of Ishimaru Yūkichi's *Cloud Atlas* (*Kumo no shashin to zukai*) (Tokyo: Hokuryūkan, 1952); colonial postcard of a dogsled and a reindeer sled from the northern colony of Karafuto on the island of Sakhalin. rb00031609, Ehagaki kara miru Asia. Source: Main Library, Kyoto University; radioautograph of a giant clam from Bikini Atoll. Accession number 00–065, box 8/11, Laboratory of Radiation Ecology records, Special Collections, University of Washington Libraries; mushroom cloud above Bikini Atoll. From United States Joint Task Force One, *Operation Crossroads: The Official Pictorial Record* (New York: W. H. Wise, 1946); stratigraphic columns in *Shōwa jūichi nen do yuden chishitsu chōsa hōkoku* [The geological survey report on oil fields] (Karafuto: Karafuto Chō, 1938). (*Background*) Benjamin Smith Lyman, *A Geological Sketch Map of the Island of Yesso, Japan* (1876).

CONTENTS

ACKNOWLEDGMENTS

A book often begins to take shape ever so imperceptibly. A seed for what became this book was planted many years ago, as I harbored a quiet hope to learn more about a blank period in my late father's family history. Then, this hope became entangled with my desire to write an informal sequel to *Climatic Media* (2022) in which I tracked the movements of people and technologies—including digital computers used to predict and control weather—across the Pacific Ocean, and how they bolstered imperial expansionism of Japan that fought against the United States and subsequently became its close political ally during the Cold War. In pursuit of this transpacific movement, the book overlooked the islands in the Pacific. I thus felt compelled to go back further in time, deeper into the transpacific context of geosciences and colonialism, with these islands at the center of their story. As I walked through a nearby forest in search of small wonders—finding snowflakes on limestone and mushrooms hiding under fallen trees—during the pandemic isolation, different strands of thought, like mycelium connecting the roots of a forest, came together and resulted in this project.

Many people inspired and helped me complete this book. I want to begin by expressing my sincere gratitude to my two external readers of the manuscript, who offered thoughtful and incisive feedback that sharpened the book's argument about epistemology and mediation. I also want to thank Bishnupriya Ghosh for her insightful feedback on the manuscript. Old and new friends and interlocutors in the ever-inviting community of scholars with kindred spirits and shared research interests also offered support. While revising the manuscript, I received helpful suggestions from participants in the Elements series author workshop at UC Berkeley. In particular, I am grateful for the comments I received from Nicole Starosielski, Stacy Alaimo, Hi'ilei Julia Kawehipuaakahaopulani Hobart, Weihong Bao, and Rafico Ruiz at the workshop. I am also grateful to Jen Rose Smith and Camille Owens for their generosity in reading chapters,

and to Gal Gvili for kindly reading the rough draft of the introduction at an early stage.

I was fortunate to receive encouragement, engaging questions, and constructive feedback from the community of environmental humanities and environmental media scholars, including the members of the Anthropocene Media Working Group, the Grierson Research Group, and the Strata of the Asia-Pacific Workshop, which I co-organized with Weixian Pan. Thank you to all the friends and colleagues not yet mentioned, and those who participated in those events where I shared my research over the past few years, including: Darin Barney, James Leo Cahill, Nadine Chan, Alenda Chang, Kimberly Chung, Sasha Crawford-Holland, Jennifer Fay, Lisa Han, Brian Jacobson, Melody Jue, Erin Huang, Katerina Korola, Burç Köstem, Krista Lynes, Debashree Mukherjee, Weixian Pan, Jennifer Lynn Peterson, Chanon Kenji Praepipatmongkol, Thomas Pringle, Nozomi Nakaganeku Saito, Nick Silcox, Solveig Suess, Hannah Tollefson, Ayesha Vemuri, Derek Woods, Mia Yu, and Alexander Zahlten. Malcolm Sanger deserves a special shout-out for carefully reading and copyediting my manuscript. Thank you also to Nicolas Holt, Heather Rogers, and Ekaterina Tutatina for their research assistance at different stages of this project.

I am also thankful to all the friends and colleagues who invited me to present and workshop parts of this book at their institutions and events, including Carolyn Birdsall, Gwyn Campbell, Josh Gilford, Tong Lam, Jinying Li, Justus Nieland, Pooja Rangan, Jussi Parikka, Patricia Pisters, Nick Sammond, Victor Seow, and Matt Tierney. Many other friends, mentors, and colleagues also shared their enthusiasm, showed curiosity, and humored my search for fossils hidden inside limestone walls and mountain rocks in Montreal: Luca Caminati, Thomas Lamarre, Josh Neves, Ara Osterweil, Carrie Rentscheler, Masha Salazkina, the late and much missed Jonathan Sterne, Alanna Thain, Ishita Tiwary, and all my colleagues and students in the Department of East Asian Studies and the Department of Art History and Communication Studies at McGill University. This research was also supported by an Insight Grant from the Social Sciences and Humanities Research Council (SSHRC) of Canada.

From the early stage of its development, my wonderful editor, Courtney Berger, has provided me with guidance and wise advice. Thank you also to Ryan Kendall and Ihsan Taylor for assisting me through the final steps of publication, and to Celia Braves for her careful indexing work.

My family on both sides of the Pacific Ocean, as always, have supported me over the years spent researching, thinking, and writing this book.

Their earnest questions (mostly "What is your book about?") kept me reflecting on the political and personal stakes of this project.

Last but not least, my most heartfelt thanks go to my partner Marc Steinberg. He listened to me rehearse ideas when they were still floating around in my head, pulled me back to reality after being lost for hours immersed in old science journals (the never-ending J-STAGE!), and tirelessly supported me as I juggled editing this book and my duties after stepping in as a first-time department chair, all the while reminding me of the preciousness of life spent together.

While significantly revised, parts of the introduction and chapter 4 previously appeared in the following publications: "Archipelagic Archives: Media Geology and the Deep Time of Japan's Settler Colonialism," *Public Culture* 33, no. 3 (September 2021): 417–40; and "The Nuclear Geopolitics of Anthropogenic Clouds," *e-flux Architecture*, December 2023.

Time gets stratified when it lies underground. Or, it is made to appear that way. Geologists and climate scientists drill through layers of rock, sediment, and ice sheets to turn the metaphorical pages of Earth's calendar in order to reconstruct its deep history. This history is recorded and rendered as visual inscriptions, such as color-coded geological maps and stratigraphic columns that mimic layers of sedimented strata. Like the hours on the face of a clock, they are a form of mediation, translating the passage of time into color-coded graphical inscriptions. As such, these cartographic and stratigraphic representations obscure the traces of their production behind the codified vision of deep time they communicate. Nevertheless, it is still possible to read the flat surface of the maps and diagrams against the grain, to read for the traces of geopolitical forces and epistemic assumptions that shaped this vision of time. When we do, we find other kinds of history.

Take, for instance, Japan's oldest geological map, *A Geological Sketch Map of the Island of Yesso, Japan* (1876). The making of this map tells a layered history of geological surveys and extraction, and of the settler colonial dispossession of the land of the Indigenous Ainu people. At the request of the newly founded Meiji-era Japanese government, American geologist Benjamin Smith Lyman and his Japanese and American assistants surveyed the island's untapped resources, including gold, coal, and iron deposits, in the 1870s. Lyman then created this exquisite, hand-colored map of Hokkaidō to depict its underground resources. Meticulously assessed and mapped by American and Japanese geologists in the late nineteenth century, the island was transformed into a metaphorical archive of its deep history and a geopolitical territory integral to the expansion of imperial Japan.

The timing of Lyman's survey was crucial. Seven years earlier, Japan had officially annexed the island and established the Hokkaidō Development Agency (Kaitakushi), a special administrative unit in charge of

facilitating the agrarian settlement of the island by Japanese migrants. The influx of these settlers led to the systemic displacement of the Ainu people across Ainu Mosir, their homeland that includes the islands of Hokkaidō, Sakhalin, and Kuril. This modern settler colonial project propelled Japan's ambitions as an archipelagic empire, as it subsequently annexed the independent Ryūkyū Kingdom (renamed as the prefecture of Okinawa) and extended its territorial claims to Taiwan, Korea, Manchuria, and parts of Micronesia and Southeast Asia. The rapid expansion of the Japanese Empire from the late nineteenth century through the early decades of the twentieth century was consolidated geopolitically and geologically.

With the Hokkaidō Development Agency's Land Regulation of 1872, the Japanese government declared the entire island "*terra nullius*, or 'masterless land' [*mushu no chi*]" so that it could confiscate it as public property belonging to the emperor.[1] This rendering of Hokkaidō as a masterless land was a modern invention that contradicted earlier acknowledgments of the vast interior of the island—or even of the whole island save for a few Edo period coastal towns—as the land of the Ainu people.[2] Consequently, the island was reconfigured as a settler colonial territory: The surface land was offered to Japanese settlers, while its subterranean space was reserved for commercial extraction by government-owned mining companies.

To support the accelerated colonial settlement of the island in the 1870s, the government brought in a group of foreign expert advisors in agriculture, civil engineering, education, geography, geology, and mining. Lyman was one of these foreign experts hired by Kuroda Kiyotaka, the Hokkaidō Development Agency's vice chairman. In hiring these experts, Kuroda argued that "we must recruit the most talented personnel who are experienced in frontier development."[3] The Japanese government's conscious effort to borrow settler colonial strategies and techniques of dispossession and territorialization from the United States was also evident in its recruitment of Horace Capron, an American agriculturalist and senior military officer who served in President Ulysses S. Grant's administration.

Capron was hired not only for his credentials of having served the US federal government as commissioner of agriculture but also for his experience of "managing the forced removal of Native Americans including Delawares, Shawnees, Creeks, Comanches, Kikapoos, Wichitaws and others, from Texas to new territories after the Mexican–American War."[4] The similarity between the settler colonization of Hokkaidō and that of

the United States is marked by Capron's 1872 proposal to turn the Ainu territory into public land that could then be divided and sold to Japanese settlers, allegedly modeled on the American Homestead Act of 1862, which granted settlers 160-acre plots for a small fee.[5]

Lyman worked closely with Capron in his new role as chief geologist and mining engineer for the Hokkaidō Development Agency.[6] While surveying and mapping the island's resources, Lyman advocated for an American and Japanese joint ownership of mining companies to extract mineral resources.[7] His proposal for Japan to grant American investors the rights to buy, sell, and own private property in Hokkaidō needs to be read in conjunction with the Japanese government's expropriation of the land from the Ainu people and its granting of the rights to own and cultivate the same land to the Japanese settlers under new land regulations.[8] Just when the Indigenous inhabitants were dispossessed of their homeland, the American geologists and developers demanded their rights to extract mineral resources from it in collaboration with the Japanese government. This triangulated, transoceanic relationship among the Ainu, the Japanese, and the Americans was pivotal to Japan's settler colonization of the island.[9] After systematic geological surveys, the island's deep underground was jointly territorialized by Japan and its American advisors. Through such geological surveys and colonial settlement, the island was transformed into what geographer Bruce Braun calls a "vertical territory."[10]

I open this book with Lyman's geological map because of its direct contribution to the making of Hokkaidō as a vertical territory. It is also an exemplary document of the standardized, codified, and visual representation of geological matter: rocks, minerals, ore veins, and fossil fuel deposits. Geologists and mining engineers like Lyman produced visual inscriptions such as this map that helped consolidate the vertical view of Earth. This method of graphically depicting subterranean space was instrumental to the project of settler colonialism, as well as the production of geoscientific knowledge. Today, scientists similarly look for stratigraphic markers, this time to investigate climate change by digging, boring, and extracting sediment and ice cores. The awareness of Earth's deep history, which we now associate with climate change, developed alongside colonial violence and through the mediation of visual inscriptions like this geological map.

Archives of the Anthropocene traces the imbrications of scientific, colonial, and natural archives by analyzing how earthly matter is inscribed

into cartographic, photographic, and cinematographic forms. I propose that these inscriptions follow a set of *grammars*—visual conventions, formal idioms, and graphic patterns—that reveal the underlying epistemic assumptions and geopolitical interests of empires and settler states. The book asks how these inscriptions helped naturalize certain viewpoints—from a linear sense of Earth's history to a resource-centered vision of seeing the sedimentary past as the extractable future—while suppressing other ways of knowing and seeing.

With this emphasis on visual grammars, I examine the formative roles of recording and storage media in producing geoscientific knowledge, including geological maps, fossil catalogs, and photographs and films of snow, ice, and coral reefs. Many of these media deployed by scientists to conceive, probe, and construct Earth's deep history were entangled with the shifting geopolitical interests of multiple empires, including those of Japan and the United States. Focusing on the twentieth century—covering Japan's imperial period, its defeat after World War II, and the Cold War—I explore the dual role of media in shaping both empires and the geosciences. In doing so, I also gesture toward one of the contradictions of modernity: It supplies the tools for critiquing it.[11] This contradiction is exemplified by the study of anthropogenic climate change through the stratigraphic analysis of extracted cores from polar ice and coral reefs. The collection of scientific data contained in these sample cores and other specimens is complicit with both colonial violence and imperialism, and yet enabled the development of climate science that demonstrated industrial modernity's excesses. This book itself benefits from the current critique of anthropogenic climate change. With this contradiction in mind, I present a media theoretical analysis of geoscientific knowledge production and its connections to imperialism and resource extraction, which predate and anticipate contemporary digital media's dependencies on rare earth minerals, fossil fuels, and other elements.

A reminder of this continuity between the past and the present is Toyoha Mine, listed on Lyman's geological map of Hokkaidō. For decades, Toyoha Mine materially supported the growth of Japan's national economy by producing indium, lead, silver, and other industrially useful metals.[12] Until its closure in 2006, it was one of the world's largest producers of indium, a silvery-white critical mineral, which is embedded in semiconductors and the transparent, conductive films of the display screens of smartphones and computers. Indium is thus indispensable for producing digital screen devices that many of us regularly touch and watch. The del-

eterious impacts of these digital technologies on Earth's biosphere, geosphere, atmosphere, and hydrosphere are unmistakable. Mining rare and critical minerals like indium and disposing of digital gadgets contribute to both environmental degradation and climate change, leaving tails of toxic waste, boreholes, and other telltale signatures of the planet-altering effects of human activities.

Yet, as in many places where critical minerals and metal ores are extracted in the world, the history of the mine's surrounding areas dates back further, beyond the narrative of productivity and prosperity. The expansion of Toyoha Mine was enabled by the rapid colonization of the island by Japanese settlers and American advisors in the nineteenth century. Traces of this violence are inscribed on Lyman's map's surface along with the island's geological features and symbols marking the locations of mineral resources. Like the invisible presence of indium in our digital screens, the transoceanic scope of these entangled histories is hard to see, for their traces are scattered across natural and human-made archives. The aim, then, is to make these entanglements visible and legible.

VISUAL INSCRIPTIONS AND TECHNOLOGICAL MEDIATIONS

The vertical view of Earth discussed above profoundly affects our understanding of anthropogenic climate change today. The contested epoch of the Anthropocene acknowledges the geophysical impacts of humans on Earth. Although scientists have proposed, debated, and officially declined to adopt this periodization in 2024, it continues to offer a crucial vantage point for reflecting on human impacts on the planet. Stratigraphic markers of these impacts are left as visible and invisible material signatures: increased greenhouse gases resulting from the burning of fossil fuels, the proliferation of radioactive materials and plastics, and other synthetic elements scattered and accumulated across the planet. Earth's subterranean depths and aerial heights now appear as *natural archives* that store valuable data to measure the extent of these impacts.[13]

The research for this book began with my interest in this analogy of natural archives. I wondered what a media theoretical analysis of visual inscriptions associated with the anthropogenic markers of the Anthropocene would look like when approached through the lens of film and media studies, science and technology studies, and critical studies of empire and settler colonialism. The debates about these markers and the more significant issues of human-induced climate change and environmental

destruction remain absolutely crucial for imagining the planet's future as well as understanding the debt of the present.

This book also has a personal beginning. About a decade ago, my father passed away, and I found two tattered identification documents—a set of international driver's licenses, to be more precise—among his possessions. The first license listed his birthplace as "Karafuto," the name of Japan's former settler colony on the southern half of the island of Sakhalin, located further north of Hokkaidō. The second one, dated a decade later, listed his birthplace as "U.S.S.R." I contemplated his decision to write down these two names, the geopolitical shift they implied, and the disappearance of both political entities by the time I came across the documents.

My father was born and raised in what is now the Russian island of Sakhalin, the younger son of a Japanese settler family that migrated from Tokyo to this northern colony two decades after Japan acquired the territory following the Russo-Japanese War (1904–1905). Losing four siblings while growing up on the island, he rarely spoke about his life there, including the three years that he spent under the governance of the Soviet Union after it occupied the entire island in August 1945.

Today, a crude oil and liquefied natural gas export terminal sits at Aniva Bay near the coastal town of Aniva, where my father grew up. Together with Hokkaidō and the Kuril Islands, the island of Sakhalin forms the ancestral homeland of the Ainu people. During the Japanese colonial era, this town was called Rūtaka, an Ainu place-name adopted by Japanese settlers, as were many other place-names on Sakhalin, Hokkaidō, and the Kuril Islands. Hydrocarbons that have accumulated over millions of years under the sea near the island are extracted and shipped from this terminal to Japan to fuel its electric grids. As my father's documents attest, geopolitical borders were drawn and redrawn above this sub-Arctic island's resource-rich strata. I wanted to learn more about their entangled histories and my own place within them.

The following chapters, however, do not focus on personal histories. Instead, I explore the production of scientific knowledge that ranges from petroleum geology to paleontology, meteorology, snow physics, coral reef ecology, and climate change science. I follow the production and circulation of specimens and visual inscriptions, including the graphic, photographic, and filmic records of fossils, geological strata, polar ice sheets, snow crystals, clouds, and coral reefs. Many of these objects and inscriptions helped establish stratigraphic markers of the

Anthropocene and evidence of Earth's geological and climate history—or "deep time," as it is colloquially known.

I examine how the production of this geoscientific knowledge intersected with the expansion and contraction of two archipelagic empires in the Pacific: Japan and the United States. Focusing on the work of scientists working first within the parameters of Japan's colonial empire and later in the research milieu fostered by the mutual security alliance with the United States during the Cold War, I explore the overlapping moments between the geoscientific history of studying Earth's deep time and the geopolitical history of territorialization, militarization, and extraction in the Pacific and the polar regions.[14]

One of the organizing threads of this book is the process of vertical territorialization of the islands, seas, and skies by state-affiliated actors, be it through imperial geological surveys of the colonized lands for resource exploration or the militarization of the occupied and geopolitically strategic lands for security purposes. I analyze how this vertical territorialization relied on recording and storage media, from geological maps to cloud atlases to microphotographs of snow crystals and radioautographs of corals.[15] The visual inscriptions and specimens associated with the vertical mapping of Earth's subterranean depths and aerial heights were produced, circulated, and exchanged within and across empires and colonies. These objects are what Bruno Latour calls "immutable mobiles," standardized inscriptions that operate as "technical mediators" of scientific knowledge as they actively construct, translate, disseminate, and organize information.[16]

To highlight the decidedly visual aspect of scientific inscriptions and images analyzed in the following chapters, I offer a heuristic framework of visual grammars to describe the codified modes of seeing, visualizing, measuring, and documenting the subterranean depths and the aerial heights embedded in and expressed by the maps, catalogs, atlases, specimen photographs and films of geological strata, fossils, snow crystals, clouds, and coral reefs that Japanese, American, and European scientists produced. These visual grammars reflect and are shaped by the geopolitical interests of multiple empires and states in the Pacific and other regions, including the Antarctic and Arctic.

Grammar is generally understood as a set of rules and conventions that govern sentence structure, sounds, patterns of word arrangement, and other syntactic and morphological elements of a particular language.[17] When applied analogically to visual inscriptions, it allows me to

parse graphic codes, aesthetic conventions, and compositional variations that register as recognizable visual patterns and semiotic idioms. These include medium-specific visual conventions (e.g., time-lapse cinematography) and scientific discipline-specific graphic conventions (e.g., stratigraphy). I also adopt this analogy of grammar to describe the underlying political and territorial assumptions anchored in the vertical and extractive modes of seeing the subterranean depths and the aerial heights.

Visual inscriptions examined in the following chapters directly and indirectly convey codified modes of seeing and inscribing the world, particularly these vertical and extractive modes of seeing Earth. These assumptions operate much like what Michel Foucault calls an "episteme." An episteme is a set of rules and relations that govern and organize the discursive formations and knowledge production of a given historical era. An individual writer or scientist does not consciously adopt these rules; instead, the episteme operates as a structuring condition of possibilities for these discursive formations and knowledge productions.[18] The "grammars" in this book thus apply to the *visible* dimension of inscriptions as well as the *invisible* dimension of organizing forces behind them. By weaving together my analysis of the visual and epistemic dimensions of the grammars of codified modes of seeing and inscribing the world, I examine how the tropes of storage, trace, archive, reservoir, deposit, sediment, preservation, and conservation have appeared and shaped the scientific and political discourses of archipelagic empires. I also pay close attention to the metaphors and analogies of communication, recording, and storage media—letters, encrypted codes, time capsules, and indexes—frequently used by scientists to describe natural elements.

Questions of language and grammar are constitutive of geoscientific knowledge production. As historian of science Martin J. S. Rudwick argues, the discipline of geology developed its own "visual language" to construct and communicate epistemic assumptions about Earth's depths and structures.[19] In a similar vein, geographer Kathryn Yusoff uses the term "geologic grammars" to describe "the epistemes of geology as material, theoretical, and temporal praxis that surveys, categorizes, catalogs, and classifies minerals and the broader divisions that are established between Life and the inhuman."[20] Geology, as Yusoff argues, emerged out of and fortified the European colonial and white supremacist conceptions of the world and the human.

While drawing on these critiques of geology's normative and regulatory operations, as a media studies scholar, I focus on the operations of

technologies that supported the production, circulation, and preservation of scientific inscriptions. Along with geological and biological specimens, these inscriptions helped measure, map, document, store, classify, and order the geoscientific and territorial understandings of the islands, seas, and skies within and beyond the borders of the archipelagic empires. By foregrounding the visual conventions, graphic codes, and epistemic assumptions underpinning these inscriptions from a media studies perspective, I demonstrate how the shifting geopolitical alliances and territorial ambitions of archipelagic empires have shaped and are reflected in their visual grammars.

Conventional histories of media usually focus on the development, circulation, and infrastructure of a single medium of communication, transmission, transportation, or storage of information and objects, along with their social impacts and industrial formations.[21] These histories may be of technologies ranging from the printing press to photography and cinema, the railroad to wireless radio, and television to digital computers. These technological inventions are also adjacent to the history of science: Sometimes scientific discoveries of new phenomena—say, radio waves and cathode rays—inspired curious engineers to tinker with devices in the laboratory, eventually resulting in the invention of new communication media such as radiotelegraphy and cathode-ray televisions. The science and art of observing and documenting the world were, in turn, brought closer to one another by the invention and the shared use of photography and cinema.[22]

My analysis of visual inscriptions of the geosciences is also anchored in the studies and histories of science and technology, though I do not stay with a single medium. Instead, I reserve the term *media* to refer to an assemblage of visual inscriptions and scientific specimens that helped to mediate—that is, construct and translate—geological, climatological, and ecological knowledge. As I elaborate below and in the following chapters, the term *media* applies to visual inscriptions such as geological maps and fossil catalogs, as well as specimens of snow crystals, ice cores, and corals.

With a focus on cartographic, photographic, and cinematographic records, I emphasize the media's recording and storage capacities rather than their communication, transmission, and data processing functions. In so doing, I parse out three levels of *mediation*: (1) the mediatic operation of natural elements and specimens, such as snow crystals, ice sheets, clouds, fossils, coral reefs, and geological strata, as nonhuman actants in

the production of knowledge; (2) the medium specificities and visual conventions associated with the technical medium, including photography and cinema; and (3) technical mediation as the processes of construction, codification, translation, and dissemination of scientific and colonial knowledge as is facilitated by visual inscriptions, such as geological maps.

Within the context of this book, the three levels of mediation are intertwined. The natural elements and specimens that operate as the nonhuman agents of knowledge production (first level) are often the material referents of visual inscriptions produced with the aid of technical apparatuses and devices, from the camera to the microscope (second level). These apparatuses and devices have their medium-specific affordances and limits that impact the visual grammars of these inscriptions. Meanwhile, material specimens and visual inscriptions, along with human actants, operate as technical mediators that help construct, translate, and disseminate observations and interpretations into knowledge (third level). They also help naturalize and codify particular modes of seeing and knowing. The analogy of natural archives emerges from this third level, leading to the view that certain elements and specimens, such as fossils and snow crystals, are functionally similar to technical recording and storage media. These three levels of mediation as analytical registers are operative in each chapter, albeit with varying emphases.

Over the past decade and beyond, film and media scholars working at the intersection of environmental humanities have turned to the materiality and technicity of media in an expanded sense.[23] In part, this expanded approach to the study of media in North America was propelled by the work of German media scholars, including Bernhard Siegert, who argued that the study of inconspicuous technical objects, such as paper, stamps, or telescopes, can be construed as media history if the symbolic operations of these objects serve as a reference system for analysis of bureaucracy, communication, or technically mediated vision.[24] However, instead of focusing on the recursive symbolic operations of media (characteristic of the German media theory), the expanded approach to media I undertake in this book is more in tune with the recent "elemental" turn within media studies, exemplified by the work of environmental media scholars as diverse as John Durham Peters, Nicole Starosielski, Jussi Parikka, Lisa Han, Melody Jue, Weihong Bao, Shannon Mattern, Liam Cole Young, and Rafico Ruiz, among others.[25] They have shown that natural elements and environments such as the weather, heat, atmosphere, ocean, seaweed, soil, salt, and ice might be studied as "media" in their own

right, as they operate as conduits—analogically and not—for the communication, transmission, and storage of data.

Moreover, as Indigenous studies scholars have argued, the elements are deeply embedded in histories of settler colonialism and imperialism. The colonial and anticolonial dynamics of power and historical imaginaries have actively shaped how certain elements are perceived and continue to shape bodies and environments. Hiʻilei Julia Kawehipuaakahaopulani Hobart critically traces how the production and circulation of comestible ice in Hawaiʻi were mediated by the normative perception of coldness and comfort imposed by white American settlers. This thermal normativity was firmly yoked to the racial, gendered, and classed hierarchies of power.[26] As Jen Rose Smith elegantly shows in her elemental analysis of Arctic ice as a racialized material geography and imaginary, ice containing tiny air bubbles is also an active participant among other respiratory beings that hold and release breath, like humans, plants, and microbes, whose stories cannot be measured simply by science.[27]

I build on these works of environmental humanities and offer a more media-centric analysis of earthly matters. However, this does not mean *all* fossils, rocks, minerals, snow crystals, ice cores, and clouds can be considered media. Herein lies my contribution to environmental media studies: These elements operate and are deemed to be operating as recording and storage media under particular circumstances and contexts. They become mediators of knowledge production in specific and limited ways, such as when they are represented through the metaphors and analogies of technical media, as ciphers and indexes of atmospheric conditions, records and documents of geological information, or repositories and archives of climatological data.

Other scholars working at the intersections created by environmental media studies have turned to the extractive practices of mining precious metals and rare earth minerals, such as cobalt and lithium, needed to generate and maintain digital media devices and renewable energy infrastructures. Various types of materials are required to manufacture and operate our telecommunications and computational devices. Many of these devices are designed to become obsolete after a few years, turning into heaps of toxic e-waste.[28] In the meantime, energy-intensive data centers continue to rely on nonrenewable fossil fuels to maintain the daily connectivity of social media, streaming video, AI, and the cloud computing that supports these.[29]

While taking inspiration from this focus on the contemporary infrastructure and logistics of mining, processing, and supplying metals,

minerals, and fossil fuels to sustain today's digital media networks, the following chapters focus on the *predigital era* of recording and storage media—in particular, photography and cinema—to examine the development of knowledge and grammars of deep time in relation to the histories of geosciences, colonialism, imperialism, and resource extraction in the Pacific and the polar regions.

Take, for instance, the mining of rare earth elements and critical metals, such as indium—indispensable for the production and operation of digital media infrastructures, consumer electronics, and military gear (all of which run on the same microchips). Understanding digital media's reliance on the extraction of minerals requires a material perspective on media, or what Jussi Parikka has aptly termed a geology of media or media geology.[30] His media geology is inspired by, yet differs from, the methodological approach known as media archaeology, which heuristically applies the metaphor of deep time to media technology in order to excavate obsolete and forgotten objects and trace discontinuities and connections across archives.[31]

Instead of treating deep time metaphorically, Parikka urges us to examine the materiality of metals, minerals, and fossil fuels used to source and power the production, distribution, and consumption of analog and digital media. Having accumulated over millions of years, these geological and mineral resources are the literal embodiment of Earth's deep time.[32] Shannon Mattern likewise encourages "media infrastructure scholars, urban historians, even engineers and urban designers . . . to look at the *deep time* of media infrastructure."[33] John Durham Peters, by contrast, has compared Charles Darwin to a media scholar who approached the fragmentary geological records as a set of hieroglyphic inscriptions that required careful decipherment.[34] This book in part responds to their calls to approach media history with and through geology and earth science, and vice versa.

Since the mid-2000s, the Japanese government has increased its investment in deep-sea mining for rare earth metals and minerals to identify alternative sources of these elements, for which it otherwise relies heavily on imports from China. The seabed around the small coralline island of Minamitori-shima (aka Marcus Island), a former site of guano mining that marks the southeastern edge of Japan's exclusive economic zone, has emerged as the most promising site. It has been dubbed the future "frontier" of Japan's resource extractivism. As with Hokkaidō in the nineteenth century and the polar regions in the twentieth century,

the surrounding seabed of this little island has consequently become an object of vertical territorialization.

While keeping this contemporary resource exploration in mind, *Archives of the Anthropocene* examines earlier moments of vertical territorialization in the Pacific and the polar regions in order to contextualize today's rush for deep-sea mining and other modes of mineral extraction that materially support the production, circulation, and operation of digital media technologies. From the seafloor to Antarctica—where natural resource extraction is legally banned—drilling and mining industries are eyeing the next frontier of rare earth metals and critical minerals. But exploration and prospecting precede extraction. The following chapters examine this preliminary stage of searching, exploring, documenting, and collecting specimens and data by scientists and surveyors.

GEOGRAPHIES AND ARCHIPELAGIC ORIENTATIONS

Finding tangible traces of Earth's deep time enchanted many Japanese scientists and surveyors who went on to study and document rocks, oil patches, fossils, coral reefs, and ice sheets in Hokkaidō, Sakhalin, Minamitori-shima, Okinotori-shima, Palau, the Marshall Islands, Greenland, and Antarctica. The archival footprints of these figures are found far away from the metropolitan centers of Western science. Yet, their knowledge-making still served the interests of states and extractive industries, even if sometimes inadvertently.

The maritime borders of the Japanese Empire once extended from the rocky islands of Sakhalin and the Kurils in the sub-Arctic Pacific to the reefs and atolls of the Palau, Caroline, Mariana, and Marshall Islands in the tropical Pacific. It also harbored imperial ambitions to assert territorial claims in the polar regions, particularly Antarctica. The main sites of this book's analysis are places where Japanese, American, and European scientists and surveyors flocked to hunt for oil deposits, guano, phosphate ore, and other precious metals and rare earth minerals while collecting, photographing, observing, and cataloging specimens of fossils, rocks, snow crystals, clouds, and corals. Many of these sites are located on the ancestral homelands of Indigenous communities and nations that multiple empires and settler states have occupied and controlled since the late nineteenth century.

The voyages of scientists and surveyors to these islands were also parallel to and followed by scientific expeditions and fieldwork in the polar

regions, including Greenland and Antarctica. Japan, the United States, and Russia (and then the Soviet Union) sent scientists to map, measure, sample, and classify geological strata, glacial ice sheets, mineral resources, and meteorological phenomena using various forms of inscription and visualization. The movement of these scientists was heavily determined by the geopolitical dynamics of the time, but a sense of wonder also drove them.

Like their Euro-American counterparts, many of these Japanese scientists viewed the strata of the continent and islands they visited as repositories of archived data that could unlock the secrets of the planet's past. The land was central to them, simultaneously as fascinating natural archives and territories to be added to the empire's map, and they often had little regard for the sovereignty of Indigenous communities that call many of these lands their home.

Sometimes, these Japanese scientists couched their studies in terms of resistance to Western scientific hegemony. Their effort to decenter the Euro-American metropoles as the default centers of science has its value. However, I insist on not overvaluing this gesture of decentering Western knowledge, for decentering Western knowledge cannot be conflated with a decolonization that seeks Indigenous peoples' sovereignty, self-determination, and rights to access and protect their ancestral lands, waters, and skies.[35] Much of the theoretical work around settler colonialism focuses on the Euro-American colonies. Yet, Japan is also a settler state as it refuses to recognize the sovereignty of Ainu and Ryūkyūan/Okinawan peoples in Hokkaidō and Okinawa, respectively.[36]

To highlight the overlapping zones of geopolitical interests among the Japanese and Euro-American empires, the trajectory of *Archives of the Anthropocene* geographically arcs from the sub-Arctic region of the Pacific through tropical waters and islands to the frozen continent of Antarctica, with a detour through Greenland at the border of the Atlantic and Arctic Oceans. I nudge the reader to look closely at the ice, rocks, fossils, minerals, and corals mapped, sampled, filmed, and classified through the mediation of the microscope and other instruments. I lift their gaze upward to see the shapes and forms of clouds and snowflakes captured by the camera and sorted neatly into illustrated atlases. I also direct attention downward to the sedimentary layers that make up the ground. And I heed the entanglement of the tiny and the gigantic, the organic and the inorganic, and the human and the nonhuman as their conceptual boundaries are drawn and redrawn like the territorial borders of empires and nations.

Islands and archipelagos are geographical and geopolitical entities that have significantly shaped Japan's territorial expansionism, as it aspired to become an island empire—or, more precisely, an archipelagic empire.[37] Many islands that came into contact with or were incorporated into the Japanese Empire from the late nineteenth to the early twentieth century—Sakhalin, Hokkaidō, Minamitori-shima, Okinotori-shima, the Palau, Caroline, Mariana, and Marshall Islands—were intensively explored and surveyed for scientific and economic purposes.

An archipelago is an ocean-centric view of an island chain, defined as a group of islands and their surrounding waters. I foreground the notion of *archipelago* as a gesture of solidarity with scholars who engage in archipelagic thinking (or archipelagic thought) in American studies, Pacific Island studies, and Caribbean studies—a move that is deeply aligned with anticolonial and comparative approaches to studying the histories and residual impacts of settler colonialism, imperialism, geography, and culture from the standpoint of archipelagos rather than continents. This approach allows researchers to critically overturn the colonial tropes of islands as insular, isolated, remote, uninhabited, peripheral, and open for conquest.[38]

Just as it moves between centering the water and centering the land, the very notion of the archipelago is split between imperial and anticolonial orientations.[39] Brian Russell Roberts and Michelle Ann Stephens call for decontinentalizing the study of American culture by turning to the expansion of the United States as an archipelagic empire that forcibly annexed, purchased, and occupied islands in the Pacific and Caribbean to expand and consolidate its territory in the Philippines, Puerto Rico, Hawai'i, Guam, and many other places since the nineteenth century. This methodological turn toward an archipelagic study of the Americas is inseparable from an anti-imperialist and transnational understanding of insular and archipelagic spaces.[40] As Tao Leigh Goffe observes in her geological analysis of the sedimented legacy of Asian indentured laborers who toiled to extract guano, mineral-rich bird excrements on the Caribbean and Pacific islands, "To think archipelagically is to think in connection like an island chain, to see the connected suffering caused by the various institutions of racial capitalism."[41]

My framing of Japan as an archipelagic empire that expanded and reimagined its territorial unity around islands in the Pacific builds on these preceding works in the interdisciplinary field of archipelagic studies. In their call for archipelagic thinking, Yolanda Martínez-San Miguel and Michelle Stephens write: "Archipelagoes happen, congeal, take place.

They are not immanent or natural categories existing independently of interpretation. Yet they can also become an episteme, an imaginary, a way of thinking, a poetic, a hermeneutic, a method of inquiry, a system of relations."[42] Bridging archipelagic and transpacific studies, sociologist Haruki Eda also critiques methodological nationalism for obscuring Indigenous and diasporic experiences.[43] In the following chapters, I focus on the relational making of the Japanese archipelago as an effect of an imperial imaginary of unified geopolitical territory, similar to and related to that of the United States.

To think of islands and archipelagos nonhierarchically is to move away from the territorial imagination of empires and nation-states. Japanese cultural anthropologist Imafuku Ryūta, whose work follows in the footsteps of Fijian and Caribbean writers Epeli Hau'ofa and Édouard Glissant, argues that thinking relationally is much needed in Japan today.[44] At the same time—and as Alexander Zahlten argues in his analysis of the documentary film *Asia Is One* (1973), shot in Okinawa and Taiwan in the wake of Okinawa's contested territorial "reversion" from the United States to Japan—a much more ambivalent take on archipelagic thought also exists in postwar Japan.[45]

While these works emphasize the distinction between viewing *an* archipelago and viewing and thinking *from* it, it is necessary to recognize the semantic and conceptual ambivalence of the term *archipelago* in Japan. Japan was an archipelagic empire, not originating on the continents, even though it borrowed the continental biases against island colonies. Its practice and use of the term as part of modern scientific knowledge production, including geology, were aligned with its settler colonial project. In other words, beginning *from* an archipelago does not mean an anticolonial orientation is inevitable.

Etymologically speaking, *archipelago* (*archi* meaning "principal" and *pelagic* meaning "sea") shares the Greek root word *arkhē* (meaning "government," "beginning," "origin") with another word: *archive*. *Archipelago* and *archive* are oriented toward the forces of origination and foundation, including the founding of the government or governing through foundational myths and the law. The archive is inseparable from the establishment of the institutional authority.[46] The geological knowledge of the Japanese archipelago contributed to the construction of such founding myths of the empire as a geopolitically unified territory.

One place to critically examine the expansion of Japan as an archipelagic empire and the development of geology is a subtle terminologi-

cal shift that occurred in the early twentieth century. During the 1910s, geologists and geographers began referring to the Japanese archipelago as *rettō* ("a line of islands" or "a chain of islands") instead of *guntō* ("a group of islands").[47] Both *rettō* and *guntō* are translated into English as "archipelago." Although the semantic difference between the two is lost in the English translation, the timing of this terminological shift in the Japanese geographical and geological writings is worth noting.

Take, for instance, the *Geological Map of Japanese Islands* (1889)—the first geological map to cover the modern state of Japan—which used the phrase *Nihon guntō* ("a group of Japanese islands") in its title. Notably, after Japan regained control of the southern part of Sakhalin from Russia in 1905 and officially annexed Korea in 1910, the use of this phrase to describe the Japanese archipelago appears to have declined. Instead, *rettō*, or "a chain of islands," became more common. In other words, as the territorial borders of the Japanese Empire shifted and expanded, so did its strategic view of the archipelago.

To support this terminological shift from a *group* of islands to a *chain* of islands in the early twentieth century, I offer a brief example from a 1909 lecture by the Japanese geologist and geographer Ogawa Takuji. The term *group* had been in use since the work of Heinrich Edmund Naumann, a German geologist hired as one of the foreign advisors by the Meiji government, who taught at the Hokkaidō Development Agency school and established the Geological Survey of Japan in 1878. Citing Naumann, Ogawa discusses a future need to revise the terminology to accommodate the expansion of the empire.[48] In the ensuing years, geologists and geographers adopted the term *chain* to describe the Japanese archipelago, which stretched north to south from Sakhalin to Okinawa and Taiwan in a single large arc, flanked by the Korean Peninsula across the Sea of Japan. I speculate that this subtle terminological shift indicates a nascent geopolitical awareness of Japan's linear unity as an archipelagic empire. The imperial vision of the empire's island territories manifests in the unity of a single arc.

Throughout the book, I also use the contested term *Anthropocene* to analyze the overlap between geoscientific knowledge production and empire-building. I do so to underscore the problematic figure of the "human," or *anthropos*, implied by its name. The questions of the human, who counts as human, why and when, are also part of my inquiry into the visual grammars of deep time. The Anthropocene, as an unofficial periodization, signifies the unique moment in Earth's history when the

human species has become not only an agent of human history but also an agent of Earth's history.[49]

As historian Dipesh Chakrabarty famously argued, the Anthropocene and its attendant anthropogenic climate change have blurred the conceptual boundary between natural history and human history, inviting scholars to bridge "recorded and deep histories of human beings."[50] Others have critiqued the political assumptions and shortcomings of the universal associated with the figure of *anthropos* and proposed alternate nomenclatures such as Plantationocene, Capitalocene, and Chthulucene.[51] Now that the proposal to formally recognize the Anthropocene as a distinct geological epoch has been rejected by geologists, holding onto this term may seem anachronistic. However, I continue to use this term in order to examine the connections across debates around this geological periodization, the figure of the human, and their relationship to the processes of vertical territorialization of the islands, the seas, and the skies.

READING ACROSS ARCHIVES

Archives can only exist with recording and storage media that preserve information. All media formats—from written documents to film strips to scientific specimens—can serve as recording and storage media, comprising various archives and collections of archival records and artifacts. I use a critical method of reading across archives to analyze the centrality of recording and storage media to the formation of geosciences and archipelagic empires with an eye toward the Anthropocene debates.

In her influential critique of liberal humanism and its racialized definition of the "human," Lisa Lowe emphasizes the methodological importance of reading across archives. Lowe observes that the state-run archives housing collections of papers, records, tables, statistics, correspondence, and legal documents related to the colonial administration and trade of the British Empire are organized by geographical areas and territories. This geographical organization of the archives "discourages links between settler colonialism in North America and the West Indies and the African slave trade; or attention to the conjunction of the abolition of slavery and the importing of Chinese and South Asian indentured labor; or a correlation of the East Indies and China trades and the rise of bourgeois Europe."[52] This organizational logic of the colonial archives that compartmentalizes information along geographical units makes it difficult to understand how the colonial taxonomy of race, the racialization of unfree

and free labor, and the liberal humanist narrative of freedom developed relationally.

To read *across* archives is, therefore, to read them *relationally*. In doing so, one may trace what Lowe calls "the intimacies of four continents" obscured by this organizational logic of colonial archives in order to undo institutionalized "forgetting" of the "colonial divisions of humanity," which provided the conditions of possibility for the emergence of liberal humanism and its abstract promises of freedom, personhood, and the rights to property.[53]

In my analysis of the geological map of Hokkaidō in this introduction and other media in the following chapters, I follow Lowe's critique of the archive as an organizational practice that obscures and enforces forgetting of intimacies and connections that exist across disciplinary separations, geographical divisions, and classificatory systems. Building on this work, I bring together a wide range of overlapping archives, both literal and figurative, visual and written, official and unofficial.[54] These archives include: first, the material strata and sediments that form metaphoric "natural archives" of deep time; second, the scientific documents, specimens, and discourses produced and circulated through academic and state institutions; and third, the colonial documents, records, and discourses on the exploration and expropriation of distant and nearby lands and their underground resources.

Both the literal and figurative understandings of the archive are integral to the discipline of geology. The historical emergence of geological strata as a natural archive, holding critical information about Earth's history preserved in the storage media of rocks and fossils, should be noted. At the basis of this analogy were metaphors of rocks and fossils as "nature's own documents," a view that emerged and consolidated in the late seventeenth and early eighteenth centuries. As Rudwick asserts, "These were metaphors, but far more than 'mere' metaphors: they did serious explanatory work. Rocks and fossils could even be treated as nature's own documents, written as it were by nature's own witnesses to events long past."[55]

In the nineteenth century, this way of analogizing geological strata to archives and fossils to documents was cemented by the invention of stratigraphy, which advanced the idea that distinct layers of geological strata hold different types of fossils. Stratigraphy remains one of the most essential tools for defining geological periods, including the Anthropocene. Understanding these fossils as nature's documents meant acknowledging

that they were deposited at different moments in the history of the planet.[56] Instead of simply collecting and classifying individual specimens such as the bones of animals and rocks of minerals as curios, geologists—after the stratigraphic turn—looked at the "correlation of strata across space" to reconstruct Earth's deep history. Based on the "superposition" principle, they reconfigured the spatial relationship among the strata into a temporal one. At this moment, the vertical depth of Earth became the chronological signifier of deep time.[57]

As historian of science David Sepkoski observes, the development of stratigraphy also gave rise to an analogy of an archive applied to strata. Stratified layers of the earth were compared to books and specimen drawers: "First, the recognition that the history of life appears to be directional reinforced the sense that geology has an essentially genealogical component. Second, the physical arrangement of the strata, layered on top of one another in precise chronological sequence, closely resembled the pages of a book or the drawers of a specimen cabinet. Thus, both in a conceptual sense—as a repository of genealogical information—and in a physical sense—as an organized cabinet of information—the geological record appeared to be a natural archive."[58] Geological strata and books, then, began to be viewed as comparable *storage media* for archiving information about the past.[59]

Archives are always already ordered and conditioned by the preceding logic of exclusion.[60] Scientific archives of inscriptions, records, specimens, and artifacts are not only repositories and collections of information; they also provide organizational frameworks that shape our interpretation of what counts as science and should be included in its archives, and what does not and therefore should not be included in its archives.[61] Similarly, the records of the Japanese archipelagic empire are archived in various institutions that both organize historical knowledge and, in turn, are organized by it. Yet, as above, the analogy of Earth as a natural archive obscures the logic of exclusion that accompanies human-made archives; it naturalizes the collection and storage of historical information as if they are geological cabinets full of sedimentary books and fossil documents simply waiting for someone to access and read them. When the analogy of Earth as a natural archive circulates and returns to our human-made archives, it obscures and naturalizes the organizational processes of collection and storage and their inherent logic of exclusion.

As an example of my methodological strategy of reading across natural, scientific, and colonial archives, let me return to Lyman's geological map of

Hokkaidō to illuminate how the settler colonization of Hokkaidō, the dispossession of the Indigenous land, the vertical strata of this island's sediments, and the geological mapping of Earth's deep history are connected.

GEOLOGICAL SURVEYS OF HOKKAIDŌ OF THE 1870S

Hired by the Japanese government as a chief geologist in the early 1870s, Benjamin Smith Lyman mapped mineral resources on this island with the help of his American assistant, Henry Smith Munroe (in charge of surveying gold fields) and his Japanese assistants, whom he taught at the Hokkaidō Development Agency school. Some of Lyman's student assistants who participated in this project became critical players in Japan's mining industry, as in the case of Shimada Jun'ichi, later the executive manager of Mitsui Mining and Smelting Company. Lyman's *Preliminary Report on the First Season's Work of the Geological Survey of Yesso* (1874) clarifies the economic instrumentality of his geological surveys (rather than their scientific purposes). This instrumental function of geology is manifested in the bulk of the report being devoted to a chapter titled "Economic Geology," which examines extractable resources, including coal, iron-sand, sulfur, limestone, gold, rock tar, and mineral springs.[62]

Two years after submitting this report, Lyman and his team completed the map with which I open this book: *A Geological Sketch Map of the Island of Yesso, Japan* (1876) (figure I.1). This beautifully colored geological map was the summation of their island surveys. Unlike the written reports that Lyman regularly produced to update the Hokkaidō Development Agency, the map offers information on various rock formations, coal and gold fields, and other mineral resources and short observations about the economic viability of mining them. At first glance, the map does not indicate the settler colonial nature of its production.

However, one can read this scientific visual inscription as part of Japan's unofficial colonial archive. One way to read the traces of settler colonialism within this geological map is to pay attention to the periodization of the island's geological history in a stratigraphic column. Located on the left side of the map, this vertical column lists rock formations and sedimentary strata corresponding to different geological periods and eras. Moving from the top to the bottom of the column, the list includes New Alluvium, Old Alluvium, New Volcanic Rocks, Toshibets Group, Old Volcanic Rock, Horumui Group, and Kamoikotan Group. Color-coded in light brown, Kamoikotan Group sits at the bottom of this vertical rendering of

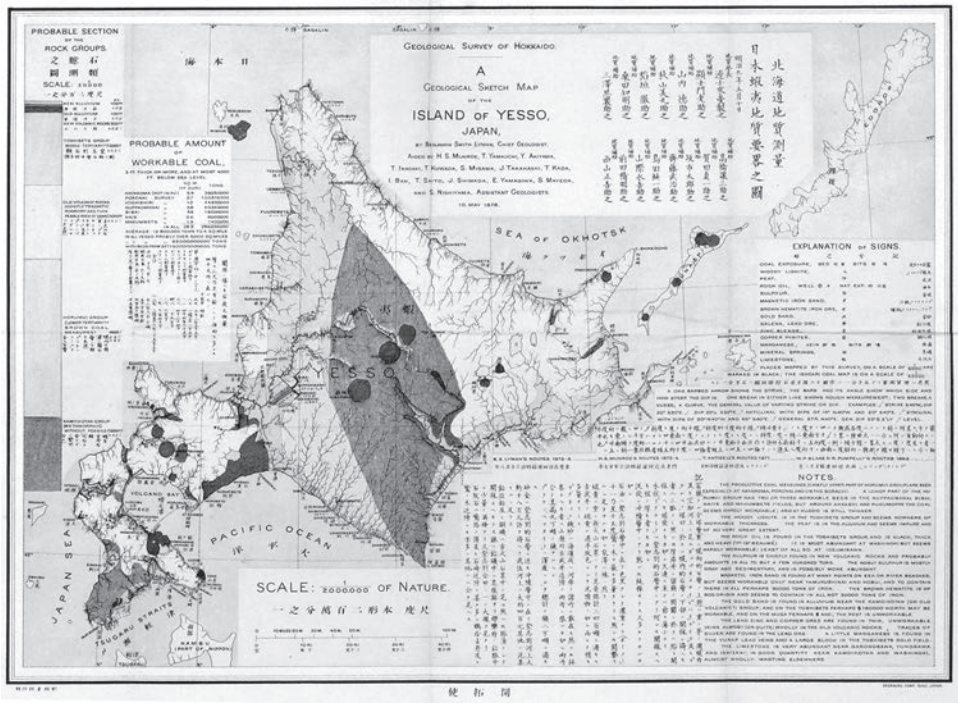

FIGURE 1.1. Benjamin Smith Lyman, *A Geological Sketch Map of the Island of Yesso, Japan* (1876). Source: National Library of Finland. CC PDM 1.0.

the earth. In parenthesis, the note indicates that this is a metamorphic rock formation without fossils. This is presumably the oldest layer of the island that Lyman's team could excavate.[63]

What the map does not explain is the fact that the word *Kamoikotan* (or *Kamuykotan*) means "Home of the Gods" in the Ainu language (*kamuy* meaning "fearful god" or "powerful deity," and *kotan* meaning "village").[64] It is also the name of a gorge near the Ishikari River.[65] There is a profound irony in naming the island's oldest strata—now a vertically colonized territory—as the home of the gods *for* the Ainu people. Under the Hokkaidō Development Agency's directive, the Ainu people were subjected to systematic dispossession, assimilation, and discrimination that suppressed their beliefs and relations to their land. Many places listed on Lyman's map bear Ainu toponyms and hydronyms, just as they do today in Hokkaidō, yet their meanings to the people who intimately observed the island's terrains and bodies of water are erased.

As Ainu linguist Chiri Mashiho argues, place-names reflect the Ainu people's ways of knowing and living with the land.[66] Like other forms of place-based knowledge, they preserve and communicate careful observations of geological, geographical, and ecological features of strata, mountains, rivers, estuaries, bays, lakes, wetlands, and islands, which mediate their kinship and connections to Ainu Mosir. These place-names also designate specific locations where salmon spawn and where elderberries, hazelnuts, rosehips, grass, reeds, medicinal plants, and willow and other trees are harvested.[67] The ancestral knowledge and the lived history of the Ainu people are preserved in these place-names, forming a counter-archive to Japan's colonial archives that contain Lyman's map.

Most place-names in present-day Hokkaidō—as well as southern Sakhalin and Kuril Islands—originate in the Ainu language, reflecting their relations to these islands. However, transcribing these Ainu place-names into kanji (the Japanese writing system that borrows Chinese characters or ideograms) has severely obscured their meanings. Ainu activist and educator Ogawa Ryūkichi offers a salient example of the colonial violence embedded in the Japanese inscriptions of the Ainu place-names: The frequent use of the ideogram meaning "buttocks" to transcribe the Ainu word *shiri*, meaning "mountain." When applied to sacred mountains, the Japanification of these place-names not only obscures their cultural, cosmological, and historical significance but also constitutes a sacrilegious act.[68] The orthographic mediation through the grammar of the settler language gestures toward the orality of the Indigenous place-name yet erases the ancestral knowledge stored by these names, which guided and oriented the island's original inhabitants for centuries.

In 1997, the Japanese government finally abolished the discriminatory Hokkaidō Former Natives Protection Act (*Hokkaidō kyūdojin hogohō*), established in 1899, which was designed to enforce the cultural assimilation of the Ainu people. To replace it, the government enacted the Act on the Promotion of Ainu Culture, which aimed to protect Ainu cultural heritage. In 2008, the Japanese government acknowledged that the Ainu people are "Indigenous to northern Japan."[69] Finally, the new Ainu Promotion Act, which formalized this recognition into a law, came into effect in 2019. This law, however, fell short of guaranteeing sovereignty or self-governing rights.[70]

In the late 1990s, Ainu activists, including Ogawa and Japanese geographers, pressed the prefecture of Hokkaidō to honor the Ainu roots of its countless toponyms and hydronyms by creating a new signage system

that acknowledged the original meanings of these place-names.[71] This was meant to revive ancestral knowledge that the century-long colonial policies of assimilation and appropriation had suppressed.[72] This grassroots movement successfully replaced a number of signs, and in so doing, shed light on the ongoing epistemic violence of settler colonialism.

I weave this place-based Ainu activism into my reading of Lyman's map because his naming of the island's oldest geological strata as Kamoikotan is part of this settler colonial history. Lyman's map—with which the Hokkaidō Development Agency consolidated the vertical territorialization of the island—indirectly helped displace the presence of the Ainu people, who contested this process of expropriation, to the geological domain of deep time.

Alongside its purpose of producing scientific knowledge for mining the island's mineral resources, the map's appropriation of the Ainu place-names metonymically aligned the Ainu people with the deepest and oldest layer of the island's geological strata, while erasing traces of their coeval presence. As I discuss below, indirectly and in concert with other forms of colonial knowledge production, Lyman's geological map helped to suppress their history and ongoing presence on the island. This symbolic displacement of the Ainu people from the island's historical realm of sovereignty, rights, and documents to the natural historical realm of rocks, minerals, and fossils is an effect of the epistemic violence that I call *geologization*. The grassroots efforts to restore Ainu place-names along with their original meanings resist this epistemic violence, which began more than a century ago and continues today.

Lyman's geological map of Hokkaidō exemplifies geology as Japan's imperial science, which worked alongside other forms of scientific knowledge of deep time to obscure the Indigenous presence and history, and in doing so helped transform the island into a vertical territory of the empire. From the late nineteenth and early twentieth centuries, European and Japanese physical anthropologists turned to the archaeological and paleontological study of artifacts and remains excavated from Hokkaidō to theorize the racial origins of the inhabitants of the Japanese archipelago. Some argued for a direct ancestral link between its prehistoric population and the ethnically Japanese population today, while others argued that the Ainu served as a buffer between the two. One of the theories that came out of this colonial milieu of Japanese anthropology was the idea that the Ainu people were "a racial island," or "an isolate race," whose origins did not neatly map onto the existing racial taxonomy.[73]

Evident in the metaphor of the *island*, this anthropological and archaeological view of the Ainu people as a racially isolated group emphasized the cultural—rather than geographical—remoteness of Hokkaidō (since the island is adjacent to the main island of Japan). Along with Sakhalin (inhabited by multiple Indigenous communities, including the Ainu, Nivkh, and Ui'lta peoples) and the Kuril Islands, Hokkaidō was derogatorily known as Ezochi ("the land of the barbarians") before Japan embarked on its settler colonization efforts. As Pacific and Indigenous studies scholar Vicente M. Diaz reminds us, "Islands are products of continental thinking." Moreover, Diaz cautions that "islands played a privileged role in the production of modern science through evolutionary theory," which, in turn, "played a privileged role in the modern conceptualization of knowledge about island cultures."[74]

While the Ainu people may not be called "Islanders" in the sense of Pacific Island nations, a similar form of epistemic violence has been inflicted on them by the modern knowledge production of geology, archaeology, and anthropology. The anthropological claim that the Ainu people who inhabited this land are a racial island further served the interests of the Japanese Empire. The colonial trope of an *island* with its continental biases and connotations of "insularity," "remoteness," and "backwardness" became associated with the Indigenous inhabitants of Hokkaidō, whom Japanese and European anthropologists presented as a "racial island," isolated from the rest of humanity. Such a view of isolation was combined with the pseudoscientific social Darwinist view of evolution and progress. Together, these manifested in a colonial rhetoric that claimed the Indigenous inhabitants of the island belonged to a "dying race."[75] The mechanism that binds the two ideas—that the Ainu people do not meet the settler colonial and liberal humanist criterion of the right for sovereignty and are left out of evolutionary selection—is a logic of exclusion. Operating with this logic of exclusion, these discursive attempts by anthropologists who imposed the colonial racial taxonomy on the Ainu people made them appear *as if* rightless and without history, or belonging only to prehistory.

By the 1930s, the Ainu people's archaeological presence on the island was gradually erased by a new anthropological theory that the ethnic Japanese were the direct descendants of the prehistoric group of the archipelago's original inhabitants.[76] Some of the Japanese anthropologists, such as Koganei Yoshikiyo, who participated in the archaeological debates on the origins of the ethnic Japanese committed grave robbery

to steal bones and remains of the Ainu and Okinawan peoples.[77] These anthropologists exercised what Nozomi Nakaganeku Saitō critiques as "ossuopower," an assertion of the sovereign right of settlers to control remains of Indigenous peoples. As Saitō writes, "Institutional possession of these remains has been a method for the settler nation to claim the indigenous past as their own."[78] This abhorrent practice of colonial anthropologists developed alongside the claim that the racial origin of the Ainu could be traced back to the Eurasian continent. This anthropological discourse helped delegitimize—or "de-Indigenize"—the Ainu people's claim to their ancestral homeland and continuous presence on the island.[79] Conversely, and echoing the linguistic shift from a "group of islands" to a "chain of islands," this legitimized the Japanese colonial settlement on the island as if it were the natural course of history—*as if* these settlers were reclaiming natural rights held by their ancestors.[80]

From the late nineteenth to the early twentieth century, archaeologists, anthropologists, and geologists helped displace, de-Indigenize, and geologize the Ainu people to consolidate Japan's territorial claim on Hokkaidō. Lyman's appropriation of the Ainu place-name Kamoikotan to designate the oldest geological strata of the island, while erasing its historicity and meanings to the local Ainu communities, is part of this epistemic violence. Devoid of cosmological connotations and ancestral memories of the land, it became a flattened signifier of the deep time of the island's geological strata. Contemporary efforts to restore original Ainu place-names and their layered meanings have exposed the coloniality of the ordering and shaping of the quotidian perception of the stolen land, traces of which are inscribed on and stored in this first geological map of Hokkaidō.[81]

As Yusoff argues, in the eighteenth and nineteenth centuries, enslaved and dispossessed Black and Indigenous peoples were deliberately aligned with the "inhuman" geological domain of extractable "matter" such as fossils and minerals. Noting the implication of geology in the discourse of racial origins, Yusoff writes: "Geology (and its fossil objects) have been entwined with questions of origins, processes of racialization through speciation and notions of progress, as well as being a praxis for inscripting racial logics *within* the material politics of extraction that constitutes lived forms of racism (from eugenics to environmental racism). To trace racial matterings across the category of the inhuman, and specifically the traffic between the *inhuman as matter* and the *inhuman as race*, is to examine how the concept of the inhuman is a connective hinge in the

twinned discourses of geology and humanism."[82] This nexus between geology and humanism, especially liberal humanism founded on the ideology of private ownership, is also present in Japan's settler colonization of Hokkaidō. The geological classification of "the inhuman as inert, ahistorical, non-political, [and] inorganic," according to Yusoff, merged with the racialized logic of objectification, which aligned subjugated persons with inhuman matter reconfigured as property.[83] Similarly, Lyman's map and the historical conditions of its production attest to the role geology has played in the colonization, racialization, and delegitimization of the Ainu people whose land was expropriated and whose presence was displaced onto the subterranean realm of geology and archaeology.

Furthermore, as I examine in the following chapters, various nations and communities within and outside the formal bounds of the Japanese Empire were also exposed to the epistemic violence of geologization and the shifting regimes of racialization. To borrow Zakiyyah Iman Jackson's critique of the Western scientific, philosophical, and legal conception of the human, associated with evolution, personhood, property, and rights, which facilitated the thingification of blackness, "Exigencies of racialization have preconditioned and prefigured modern discourses governing the nonhuman."[84] While the history of colonial dispossession, the processes of racialization and geologization, and critiques against them explored in this book differ from the contexts analyzed by Yusoff and Jackson, the questions of who counts as human, when, and why reverberate throughout the book's inquiry into geosciences' entanglement with the territorial expansion of archipelagic empires that produced and collected many of the stratigraphic markers associated with the Anthropocene, the era of the "human" or *anthropos*. As I explore in later chapters, this species-centered narrative of the Anthropocene is also complicated by the conceptual ambiguity of matter, which points to the inseparability of biosciences and geosciences and that of life and nonlife, as well as the differential positioning of the human through racialized labor.[85]

Here, in this introduction, I offer my close reading of Lyman's geological map because its visual grammar makes legible the parallel processes of the geological surveying of Hokkaidō, the dispossession of the Indigenous land, and the epistemic violence of geologization. I highlight the role of vertical territorialization performed by visual inscriptions that construct the graphic perception of deep time. The following chapters turn to other examples of visual inscriptions, knowledge production, and the territorialization of islands, seas, and skies within and beyond the

archipelagic empire of Japan. In doing so, I also pay heed to the caution offered by J. Kēhaulani Kauanui, who argues that a critique of settler colonialism needs to be coupled with a "meaningful engagement with the indigenous" perspectives and experiences so that it does not risk reproducing "another form of 'elimination of the native.'"[86] With this critique in mind, whenever possible, I also turn to counterarchives of Indigenous voices, place-names, and other forms of media to interweave place-based perspectives that exceed, resist, and contradict the colonial and imperial assumptions that organize the dominant visual grammars of deep time.

CHAPTER OUTLINES

Each chapter in this book is anchored around sets of visual inscriptions and scientific specimens from various branches of geosciences. Running through all the chapters are several anthropogenic markers of the Anthropocene, from fossil fuels that drive the increased accumulation of greenhouse gases in the atmosphere to what some scientists call "technofossils," including microplastics and synthetic minerals whose enduring lifespans are compared to organic fossils. Instead of chronologically moving from the late nineteenth century to the present, chapters are geographically organized around one or two locations, centered on the islands that archipelagic empires attempted to map and territorialize.

The following chapters also center on the mid-twentieth century because this was the moment when geophysical impacts on Earth due to human activities began to accelerate and accumulate as stratigraphic markers that have been used to classify the contested—and now officially rejected—epoch of the Anthropocene. This was also the period when the geopolitical alliance between the former archipelagic empire of Japan and the ongoing archipelagic empire of the United States was reconfigured, in large part due to the Cold War.

Chapter 1, "Indexing Fossil Archives," brings together the development of applied micropaleontology in the service of oil exploration and the settler colonization of Sakhalin by Japan and the Soviet Union. Highlighting the indexical function of certain key fossils that guided these scientists to identify oil-bearing strata, I analyze how the allure of hunting down microfossils intersected with the vertical territorialization of the island of Sakhalin. I further examine how oil industry–sponsored popular science films of the 1950s borrowed the visual grammar of geological maps, cross-section diagrams, and stratigraphic columns, thereby cementing

an extractive view of fossils and fossil fuel. In doing so, I argue that the sedimentary past was transformed into an extractable future through the mediation of visual inscriptions produced by geologists and micropaleontologists who worked for and with oil companies.

"Recording Ice Archives"—chapter 2—explores the colonial roots of Japan's polar science by examining records from its first expedition to Antarctica, conducted from 1910 to 1912. This expedition took place amid Japan's colonization of Sakhalin and the Kuril Islands, which emerged as a climatological proxy or analog of Antarctica. I analyze the little-discussed contribution of Yamabe (Yayomaneku) Yasunosuke and Hanamori (Sisratoka) Shinkichi, two Indigenous Sakhalin Ainu explorers, to this expedition, which is partly documented in its cinematic record: *The Japanese Expedition to Antarctica* (*Nihon nankyoku tanken*, 1910–1912). By foregrounding the expedition team's reliance on Indigenous knowledge and technology for traversing the frozen terrain, most notably the dogsled, I complicate the nationalist narrative of scientific modernity associated with this expedition. Through my reading of the expedition's records, I also examine the material vulnerability of both ice cores and cinema, which operate as comparable forms of storage media. To highlight this material vulnerability, I turn to Bruno Latour's well-known theory of "immutable mobiles" and demonstrate its historical relevance and conceptual limitations for media studies.

I move from ice to snow in chapter 3, "Forming Snow Archives," which examines the historical connections between glaciology, climate science, and snow engineering in the Arctic. Focusing on the research of Japanese scientists at the Hokkaidō University, including Nakaya Ukichirō, who worked as contract researchers at the Snow, Ice, and Permafrost Research Establishment (SIPRE) established by the US Army Corps of Engineers in the 1950s, I explore how the visual grammar of photomicrographs and time-lapse films of snow crystals relates to the scientific studies of polar ice sheets, which began to be viewed as natural archives of climatological data. I focus on the plasticity of snow, ice, and recorded time in order to think through the analogies of storage and archive applied to the ice sheets. The viscoelastic properties of polar ice were central to the research conducted by SIPRE scientists, which indirectly supported the American military's infrastructure development in Greenland. There, the United States built underground military bunkers, camps, and storage for nuclear missiles in anticipation of future military conflicts with the Soviet Union in the Arctic. Highlighting this geopolitical context behind the

scientific studies of snow crystals and polar ice sheets, I demonstrate how the development of climate science intersected with the vertical territorialization of the island's underground ice sheets, which materially bear witness to the island's colonial and imperial legacy.

Chapter 4, "Classifying Cloud Archives," reads the history of cloud taxonomy through the lens of nuclear imperialism in order to unpack the classificatory ambiguity of anthropogenic clouds, including mushroom clouds resulting from the detonation of atomic bombs.[87] I begin by examining the imperial aesthetics of Japanese cloud atlases compiled by meteorologist Fujiwara Sakuhei in comparison to the English-language *International Cloud Atlas*, published in the first half of the twentieth century. By foregrounding the epistemic power of classification and turning to the postwar publications of cloud atlases, I further discuss how the classificatory ambiguity of mushroom clouds parallels the categorical ambiguity of *anthropos* or the "human," which is central to the Anthropocene and anthropogenic climate change. In doing so, I connect the geopolitics of cloud observation to the violence of American nuclear imperialism in the Pacific, the legacy of which is materially stored by the marine life and the irradiated reefs of the Marshall Islands that the US military chose as a nuclear weapons testing site.

Looking at the imperial origins of Japan's coral reef science together with the racialized labor of guano and phosphate ore mining in the Pacific, chapter 5, "Building Coral Archives," turns to the lands and reefs of the Palau and the Marshall Islands, which Japan informally colonized under the League of Nations mandate. I begin my analysis with Charles Darwin's map of coral reefs (1842) and his anthropomorphization of coral polyps as "little architects" to argue that the Victorian virtue of industriousness associated with this figure of hard-working coral needs to be historicized in relation to the shifting colonial regimes of racialized labor in the nineteenth century and early twentieth century. I then turn to the coral research conducted at the Palao Tropical Biological Station, which Japan operated on the island of Koror (in what is today the Republic of Palau), and trace how the colonial violence of resource extraction is embedded in the history of radiation ecology. Central to this chapter is a set of radioautographs of irradiated corals and seashells extracted from the reefs of the Marshall Islands that American and Japanese scientists used to document and visualize anthropogenic radiation after the US military's nuclear weapons tests on the islands. Drawing on contemporary theories of nonhuman agency and labor, I explore the ethical and conceptual limits of using the analogy

of "labor" to describe the contributions of nonhumans, particularly that of corals, to the production of scientific knowledge.

In the conclusion of this book, I briefly turn to the present-day deep-sea mining of rare earth minerals from the seabed around Minamitorishima and other islands to underscore the relevance of the transoceanic studies of media, geosciences, and colonial legacies to the present-day extraction of mineral resources that sustain our reliance on digital media devices and energy-intensive computational infrastructures.

History may be sedimented, and time may appear stratified, but they are by no means static. *Archives of the Anthropocene* brings to light the struggles over knowledge and the material depths that constitute the colonial underbelly of the Anthropocene.

NOTES

INTRODUCTION

While significantly revised, parts of the introduction previously appeared in "Archipelagic Archives: Media Geology and the Deep Time of Japan's Settler Colonialism," *Public Culture* 33, no. 3 (September 2021): 417–40.

1. Hirano, "Settler Colonialism," 328.

2. Shinya, *Ainu minzoku teikōshi*, 167–68.

3. Quoted in Hirano, "Settler Colonialism," 329.

4. Hirano, "Settler Colonialism," 329.

5. Hirano, "Settler Colonialism," 332. In addition to the Homestead Act, a series of Indian Appropriations Acts led to the forcible relocation of Indigenous peoples to federally managed reservations. These policies turned them into legally designated "wards" of the federal government of the United States. As a result, Indigenous peoples were stripped of their status as belonging to independent nations. The Homestead Act and its associated land redistribution legislations thus accelerated the dispossession of Indigenous nations in the United States. In this context, it is worth remembering that the Department of the Interior, which continues to spearhead intertwined US strategies of mineral extraction and environmental management domestically and abroad, is in charge of the Bureau of Indian Affairs, which helped systematically dispossess Indigenous nations of their lands and mineral resources. See O'Brien, "Federal Indian Policies," 46.

6. During the preliminary survey trip in 1874 to Hokkaidō, for instance, Capron accompanied Lyman and his assistants. See Lyman, *Preliminary Report*, 12. As Megan Black argues, the United States Department of the Interior, which houses the Bureau of Indian Affairs, long held to a fallacy of "resource primitivism," insisting that "'primitive' people failed to value and tend land properly and should therefore be dispossessed of it." A similar rhetoric of resource primitivism underpinned the Japanese government's treatment of the Ainu people, whose main livelihood was fishing for salmon and hunting rather than farming and mining the land. See Black, *Global Interior*, 121.

7. Lyman's report, *Geological Survey of Hokkaido* (1877), states that mining would be expedited if "the property of the companies were to be held equally by Japanese and foreigners" (97–98). Lyman includes a lengthy discussion of "political obstacles" for developing "modern methods" within the mining industry, the largest being

the lack of the "right to buy and sell in the interior of Japan" for non-Japanese individuals (96).

8. Emori, *Ainu minzoku no rekishi*, 394.

9. Lyman contends that the Development Agency "has the credit of beginning and carrying nearly to completion the first geological survey of the kind undertaken by any native Asiatic Government, and of publishing the results to the world, not merely for the benefit to the finances of its own Government, but for the better information of all who are interested in geology." By calling the newly established Meiji-era Japanese government the first "native Asiatic" government to carry out geological surveys, Lyman's report also gestures toward the Western view of civilizational hierarchy, in which the United States—and Europe—appeared as the source of modernization of non-Western nations. See Lyman, *Geological Survey*, 108–9. As an Anglo-American elite educated at Harvard University and the Freiberg Mining Academy, with an illustrious career of working as a mining engineer to survey oil fields for the government of British India before going to Japan, Lyman highly valued his advisory position with the Japanese government. See Yajima, *Chishitsu gakusha Naumann den*, 43.

10. Braun, "Producing Vertical Territory," 7–46. Braun's analysis focuses on geological surveys of Canada. I borrow and use his phrase "vertical territory" throughout the book. On the vertical territory, Indigeneity, and resource nationalism in the case of Bolivia, see also Marston, "Strata of the State."

11. I thank my anonymous reader for encouraging me to include this reflexive critique of modernity. I also take inspiration from the work of Rey Chow, whose work shows how seemingly distant practices and disciplines such as aerial military surveillance, area studies, and comparative literature that flourished in the postwar United States are implicated with each other. See Chow, *World Target*.

12. Ishihara, "Ima ingiumu ga omoshiroi," 46–54.

13. As Liam Cole Young writes, "The very concept of an 'Anthropocene epoch' is derived from 'reading' inscriptions of human activity that are stored in the earth's mineral and liquid archives." Young, "Salt," 13. For the intersection of geoarchives and big data analyzed from the media studies perspective, see Mattern, "Big Data."

14. Jodi Kim uses the phrase "settler imperialism" to talk about Guam, which is highly militarized, as an unincorporated territory of the United States. See Kim, *Settler Garrison*. On the semicolonial status of the South Sea Islands or "Japanese Mandated Territories" in Micronesia, see, for instance, Permanent Mandates Commission, "Comments on the Observations of the Commission Presented by the Accredited Representatives of the Commonwealth of Australia and of Japan," League of Nations (C.552.M.334.1922.VI.A.37), https://archives.ungeneva.org/japanese-mandate-for-pacific-islands-mr-matsuda-comments-by-the-accredited-representative-of-the-mandatory-powers-for-this-territory-on-the-observations-of-the-permanent-mandates-commission-concerning-the-reports-on-the-administration-/download.

15. The technological operation of vertical territorialization is implicated in what media scholar Lisa Parks has called "the struggle for vertical hegemony" asserted

by imperial states. Parks, *Rethinking Media Coverage*, 3. Parks focuses on the vertical hegemony asserted by the United States in the aftermath of 9/11, including the skies and outer space.

16. Latour, "Visualization and Cognition"; Latour, "On Technical Mediation."

17. *Britannica*, "grammar," January 2, 2024, https://www.britannica.com/topic/grammar.

18. Foucault writes: "By episteme, we mean, in fact, the total set of relations that unite, at a given period, the discursive practices that give rise to epistemological figures, sciences, and possibly formalized systems." Foucault, *Archaeology of Knowledge*, 211.

19. Rudwick writes: "In other words, a geological map—or any other visual diagram in geology—is a document presented in a visual language; and like any ordinary verbal language this embodies a complex set of tacit rules and conventions that have to be learned by practice. Again, like an ordinary language, visual means of communication necessarily imply the existence of a social community which tacitly accepts these rules and shares an understanding of these conventions." Rudwick, "Emergence," 151.

20. Yusoff, *Geologic Life*, 17.

21. As Jonathan Sterne argues, the term *communication*, which media scholars use to describe technological means of symbolic communication, such as telegraphy, should be extended to include nonsymbolic systems of organized movement such as a railroad as a modern infrastructure of physical transportation. See Sterne, "Transportation and Communication."

22. See Daston and Galison, *Objectivity*; Galison and Jones, *Picturing Science*; Mitman and Wilder, *Documenting the World*.

23. See, for instance, the essays collected in Buckley et al., *Screen Genealogies*; Bozak, *Cinematic Footprint*; Pasek, "Managing Carbon"; Mukherjee, *Radiant Infrastructures*; Cahill et al., "Media Climates"; and the essays collected in Wickberg and Gärdebo, *Environing Media*.

24. Siegert, *Cultural Techniques*, 5. See also Vogl, "Becoming-Media."

25. Not all of the scholars working on the mediatic function of elements, such as heat and ice, are *in* media studies. See Peters, *Marvelous Clouds*; Starosielski, *Media Hot and Cold*; Parikka, *Geology of Media*; Jue, *Wild Blue Media*; Mattern, "Big Data"; Young, "Salt"; Han, "Precipitates"; Ruiz, *Slow Disturbance*; Bao, "Hermeneutics of Doubt."

26. In her inspiring colonial history that traces the global trade of ice as a modern commodity and the settler imposition and normalization of the sensation of the "cold" in relation to the Indigenous sovereignty in Hawai'i, Hobart writes, "Thermal technologies, like air-conditioning and refrigeration, affirm normative subjectivities as they are deployed across public and private spaces and, in turn, mark difference. This phenomenon is akin to 'settler common sense,' as Rifkin calls it: the lived conditions of settler possibility that appear self-evident." See Hobart, *Cooling the Tropics*, 9.

27. Drawing on the work of Timothy Choy on air, Smith writes beautifully: "Breath, what it holds, how it is held, how it harms, or how it sustains, shapes a moment-to-moment human experience and, depending on who is holding breath, a nonhuman experience. Ice also holds breath; this breath is what tells stories about 1765, the sixteenth century, or something more finite. Similarly, plants hold and release breath in ways that shape the atmosphere." Smith, *Ice Geographies*, 63.

28. See, for instance, Cubitt, *Finite Media*; Gabrys, *Digital Rubbish*; Han, "Blue Frontier; and Halpern, "Planetary Intelligence." Brian Jacobson's work on cinema and oil exploration also situates the history of cinema within the larger history of fossil fuel extraction. While on the historical context of India's nationalization of the coal mining sector, Debashree Mukherjee's work similarly on cinema and energy humanities also foregrounds the issue of extraction. See Jacobson, "Prospecting"; Debashree Mukherjee, "Energy and Exhaustion."

29. See Hogan, "Data Flows"; Holt and Vonderau, "'Where the Internet Lives.'"

30. As Parikka notes, media history is billions of years old if we are to pay attention to the material substrate of digital and analog media, comprised of mined geological matter, especially precious metals and minerals. According to Parikka, "Deep temporalities 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." Citing John Durham Peters's provocation to consider astronomy and geology as a potential part of media studies, Parikka writes: "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." Parikka, *Geology of Media*, 44.

31. Huhtamo and Parikka, *Media Archaeology*.

32. Parikka, "Deep Times," 177.

33. Mattern, "Deep Time"; emphasis in original. Lisa Han's critique of maritime archaeology, which centers the human notions of cultural heritage and history in contrast to the nonhuman time scale of geology also encourages us to take deep time seriously. Han, "Blue Frontier," 479–80.

34. Referencing Charles Darwin's analogies of books and libraries to describe geological records, Peters compares Darwin to "a good media scholar" who reads "texts by reference to the processes that formed them." Peters, *Marvelous Cloud*, 359.

35. As Indigenous studies scholars in North America insist, decolonization cannot be taken lightly as a metaphor without the reparation of the land and the support for Indigenous sovereignty. See Tuck and Yang, "Decolonization"; Liboiron, *Pollution Is Colonialism*; Duarte, *Network Sovereignty*. Without addressing the importance of the land-based practice of decolonization, centering Indigenous knowledge could verge on cultural appropriation, a problem Zoe Todd finds in the "ontological turn" in anthropology and environmental humanities. See Todd, "Indigenous Feminist's Take."

36. On the definition of settler colonialism, see Wolfe, *Settler Colonialism*; Veracini, "Understanding Colonialism." Unlike the Ainu people, the Japanese government never recognized Ryūkyūan/Okinawans as an Indigenous group despite the recommendation of the United Nations Human Rights Council. On the history of settler colonization of Okinawa and Hokkaidō and the issue of sovereignty, see Matsumura, *Limits of Okinawa*; Morris-Suzuki, *Frontiers of History*; Saito, "Bone and Coral."

37. On Japan's settler colonialism and its formation of an island empire, see Lu, *Japanese Settler Colonialism*.

38. On the philosophical connection between the tropes of the island and sovereignty, see Huang, "Ocean Media."

39. As sociologist Lanny Thompson argues in his analysis of the archipelago as a heuristic method, "Empires are often constituted by continental powers and their 'imperial archipelagos' that are neither geographically contiguous nor uniformly governed." Contrasted with this territorial imaginary of the imperial archipelago is a more equitable—"tidalectic"—approach to the island-sea relationship cultivated by Pacific Island communities and scholars. See Thompson, "Heuristic Geographies," 63.

40. Roberts and Stephens, "Introduction." CHamoru literary scholar Craig Santos Perez further coined the phrase "imperial terripelago" to describe the terrorizing acts of the United States as a settler colonial empire in the Pacific. See Perez, "Transterritorial Currents," 620. Perez also writes: "Mapping territoriality within the Pacific draws attention to the surface and rip currents of American colonialism, capitalism, militarism, nuclearism, tourism, urbanism, missionization, and plantationism throughout the islands, which resulted in profound depopulation, dispossession, displacement, and disenfranchisement of Native Pacific Islanders" (622). Meanwhile critical refugee studies and transpacific studies scholar Evyn Lê Espiritu Gandhi foregrounds the notion of "relational archipelagics" as an analytical method to trace the medium of water that divides and connects the Vietnamese refugee resettlement in Guam and Israel-Palestine in order "to illuminate an archipelago of US empire and a corresponding archipelago of trans-Indigenous resistance." Gandhi, *Archipelago of Resettlement*, 11.

41. Goffe, "Guano in Their Destiny," 44.

42. Martínez-San Miguel and Stephens, "Introduction," 3. In his analysis of Japan's oceanic expansionism via offshore fisheries historian William Tsutsui uses another term: "pelagic empire." In so doing, he offers a critique of terrestrial bias built into our understanding of imperialism, which highlights the acquisition of lands rather than seas. See Tsutsui, "Pelagic Empire."

43. Eda, "Archipelagic Feeling," 339.

44. Ventriloquizing the voice of a stone deity on the shore of Amami Oshima island (located between the Kyūshū island of mainland Japan and the Ryūkyū islands of Okinawa), Imafuku contends that "the shore is where the ideology of systematic structure, aggressive possession, and occupation finally fail. So, I don't belong to the continent, but to the archipelago." Therefore, Imafuku con-

cludes, aligning oneself with the perspective of a stone deity on shore is a "totally anti-continental, anti-colonial, anti-imperialistic" gesture. See Imafuku, "Castaway Ishmael," 86. See also Imafuku, *Guntō*. While Imafuku's remapping of the Japanese archipelago around the southern Amami Islands, which poetically associates them with the Pacific Islands and the islands of the Caribbean, may lean too hard into utopianism, his anticontinental, anticolonial, and anti-imperialistic understanding of archipelagoes as interconnected islands and seas offers one strategy of conceptual reorientation. As Dennitza Gabrakova writes: "The archipelago emerges in Imafuku's thought not simply as a reversal of territoriality (particularly of the modern political and epistemic type) but as a submerged possibility for critique and epistemic breakage, a latent desire: the unconscious of/as the island metaphor becomes the formative unit of the archipelago." Gabrakova also offers a nuanced critique of Imafuku's ambivalent positionality as a cultural anthropologist and a Native informant who relies on poetic language to undo his own disciplinary formation. Gabrakova suggests that Imafuku turns to poetic and literary language as an alternative mode of critique, whose analysis often moves through the evocative force of homophones in what might be called the "errantry" mode of writing. For instance, Imafuku follows a homophonic nexus between *shima* (stripe) and *shima* (island) to reflect on the positionality of an anthropologist. See Gabrakova, *Unnamable Archipelago*, 20. See Hau'ofa, *We Are the Ocean*. I also borrow the "horizontal" orientation from DeLoughrey, "Myth of Isolates."

45. See Zahlten, "Archipelagic Thought." Zahlten writes: "However if Imafuku attempts to put forward the positive potential of such a counter-model for a better future, NDU's film makes it clear that East Asia—and especially the East Asia of the twentieth century—is always already archipelagic. And while Okinawa stands in as a centerpiece for East Asia's functional archipelagism, it is one that is more ambivalent than Imafuku's generally positive framing of the potential of archipelagic thought can allow for. In *Asia Is One*, NDU [Nihon Documentarist Union] paints a picture less of larger historical rupture via the introduction of a new model than one of continuity. The archipelago adjusts and thereby survives throughout the blanketing connectivity of empire or military occupation, yet it retains its in-betweenness and cannot be fully incorporated into colonial time—the temporality that divides the colonizers into representatives of the present future, and the colonized into the chronically behind" (121).

46. As Jacques Derrida argues, the term *archive* refers "to the *arkhe* in the *physical, historical*, or *ontological* sense, which is to say to the originary, the first, the principial, the primitive, in short to the commencement." Derrida, *Archive Fever*, 2.

47. This observation is based on the titles of articles and books published in Japanese between the 1890s and the 1970s, which are accessible from the online database at the National Diet Library.

48. Referencing the news that Korea is about to be annexed, Ogawa writes: "When that happens, I need to reconsider whether or not to include Korea under the banner of Japanese archipelago [*Nihon guntō*]." Ogawa, *Nihon guntō*, 357–58.

49. As the editors of *Arts of Living on a Damaged Planet* put it, "The deep time of geology, climate, and natural science is collapsing into the historical time of human technology." Introduction to Tsing et al., *Arts of Living*, G12.

50. Chakrabarty, "Climate of History," 219.

51. See Haraway, "Anthropocene, Capitalocene"; Moore, *Anthropocene or Capitalocene?*; Haraway, *Staying with the Trouble*.

52. Lowe, *Intimacies of Four Continents*, 5.

53. Lowe, *Intimacies of Four Continents*, 7.

54. In this book I adopt an inclusive definition of "scientific archives" offered by historian of science Lorraine Daston: "Given the historical heterogeneity of archives, it makes little sense to seek a definition bound by form, location, content, or proprietor. The boundaries between archives and collections (including museums, libraries, and data banks) have also been historically fluid. Scientific archives may consist of digital data stored on servers, paper articles in bound journals stored in libraries, or fossils stored in the drawers of museum cupboards." Daston, "Introduction," 5.

55. Rudwick, *Earth's Deep History*, 48.

56. Sepkoski, "Earth as Archive," 57.

57. Braun, "Producing Vertical Territory," 22.

58. Sepkoski, "Earth as Archive," 60.

59. In his discussion of Darwin and his interlocutor Charles Lyell, who penned *Principles of Geology* (1830–1833), Peters writes, "The earth was a profoundly fallible recording medium that inscribed hieroglyphs at best and blank stretches of oblivion at worst." Peters, *Marvelous Clouds*, 360.

60. For instance, political geographer Adam Bobbette has examined how the modern field of Javanese geology developed in relation to local cosmology and spiritual geography by reading across Javanese and Dutch colonial archives of geology, volcanology, and theology in Indonesia. In doing so, he blurs a commonly assumed division between science and theology, wherein the latter is excluded from the former. Bobbette, *Pulse of the Earth*. Taking the history of Javanese geology as an example, Bobbette writes: "Standard Western geological science was not simply imposed on a prior indigenous geology; instead, Native and colonial geological knowledges produced each other, even if the process was uneven, indirect, and sometimes violent. And now they contain each other" (x).

61. I draw on the important political work done by feminist, anticolonial historians of empires, art, and science who have both problematized and expanded the very parameter of "archive." See Rony, *Third Eye*; Hartman, "Venus in Two Acts"; Kim, "Unpacking the Archive"; Stoler, *Along the Archival Grain*.

62. Lyman, *Preliminary Report*, 35–43.

63. In the 1877 *Geological Survey of Hokkaido*, Lyman writes, "The rocks of the Kamoikotan Group would appear to form the core of the Island reaching in a shuttle

shape from Cape Erimo northward to the middle Teshio valley, and crossed near its widest part and near the center of the Island by the Ishcari river." Lyman, *Geological Survey*, 56–57.

64. Ainu linguist Chiri Mashiho notes that *kamuy* does not necessarily mean a benevolent god, but more of a fearful entity closer to the Japanese concept of *ma* (meaning a mysterious force or a malevolent spirit). See *Chiri Mashiho chosakushū*, 3:248.

65. Lyman, *Geological Survey*, 57. Other layers in Lyman's stratigraphic column also bear Ainu names.

66. *Chiri Mashiho chosakushū*, 3:247.

67. See Podmaskin, "Geograficheskie terminy."

68. Ono, *"Atarashii Ainu gaku" no susume*, 21–22.

69. Medak-Saltzman, "Transnational Indigenous Exchange," 612.

70. "Japan: New Ainu Law Becomes Effective," *Library of Congress*, August 5, 2019. https://www.loc.gov/item/global-legal-monitor/2019-08-05/japan-new-ainu-law-becomes-effective/.

The official title of the 2019 law is "Act on the promotion of measures to realize a society where the pride of the Ainu people is respected" (*Ainu no hitobito no hokori ga sonchō sareru shakai o jitsugen suru tame no shisaku no suishin ni kansuru hōritsu*).

71. Ono, *Tatakau chirigaku*, 297.

72. Ono, *Tatakau chirigaku*, 298.

73. Roellinghoff, "Osteo-Hermeneutics," 301.

74. Diaz, "Anti-Colonial Recovery," 28.

75. Mark K. Watson writes, "Japanese academic discourse became prevalent with the images of the Ainu as a by-gone 'dying race' (*horobiyuku minzoku*) inherently inferior to the Enlightened, modern, progressive Japan." Watson, *Japan's Ainu Minority*, 14. See also Siddle, *Race, Resistance*.

76. Sakano, "Nihonjin kigen ron to Kōkokushikan."

77. Roellinghoff "Osteo-Hermeneutics," 295. See also Matsushima and Kimura, *Daigaku ni yoru tōkotsu*.

78. Saito, "Bone and Coral," 575. On the legal struggles for repatriation and the lived experiences of the Ainu and Okinawan descendants whose ancestors' remains were stolen by and stored at the university research facilities, see Ishihara and Murakami, *Ainu ga manazasu*; Matsushima and Kimura, *Daigaku ni yoru tōkotsu*.

79. I borrow the phrase "de-Indigenize" from Michael Roellinghoff. See Roellinghoff, "Osteo-Hermeneutics," 301.

80. This mobilization of archaeology and anthropology to justify colonial settlement is not unique to Japan. As Nadia Abu El-Haj analyzes, biblical archaeology was central to the territorial self-fashioning and nation-building of Israel, which, in turn, "effaced Arab/Palestinian claims to presences within the very same place." See Abu El-Haj, *Facts on the Ground*, 18.

81. Geographers and critical place-name studies scholars have analyzed the coloniality of both erasure and appropriation of Indigenous place-names by settlers. As Rose-Redwood writes in the context of Canada: "The act of place naming has been used as a strategy to inscribe political ideologies, historical memories, and

social identities into the fabric of everyday landscapes." Rose-Redwood, "Reclaim, Rename, Reoccupy," 192. See also Rose-Redwood et al., "Geographies of Toponymic Inscription"; Williamson, "Historical Geographies."

82. Yusoff, *Billion Black Anthropocenes*, 5–6.

83. Yusoff, *Billion Black Anthropocenes*, 72.

84. Jackson, *Becoming Human*, 14.

85. I discuss this species-centered view of the Anthropocene and the inseparability of life and nonlife in chapter 5, especially in my discussion of the nonhuman labor via the new materialist thought of Jane Benett. For an insightful critique of the life/nonlife binary and the limits of new materialism that posits the vitality and agency of the nonhuman, see TallBear, "Life/Non-Life Binary."

86. As Kauanui notes, it is important to remember that Patrick Wolfe's defining work on settler colonialism owes much to the preceding critical works by Indigenous scholars. See Kauanui, "Not an Event."

87. Media scholars John Durham Peters and Shannon Mattern have recently turned to the studies of literal clouds in light of metaphorical clouds associated with the digital technology of cloud computing. But I make the case for why clouds' natural history and their analog records such as cloud atlases need to be analyzed in relation to the taxonomic practice of classification and its underlying geopolitics. See Mattern, "Cloud and Field"; John Durham Peters, "Cloud," in Beyes et al., *Oxford Handbook of Media, Technology, and Organization Studies*; Furuhata, *Climatic Media*.

CHAPTER 1. INDEXING FOSSIL ARCHIVES

1. Latour's understanding of mediation is opposed to the passive sense of middleness associated with an intermediary agent of representation or a communication channel that "transports meaning or force without transformation." Mediators are more active than intermediaries, as they "transform, translate, distort, and modify the meaning or the elements they are supposed to carry." Latour, *Reassembling the Social*, 39. See also Latour, "On Technical Mediation," and "Visualization and Cognition."

2. Doane, *Emergence of Cinematic Time*, 16.

3. Rosen, *Change Mummified*, 114. Rosen also draws an apt comparison between the indexical function of fossils and that of cinema, the quintessential medium of preserving time invented in the nineteenth century: "Documents, remains, survivals, ruins, and edifices, fossils—in short, indexical traces that attest to a past emerging into the present from it—achieved a kind of epistemological prestige in an era of intensifying time consciousness" (115).

4. As media scholar Lisa Yin Han argues in her analysis of deep-sea mining, the practice of nautical archaeology that salvages sunken ships has helped transform and naturalize the view of the seabed as an archive of cultural heritage and a new frontier. Armed with these metaphors of archive, heritage, and frontier, deep-sea mining facilitates the "epistemological collapse between material and informational extraction." Han, *Deepwater Alchemy*, 29. A similar epistemic blurring of the extraction of geological matter and information occurs with the storage metaphors applied to Earth's underground by petroleum geology.