

Ice Core Verticality. The Eloquence of Ice and the Visual Construction of Deep Time

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Abstract

Ice cores are fundamental techno-scientific components of the visual culture of the Anthropocene. Through the eloquence of ice, the Anthropocene sets the tone for its own narration, one made of impending apocalypse, planetary boundaries, and irreversible tipping points, while, at the same time, attesting for the “lively materiality” of ice, and of its past and present states. This essay analyzes and determines the narrative agency and the semiotic complexity of ice cores within the contested terrain of the Anthropocene thesis and presents two recent art-science collaborative projects exploring the aesthetic dimension of ice cores: Susan Schuppli's *Ice Cores* (2019) and Giulia Bruni and Armin Linke's *Earth Indices* (2022).

A Glacial Anthropocene

In the year 2000, Nobel Prize-winning atmospheric chemist Paul Crutzen and ecologist Eugene Stoermer introduced the public to the Anthropocene thesis on the International Geosphere-Biosphere Programme's *Global Change Newsletter* (Crutzen, Stoermer 2000: 17-18). Crutzen and Stoermer's groundbreaking proposition represented the culmination of a vast and diverse body of scientific research on the Earth system (Ellis 2018; Uhrqvist, Linnér 2015; Waters et al. 2014) that had been developing since, at the very least, the 1960s. The unprecedented planetary change associated with the notion of the Anthropocene was soon conceived as the combination of key phenomena affecting the planet, such as the increase in atmospheric carbon dioxide concentrations and the alteration of biogeochemical cycles; deforestation and mass extinction events; human exploitation of natural resources and anthropogenic climate change (Steffen et al. 2005; Grinevald 2008). Since its first appearance in scientific and non-scientific contexts, the Anthropocene thesis has sparked an intense – and still ongoing – debate about the criteria for the stratigraphic evidence and its legitimacy (Lewis and Maslin 2015; Zalasiewicz et al. 2011) and the methods to establish accurately and formalize the start of this “era of man”. The proposal for this new geological epoch has also generated a variety of origin stories that locate the start of the Anthropocene at different times, from the Neolithic and the Industrial Revolution to the “Great Acceleration” in the mid-twentieth century (Schwägerl, Crutzen 2014; Scott 2015; Steffen et al. 2011; Yusoff 2016), together with reconceptualizations and critiques stemming from the humanities and the social sciences, as well as arguments for alternative, more politically conscious definitions and recenterings (Bonneuil, Fressoz 2016; Chakrabarty 2009; Moore, Altvater, Crist 2016; Haraway 2016; Tsing 2018; Stiegler 2018; Luisetti 2019; Demos 2017).

Within the public sphere, climate change and its anthropogenic origins have become common objects of data visualizations and modeling, often promoted and popularized by intergovernmental policy-making organizations and scientific institutions,¹ but also dramatized and aestheticized in mainstream media and the visual arts.² In this context, the imagery connected to the ice masses of the planet occupies

an important role in offering tangible and accessible proof of the geo-physical transformations caused by industrialization, fossil economies and global extractivism. In the Anthropocene, the various forms of visibility associated with glaciers, ice sheets, icebergs, the Arctic ice pack, perennial snows, ice masses, polar landscapes, tundras, and ice cores are deeply embedded within the global visual culture of climate politics and environmental activism. Historical, satellite, and infrared photography, as well as computer generated visualizations and speculative scenarios are mobilized to depict global warming and its effects in an immediate and relatable way. Centuries and decade-long processes such as the retreat of glaciers, the calving of icebergs, and ice-shelf thinning become thus accessible to the public through chronological comparison with historical data and images, and elicit a sense of urgency aimed at political action and participation. Moreover, the graphic images of melting and dissolution of ice landscapes caused by global warming prove, persuasively, even to skeptical and uninformed audiences the magnitude of the ecological disaster endangering the geo-physical equilibrium of the earth. Within the visual and media arts and design, impactful public projects such as Olafur Eliasson's *Ice Watch* (2014) (Hornby 2017; Jackson 2015), hybrid installations like Julian Charriere's *Towards No Earthly Pole* (2019) (Hannah 2021), speculative filmmaking like Juan Francisco Salazar's *Nightfall on Gaia* (2015), the work of painters and mixed media artists such as like Diane Burko (Garrard, Broude 2021) and Justin Brice Guariglia (Horn 2019), of designers such as Irene Stracuzzi,³ or thematic exhibitions like *Vanishing Ice* (Matilsky 2013; Kothe, Maute, Brewer 2015), among many others, demonstrate the variety of forms and creative practices currently engaging with the endangered vitality of glacial landforms while operating within the cultural logic of the Anthropocene.⁴

The prominence and ubiquity of ice in climate communication and in the visual culture of the Anthropocene attest for the intrinsic narrative potential of glacial matter and of its sense-making agency. The polar regions of the planet, together with glaciers at every latitude, are connected by anthropogenic narratives of vulnerability and environmental violence, extinction, and forced mutation. The ice from glaciers and the polar landscapes can be read as examples of what material ecocriticism defines as *storied matter*.⁵

“a material mesh of meanings, properties, and processes, in which human and nonhuman players are interlocked in networks that produce undeniable signifying forces” (Iovino, Oppermann 2014: 1-2). Similarly to the other material and living subjects of the planet, ice manifests forms of eloquence as a specific type of storied matter:

A non-linguistic performance inherent in every material formation from bodies to their atoms making them telling or storied. Whether it is a cell, a singing whale, a whispering wind, a pebble on the beach, an erupting volcano, a hurricane or a plastic bag, matter is encoded with meaningful narratives, or narrative agencies through which the world becomes eloquent (Oppermann 2018: 412).

Through the eloquence of ice, the Anthropocene sets the tone for its own narration, one made of impending apocalypse, planetary boundaries, and irreversible tipping points, while, at the same time, attesting for the “lively materiality” of ice, and of its past and present states (Salazar 2018: 32). Depending on its mediators, interpreters, and intended audiences the storied matter of ice enables different – at times divergent – narratives and historiographies, and contested political projects. Compared to the visibility of glacial geomorphological subjects and to the narrative agency of ice, ice cores, specifically, occupy a unique role within the technical imagination of the Anthropocene, as they represent a readable, chronological inventory and a “reliable” testimony of the changes in the atmospheric composition of the planet: “when snow is transformed to ice, air bubbles are enclosed, providing actual snapshots of the atmosphere of the past and constituting a stand-alone feature of this natural archive (Bohler et al. 2021). As material metonymies, ice cores are objects of interest for both scientists and visual practitioners, as their narrative agency is unlocked, interpreted, and expressed through advanced techniques of spectrometric analysis, and through the construction and maintenance of complex infrastructures of knowledge production and cryo technologies (Achermann 2020). Ice cores are not the only form of “natural archive” (Nowak 2022: 19) or climate testimony available to us, but, post-extraction, they transform “the dense, frozen water of glaciers into latent archives of the atmosphere, providing evidence of recent and significant spikes in greenhouse gases” (Salazar 2018: 36) proving that “climatic change did not happen only

locally, but globally” (Achermann 2020: 21). They serve as “interscalar vehicles” (Hecht 2018) connecting deep time and human time, radically expanding “the ‘sphere’ of a given historical moment. Events and forces that we once thought had purview of only a relatively limited geographic area are suddenly legible at planetary scale” (Taylor 2014: 75). Moreover, in the brief moment in which they physically exist, during the ephemeral lapse of time between their extraction and their narrative expression, ice cores remind us of past states of the planetary climate that we, as humans, may experience never again. If the geological imagination of the Anthropocene implies the sedimentation of the human and its socio-political formations, in its glaciological version, humankind manifests as interruption, vanishing, melting and thawing.

In this essay, we will try to analyze and determine the narrative agency of ice cores within the contested terrain of the Anthropocene thesis. We do so by confronting and reading ice cores as techno-scientific instruments and as aesthetic objects that express their agency to a diverse audience of interpreters through various technological mediations, ultimately inscribing human history within the geological domain of the Earth as well as enabling planetary politics of nature. In order to give justice to the complexity of ice core knowledge, in this essay we present two recent art-science collaborative projects and we draw concepts developed in the environmental humanities, visual semiotics, design studies and science and technology studies: disciplines that are critically interrogating the far-reaching aesthetic, epistemological, and political consequences of the Anthropocene paradigm.

Vertical Time Machines

A timeline is a representation of time through space, where events, filed in an ordered and linear dimension, create a chronology. In a timeline, due to western alphabetic conventions, the graphical space is usually assumed as a continuum moving from left to right, in which every point occupies a position in a linear chronology that runs from earlier to more recent times.

Timeline was first used as a didactic tool for history by Joseph Priestley who, in 1765, depicted the lifespans of illustrious individuals in parallel horizontal lines along a timescale (Rosenberg, Grafton 2010:

122-126). This graphical representation of time as a horizontal line was established as a convention when William Playfair used it for his time series a couple of decades later, inscribing the variable 'time' on the x axis.⁶ Only in the early decades of the nineteenth century did geologists develop their own visualization of time through space, rooting their dating techniques to stratigraphic superposition following a rule that sounds simple nowadays: other things being equal, newer rock beds lie on top of older rock beds and finds and fossils on the bottom are older than finds and fossils on the top.⁷ This law also applies to archeological practice, where the past is always connected to depth, both in the language and in the time concepts used by archeologists (Carman 2006; Simonetti 2015). From a visual perspective, such configuration implies a 90° degree rotation of the timeline that, in this case, asks to be seen, out of convention, as a representation of an empirical reality: the different layers of time slowly accumulating on top of each other. Substantial and material human efforts of excavation, extraction and interpretation are required to detect, uncover, and identify the layers of time. This vertical visualization of chronology, based on the stratigraphic arrangement of soils drawn from geology and archeology, has competed with the horizontal sequence that usually paves the succession of historical events. However, the ordinary practice of 'scrolling' that is typical of our days has naturalized the vertical structure of the timeline, making it even more immediate than before for an observer to understand the easy equation "the deeper the older". Indeed, history and geology are based on different forms of representation of time which also act as influential conceptual frames: on one hand "the horizontal, linear, uniform, homogeneous time of historical progress" (Jordheim 2022: 23) – that is actually only one of the forms of visualization of historical time;⁸ on the other hand "a multilayered, vertical oriented time from deep hidden pasts to superficial, visible and tangible presents" (ivi: 26). In facts, as Rheinart Koselleck (2018) claims, with the temporalization of natural history in the second half of the XVIII century (from Buffon on, mainly), not only did the idea of change and transformation enter the natural realm, until then considered unchanging, but also a stratigraphic and vertical conception of time was introduced in the historical discourse. Fernand Braudel (1972), with his theory of the *longue durée*, considered

human event-based history as a superficial structure, rooted in a deeper structure of slow movement and change. Afterwards, Koselleck (2018) analyzed time as a sedimentary structure, in which each layer moves at different speeds and experiences moments of acceleration in which also events on the superficial layers affect the deeper ones in some capacity.

The physical conditions of production of the ice cores have necessary reflections on their signification structures, which respond to the same logic of vertical time visualizations. As long, linear samples of a stratigraphic structure in cylindrical shape, they are the outcome of a massive effort in extraction that is not extraneous to military enterprises.⁹ If the practice of extraction, transportation, conservation, analysis and interpretation is executed correctly, ice cores, in their verticality, arrange the successive layers of snow fallen on earth in the last millennia from newest to oldest. By entrapping air bubbles, dust and sea salt brought by winds of the past, they are deep mirrored reflections of the changing skies under which they were lying for millennia. In comparison to geological strata, ice is more ductile than dust: the bottom layers of snow are thinner than the superficial ones, as they tend to stretch under the weight of the ice sheet above and to flow towards the coasts (Alley 2014: 31-39). This diverse composition causes a lack of regularity in the time scan. The intervals related to the deep past are indeed more closely spaced than those related to recent years.

However, the revolution of geology – and its effects on glaciology – does not lie only in having effectively rotated the timeline by 90°. In fact, the discovery of the concept of "deep time" has created a new time regime in which human time has been embedded in a much longer geological time, overlapping chronologies that belong to different scales.¹⁰ On the one hand, the natural world has acquired a historical dimension; on the other, human history has been reduced to a small fragment of a long "geohistory" (Rudwick 2005). This, always in Helge Jordheim's words, has been seen as a further strike of the Freudian "outrage upon humanity's self-love", following the Copernican revolution, Darwin's evolution theories and Freud's psychoanalysis (Gould 1987), because it put into light man's insignificance and brief history in comparison to the long times of nature.

Nonetheless, it is still humans and their history to

be at the center of the ways in which scientific communities discuss ice cores and present them to the public. A common manner of “making ice cores meaningful” (Antonello, Carey 2017: 189) is to interpolate events from human history and prehistory into them: marking specific levels with reference to well-known human events serves as “a way of orienting public to scientific meaning and significance” (ivi: 189). As a matter of fact, dating ice cores through the grid of human events is not just a way to popularize science to a wider public. It is part of the scientific practice itself, in which scientists try to orient themselves and make sense of the depth of time through what they already know: a linear conception of history, composed of events and discontinuities. As noticed by Erik Isberg (2018), connecting historical facts with climatic events has been a narrative thread since the first articles written in the scientific field to document the analysis of ice cores (see for example Dansgaard et al. 1969). The captions on the timelines that illustrate Dansgaard et al. (1969) make reference to the interglacial period (between the 11th and the 14th centuries) in which Vikings were able to settle in Greenland, due to favorable climatic conditions. The system of dating also includes Lascaux cave paintings – thus implying a more favorable climate for the development of human civilization. The essay and the scientific images included in it acknowledge a certain causal relation between climate and human decisions. On the contrary, in his report of the GISP2 (Greenland Ice Sheet Project, 1993), the American geologist Richard Alley refers to the activity of dating ice cores as a way of “keeping track of the passing of history: this snow fell the year I was born, that snow when Lincoln spoke at Gettysburg, and so on” (Alley 2014: 54). People and climate are thus tied close together both by the imposition of a grid of events on the continuity of ice and by the extraction from this “time machine”, as Richard Alley himself calls the ice-cores, of memorable stories – like the 1966 press conference in which officials from the Pentagon cooled their Coca-Colas with ice originating when Christ was born (Antonello, Carey 2017: 190). In any case, the practice of “synchronization” (Jordheim 2014) between human time, made of small individual events, and Earth’s time, made of slow transformations, is key to scientific practice to face the vertiginous scale of nature’s times. Only in this way, the two scales are brought to a condition of commensurability.

In any case, the different shades of white of the ice cores are mostly imperceptible to the human eye and slight differences in the chemical composition need scientific analysis to be detected and explanatory apparatus to be communicated. There are then different forms of discontinuity in the reading of the ice cores: one is visible and inscribed in the matter itself. For example, a darker layer appearing in all evidence in the ice cores extracted in the Northern hemisphere can represent the dusty remains of the eruption of the Laki Peak volcano in Iceland that occurred in 1753 (Alley 2014: 54). The traces of the atomic experiments conducted since the 1950s – easily detectable through the analysis of radioactivity – belong to an evidentiary paradigm that is only visible through scientific devices. However, the organic trace of those events (natural and anthropogenic) becomes a time marker that is useful to date also the rest of the ice core. The other kind of discontinuity depends on the imposition from the outside of an extraneous grid, not founded on traces, with the objective to give an orientation and a recognizable background to the process of periodization and to give significance to something that is, in appearance, non-significant. At times, the discontinuities in the ice cores respond to discontinuities in human history (e.g. the rise and fall of the Greenlandic settlements) in an attempt to construct causal connections between environmental causes and human events. In other occasions, the correlation is instead totally arbitrary, as there is no climatic evidence for the existence of Jesus Christ or for Abraham Lincoln’s speeches.

The emergence of the Anthropocene paradigm re-directs the causal connection between environmental traces and human history: not only the reason for a human event (e.g. the disappearance of a civilization in a geographic area) can be found in the climatic data stored in ice; but it is the traces of mass industrialization that can now be found in the ice, and thus become the cause of an environmental change that has repercussions on human history itself. Paradoxically, the Anthropocene thesis has restored the centrality of the human agents in the history of earth, giving them the power of influencing what were once considered independent variables: “the metahistorical pre-givens of the human *lebensraum*” (Koselleck 2018: 29). The Anthropocene thesis thus places “the long history of the planet and the short history of humans on the

same chart, not in order to stress the *insignificance* of humanity in the face of the Earth's vast history, as we used to do, but, on the contrary, in order to put the burden of unprecedented geological power abruptly on that same humanity's shoulders" (Latour 2017: 44).

The Anthropocene thesis has thus contributed in integrating the scale of human history with the slow times of geological transformation into a specific, unique form of visualization.

Autographic Visualizations

In scientific language, ice cores contain *data proxies*. They are empirical objects which are able to provide indirect measurements of past climate conditions. Although the information about the climate is indirect, they have the peculiarity of being made of material traces, thus giving direct access to that evidence that is the air encapsulated from the past. Through the chemical analysis and measurement of the quantities and weight of oxygen, hydrogen and carbon, scientists can reconstruct climatic data from the past and build narratives about the kind of air that past species and individuals have breathed. By enriching the evidential support of the ice cores with marks and annotations, they can tell stories of millennia-long climate and planetary change to the general public. The matter ice cores are made of has no relevance nor meaning until the researcher extracts them from a wide, indistinct continuum and looks at the lines, the spots and the slight changes of whiteness as material traces of seasonal cycles and abrupt events. As stratifications of traces, their semiotic existence depends on the presence of an interpreter: it is through the complex series of acts of recognition inherent in scientific practice that they reveal and produce environmental information." Scientists are then to be considered *messengers* – the "spokespersons" in Bruno Latour's words (Latour 1987; 2004a) – who are able to give them a voice. Instruments encapsulating "mute entities (...) thus capable of speaking, writing, signifying within the artificial chamber of the laboratory" (Latour 1991: 29), the ice cores – as both scientific instruments and communication tools – can be considered as "speech prostheses that allow nonhumans to participate in the discussions of humans" (Latour 2004a: 67). On the one hand, then, ice cores belong to the world of facts: as records of past processes and events, they have an indexical

and existential relation with 'what has been'; on the other, they belong to the realm of artifacts – they are the result of a massive and collective act of extraction, elaboration, codification and preservation. This is why Susan Schuppli calls them "double agents" (Schuppli 2020: 3): as "material witnesses", they have an evidential role and register external events; as scientific instruments, they also "expose the practices and procedures that enable such matter to bear witness" (ivi: 3). They are "Moebius-like concepts that continually twist between divulging *evidence of the event* and exposing the *event of evidence*" (Ibidem). We can add to this double role their function as communication devices, when they are exhibited in science museums with the purpose of assigning the environment the status of source and informant of its own transformations. In this respect, drawing from design theory, Dietmar Hoffenhuber sees ice cores as devices for collecting and displaying data through *autographic visualization*: "a set of techniques for revealing material phenomena as visible traces and guiding their interpretation. Designing an autographic display means setting the conditions that allow a trace to emerge" (Offenhuber 2020: 99). Avoiding ontological temptations that yet would seem consistent with the idea of "autography", Offenhuber considers ice cores not as mere supports bearing scars of past events, but as complexly designed communication machines whose goal is to make environmental information legible. The autographic act refers to "the self inscribing nature of material displays, in which the designer creates the apparatus that lets traces emerge rather than explicitly defining symbolic mappings" (ivi: 101). The semiotic act of recognition becomes an act of revelation: it allows nonhuman voices to emerge from the depths of time. Revealing memory encapsulated in ice is an act of 'connaissance' in its etymological sense of "co-birth": knowledge being born from the dialogue between the intelligence of things and that of human intermediaries, ice cores, as "mnemonic banks" (Serres 2003: 28) are there to show that Nature has a memory and that past is inscribed in it. Things, in Serres' words "set down codes" (198) that ask to be deciphered. Offenhuber's autographic visualizations can then be profitably associated with the concept of *gnomon*, a Greek word referring both to an object – the axis of a sundial – and to a concept – the knowing thing, which implies an attribution of cognitive agency to Nature. In Michel Serres' words, a

gnomon “functions automatically (...) without the intervention of intention, which is subjective and cognitive” (ivi: 37). Paul Ricoeur (1985), speculating about the form of the calendar, sees in the gnomon the place of the encounter between the universe of things and the schematizing habit of man: the only subject who is able to make the two systems – the system of things and the system of humans – commensurable.

As Susan Schuppli claims, if it is true that “ice cores are like a tape recorder of climatic history”, then the role of the scientists is to “playback history” (Schuppli 2020: 284) as if it were a score to execute: the autographic act of environmental data self-inscribing in the ice strata can then be subdued to the possible multiple executions of the scientists reading them. As communicative devices, they give nature the active status of a subject who tells the slow history of atmospheric changes. So, the enunciation act becomes a collective effort in which the scientists expose the evidential proofs of climate change: in this construction, nature is allowed to occupy the position of enunciator and brings together the heterogeneous voices of humans and nonhumans.¹² It is humans though who have put nature in the position of speaking for itself and for them. Humans, whose impact on the earth is as accidental as a volcanic eruption, are the active directors of this collective act of communication.

Laboratories of Time

In this section, two recent artistic-research projects are presented: Susan Schuppli’s *Ice Cores* (2019) [Fig. 1-3] and Giulia Bruno and Armin Linke’s *Earth Indices. Processing the Anthropocene* (2022) [Fig. 4]. Making use of different media – documentary film-making, in the case of *Ice Cores*, and photography for *Earth Indices* –, these multi-year projects bring to light the network of actions, technologies, and processes required and enabled by ice coring within glacio-geological and climate change research. In their works, Schuppli, Bruno and Linke seem particularly interested in the scientific and archival practices and structures that emerge with the intent of producing knowledge on the planet’s atmospheric, climatic, and geological history through the extraction, conservation, and interrogation of material samples from all over the world.¹³ These artistic ventures explore the cultural and aesthetic significance of the ice core as a time capsule and as an

eloquent material witness, but they also shed light on the network of intimate bonds between scientists and the objects of their study in the spaces of the field, the archive, and the laboratory.

Susan Schuppli is a multi-disciplinary artist-researcher whose work focuses on material evidence in the context of armed conflicts and environmental disasters. Through investigative processes that involve an engagement with scientific and technical modes of inquiry, she aims to open up new conceptual pathways into the material strata of our world.¹⁴ *Ice Cores* (HD Film, 1:06:22, 2019) is part of Schuppli’s multi-year research project *Learning from Ice*, which explores “the ways in which different knowledge practices engage with the situated material conditions of ice and the politics of cold”.¹⁵ In particular, *Ice Cores* documents activities in the Canadian Ice Core Archive and the Oregon State University’s Ice Core and Quaternary Geochemistry Lab in the US as well as glacial retreat at the Athabasca Glacier in the Columbia Icefields and ice core drilling at Mount Oxford, Nunavut.¹⁶ In the film, ice cores are shown in their multiple habitats: ice fields, laboratories, cryo-archives, refrigerated trucks, surrounded by complex technological and scientific apparatuses, and subjected to the acts of re-sizing and analysis by the researchers studying their chemical composition. Ice cores are extracted and then travel to institutions that are often on the other side of the planet, sometimes only to be shipped away again to other laboratories and research centers. Successful transportation, handling, and storage require a functioning infrastructure of artificial cold: without the development of cryo-technologies, ice coring could not be a viable enterprise. But the transportation can also go in a different direction, as the Unesco Ice Memory Project since 2017 is migrating ice cores from endangered glaciers in sub-Alpine and sub-Arctic regions to Antarctica, the ultimate repository of repositories: “a vast data set of vanishing information now stored in the material memories of ice”.

Schuppli’s film displays the relationship between researchers and ice cores, a relationship that is ultimately paradigmatic of humans and the geological past of the planet. In the film, the scientists extract, store, touch, sense, admire, brush, cut, crush, reshape, care for, and feed the ice cores into laboratory machines. The scientists are intermediaries and messengers in a larger, anthropocenic project of transmu-



Fig. 1-2 | Susan Schuppli, *Ice Cores* (2019)

tation of matter: “the archive is a space of preservation where cores stand in purposeful wait; whereas the laboratory is the demesne of destruction, the site where ice is cut, crushed, and melted so that its internal lifeworlds can be released and studied”.

The laboratory becomes a space where water, no more solid, neither liquid nor gaseous, transcends to a new non-physical state: “In the lab, ice retreats returning to granular and gaseous state, as samples move through various instruments and processes in their journey to becoming data”. In this context, data is a phantasmatic exhalation of the storied materiality of ice that can be computed and stored as long as electronic supports and servers may function, potentially surviving both ice and humans’ existence on Earth, to be read by machinic eyes and artificial intelligences. Schuppli’s film reveals the bond between humans and the ice cores as an intimate one, veiled with a shade of proleptic nostalgia; seeing the scientists at work, with ice dust on their eyelashes and their hands sensing the textures of each ice core, we are made aware of the existential trepidation of facing a fragile and ephemeral embodiment of time.

Holding a diapositive photo, Schuppli reveals herself as a living witness: “As a teenager, I saw the snowy peak of the Kilimanjaro every day from our home in Lyamungo, Tanzania. But today, the mountain’s glaciers have almost entirely disappeared, and will soon only exist within their distant sanctuary in the Antarctic”. In the final sequence of the film, three researchers are shown engaging in ice coring operations in Greenland. Surprisingly choreographic, their processes and actions are accompanied by a rhythmic electronic soundtrack of distorted and looped laboratory sounds.

If the laboratory is the space of destruction and transcendence into data, the field, in its white immensity, appears as the site of encounter between the scientists and the raw narrative potentiality of the storied materiality of ice.

Realized within the framework of *Evidence & Experiment* (2019–22), an initiative of Berlin’s Haus der Kulturen der Welt in cooperation with the Max Planck Institute for the History of Science, Giulia Bruno and Armin Linke’s project *Earth Indices: Processing the Anthropocene* (2022) is a multi-year artistic research project that focuses on the scientific processes involved in the search for the golden spike of the Anthropocene. For *Earth Indices*, Bruno and Linke closely followed the work of twelve laboratories of the Anthropocene Working Group¹⁷ in their investigation for stratigraphic evidence of the Anthropocene epoch.¹⁸ The artists gathered hundreds of photographs and images, which were later organized in an archive as index cards.

Every single one of these index cards is composed by three layers of meaning: a photograph depicting an object, a sketch, or some form of data visualization relevant for the stratigraphic investigation accompanied by its metadata (institutional data, technical data, coring and analysis data) and by an overlay of personal notes or commentary added by the scientists themselves. Bruno and Linke’s idea was to re-create a graphic template reminiscent of the PDF format in order to convey the sense of the production and circulation of knowledge within the scientific world, while simultaneously inserting a quasi-poetic and self aware moment of reflection from the researchers in the form of commentary, instructions or caption. These notes



Fig. 3-4 | Susan Schuppli, *Ice Cores* (2019)

“unlock the technical and anecdotal knowledge hidden in the documents and reflect the praxis of the scientists’ own work” (Klingan 2022: 6). The result is a vast visual repository of images and texts documenting and self-reflecting upon the collaborative and co-emergent nature of the scientific process itself. The images speak organically about the conditions of the scientific production to make the Anthropocene epoch readable: it is, according to Katrin Klingan, curator at HKW, a project informed by “the spirit of latourian laboratory studies”, one aimed at making processes visible.¹⁹

The variety of subjects displayed in the index cards reveal the conjunction of time scales and geographical dimensions interrogated by the AWG project. Different types of high-end and low technology, macro and micro-scopic devices are mobilized in this investigation of time. Bruno and Linke wanted to express and replicate the idea of a methodology as a series of acts and processes to ultimately “transfer and translate the idea of a unit of time” and “to think about the verticality of stratigraphy”. Only one ice core is studied in AWG’s project (see Klingan 2022: 17), but it is the act itself of coring that is crucial for Bruno and Linke: coring contains the shape of the drilling technology, and it inscribes the human presence in the field, with various degrees of persistence in time according to the material composition of the extraction site. The stratigraphic search for the Anthropocene produces voids and pockets wherever the cores were extracted, similar to the bubbles of air encapsulated in the ice cores.

As in Schuppli’s film, data is what remains at the end of the journey of the material witnesses collected in the AWG project. In *Earth Indices*, data is presented as metadata undetachable from the images they



accompany. Scientists interpret the corporeal text of the cores and translate it in their language through a variety of technologies and visualization techniques: the laboratory is not too different from an artist studio, according to Bruno and Linke. Through scientist practice, as in the arts, researchers facilitate and become spokespersons of the storied matter composing the physical dimension of the planet, providing tales of precarious cohabitation, and of deep time entanglements.

Conclusions

The two case studies presented in this essay contribute to ice core knowledge in creative new directions, expanding and reconfiguring the relationship between humans and geological timescales. *Ice Cores* and *Earth Indices* inscribe the human within the vertical timelines of ice and geological stratigraphy, not as abstractions seized from Western history – the aforementioned examples of Lincoln and Jesus –, but rather



Fig. 5 | Giulia Bruno and Armin Linke, *Earth Indices* (2022). One of the index cards for the Palmer ice core.

as corporeal first-person eye-witnesses experiencing and interpreting the storied matter of ice, rocks, corals, or peat – the scientists, Schuppli herself, the AWG. They do so by using different media and registers, but converging on the idea that the acts of coring, the cores, and the empty spaces they produce are themselves acts of inscription of humans into nature that complexify and displace their relations to materiality and temporality. In contrast with the apocalyptic and extinction imaginaries mobilized by the Anthropocene paradigm, these practices and procedures introduce narratives of care and preservation. Rather than being “matters of fact” or “matters of concern” (following the distinction suggested by Latour, see 2004b), ice cores become a “matter of care”, to use the definition of Maria Puig de la Bellacasa (2017). These scientific and artistic gestures appear in their gentleness and brutality, exposing care next to the inevitably harsh experience of human intervention. In their works, by focusing on ice core extraction, classification, and analysis and by documenting the search for a starting date of the ‘age of man’, Schuppli, Bruno and Linke subtly introduce us into the spaces and within the network of actions that produce the Anthropocene on an epistemological level. In the lab and in the ice repositories, before the air trapped in the ice cores can reveal their stories to human audiences, and before these stories can be transmuted into data, visualizations, and planetary politics, ice cores stand in “purposeful wait”, handled, admired, protected by the scientists that will read and translate their final witness.

Notes

¹ For instance the *Welcome to the Anthropocene* website (<https://www.anthropocene.info>) developed in 2012 by Commonwealth Scientific and Industrial Research Organization (CSIRO), Globaia, International Geosphere-Biosphere Programme (IGBP), International Human Dimensions Programme on Global Environmental Change (IHDB), Stockholm Resilience Centre and Stockholm Environment Institute. For critiques to the politics of data visualization in the *Welcome to the Anthropocene* website, see Demos 2017 and Barca 2020.

² See, for example, *Anthropocene* (Burtynsky, Baichwal, de Pencier 2018), the 2019 film *Breakpoint: A Counter History of Progress* (dir. Jean-Robert Viallet), or Subhankar Banerjee' Arctic photography (Demos 2016: 89–94).

³ See, for instance, Stracuzzi's projects *The Legal Status of Ice* (2017–19) and *On Melting Ground* (2021).

⁴ See also Buckland, MacGlip, Parkinson 2017; J. Reiss 2019. In particular, alpine glaciers are the focus of a very large and diverse body of works, for example: the 2007 activist performance organized by Spencer Tunick and Greenpeace on the Aletsch glacier (Wallis, Switzerland); Eddy Mottaz's glacier photography (Moiry and Rhone-gletscher, 2019–2021); Olivier de Sépibus' *Mountain Undown and Hyper-mountain* series (2017–2018); the initiative "Project Pressure" (<https://www.project-pressure.org/about>).

⁵ See also the process of semiotization of matter theorized by eco-semiotician Timo Maran (2014).

⁶ Playfair may have been influenced by Priestley, as stated in Friendly (2006: 26). The practice of noting variation of a phenomenon in time through a horizontal line was also used in natural sciences, as Playfair himself tells us in his introduction to Adam Smith (1805, 3:xvi). That his connection to strategies of notations in natural sciences came from his relationship with his mathematician brother John is found in Berkowitz (2018: 253). As stated in Funkhouser (1937: 289), there is also a connection between financial graphs by Playfair and the visualization of meteorological data that was taking hold in the same years.

⁷ The first geological maps and the definition of stratigraphy are attributed to William Smith in 1815 (see Palmer, Macfarlane 2020) while the first visualizations of cross-sections of the earth's layers as connected to time are by Cuvier and Brongniart (1822), as found in Sepkoski, Tamborini (2018). That earth is made up of layers, the oldest at the bottom, the newest on the top, was discovered as early as 1667 by Danish geologist Nicolaus Steno.

⁸ See for example Krzysztof Pomian (1984) and the different forms of visualization of history (chronometry, chronology, chronography and chronosophy) that reflect the different approaches and instruments (quantitative or qualitative) for analyzing time.

⁹ One of the first most successful drillings took place in 1966, the military outpost of Camp Century in Greenland. This camp was aimed to be a base of nuclear missiles and hosted a maze of under-ice tunnels. See Achermann 2020.

¹⁰ Although the concept of time as a "dark abyss" is already present in Buffon, the best reference we can give to the concept of "deep time" is to the classics Toulmin & Goodfield 1965 and Gould 1987.

¹¹ Recognition is one of the modes of sign production indicated by

Umberto Eco that has to do with imprints, traces and clues. In his words, "recognition occurs when a given object or event, produced by nature or human action (intentionally or unintentionally), and existing in a world of facts as a fact among facts, comes to be viewed by an addressee as the expression of a given content, either to a pre-existing and coded correlation or through the positing of a possible correlation by its addressee" (Eco 1976: 221).

¹² I am influenced here by the reflections on "impersonal enunciation" by Claudio Paolucci (2020) and his reinterpretation of the notion of "collective assemblage of enunciation" by Deleuze and Guattari (1980).

¹³ These projects are not the only significant contributions on ice core knowledge stemming from visual and media arts. See, for instance, *Ice Core Modulations* (Wollensak, Goldman, Baird 2015) and Wayne Binitie's *Polar Zero* exhibition (2021).

¹⁴ <https://www.gold.ac.uk/visual-cultures/staff/schuppli-susan>.

¹⁵ <https://learning-from-ice.org>.

¹⁶ <https://susanschuppli.com/ICE-CORES-1>.

¹⁷ The AWG is a research subdivision of the Subcommittee on Quaternary Stratigraphy, a constituent body of the International Commission on Stratigraphy. One of their main objectives is to date the beginning of the Anthropocene by finding a "golden spike" (formally known as Global Boundary Stratotype Section and Point), a demarcation in stratigraphy to mark the beginning or end of a geologic period <http://quaternary.stratigraphy.org/working-groups/anthropocene>.

¹⁸ Each laboratory studied a different sample from a different location: Antarctic Peninsula, Antarctica (the only ice core of the project); Beppu Bay, Japan; Crawford Lake, Canada; East Gotland Basin, Baltic Sea; Ernesto Cave, Italy; Flinders Reef, Australia; Karlsplatz, Wien Museum, Vienna, Austria; San Francisco Estuary, USA; Searsville Reservoir, USA; Sihailongwan Lake, China; Śnieżka Peatland, the Sudetes, Poland; West Flower Garden Bank Reef, USA.

¹⁹ According to Klingan "Earth Indices portrays both the natural landscapes from which anthropogenic sediments are laboriously extracted as well as the complexities of laboratory processes and the inscription devices they employ to transform the sediment into data that can be interpreted. The exhibition focuses on the spaces of social interaction in which this scientific research takes place, shedding light on the specific procedures and tasks involved in the production of geological evidence. In this way, a multilayered archive is created that relates the anthropogenic traces in the Earth system to the emerging body of knowledge of a new geological epoch" (Klingan 2022: 5).

Bibliography

- ACHERMANN D. (2020), "Vertical Glaciology: the Second Discovery of the Third Dimension in Climate Research", in *Centaurus*, 4, pp. 720–743.
- ALLEY R. B. (2014), *The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change, and Our Future*, Princeton University Press, Princeton.
- ANTONELLO A., CAREY M. (2017), "Ice Cores and the Temporalities of the Global Environment", in *Environmental Humanities*, 2, pp. 181–203.
- BARCA S. (2020), *Forces of Reproduction: Notes for a Counter-He-*

- gemonic Anthropocene, Cambridge University Press, Cambridge.
- BURTYNSKY E., BAICHWAL J., DE PENCIER N. (2018), *Anthropocene*, Steidl, Göttingen.
- BERKOWITZ B. D. (2018), *Playfair: The True Story of the British Secret Agent Who Changed How We See the World*, George Mason University Press, Fairfax.
- BOHLEBER P. et al. (2021), "Ice Core Science Meets Computer Vision: Challenges and Perspectives", in *Frontiers in Computer Science*, 3.
- BONNEUIL C., FRESSOZ J.-B. (2016), *The Shock of the Anthropocene*, Verso, New York.
- BRAUDEL F. (1972), *The Mediterranean and the Mediterranean World in the Age of Philip II*, Collins, London.
- BUCKLAND D., MACGLIP A., PARKINSON S. (edited by) (2017), *Burning Ice: Art and Climate Change*, Gaia Project Press, London.
- CARMAN J. (2006), "Digging the Dirt: Excavation as a Social Practice", in EDGEWORTH M. (edited by), *Ethnographies of Archaeological Practice: Cultural Encounters, Material Transformations*, Worlds of Archaeology, Altamira Press, Lanham MD, pp. 95-102.
- CHAKRABARTY D. (2009), "The Climate of History: Four Theses", in *Critical Inquiry*, 2, pp. 197-222.
- CRUTZEN P., STOERMER E. (2000), "The 'Anthropocene'", in *Global Change Newsletter*, 41, pp. 17-18.
- DANSGAARD W., JOHNSEN S. J., MØLLER J., LANGWAY C. C. (1969), "One Thousand Centuries of Climatic Record from Camp Century on the Greenland Ice Sheet", in *Science*, 166 (3903), pp. 377-381.
- DELEUZE G., GUATTARI F. (1987), *A Thousand Plateaus. Capitalism and Schizophrenia* [1980], trans. by Brian Massumi, University of Minnesota Press, Minneapolis.
- DEMOS T. J. (2016), *Decolonizing Nature: Contemporary Art and the Politics of Ecology*, Sternberg Press, Berlin.
- Id. (2017), *Against the Anthropocene: Visual Culture and Environment Today*, Sternberg Press, Berlin.
- ECO U. (1976), *A Theory of Semiotics*, Indiana University Press, Bloomington.
- ELLIS E. C. (2018), *Anthropocene: A Very Short Introduction*, Oxford University Press, Oxford.
- FRIENDLY M. (2006), "A brief history of data visualization", in CHEN C., HÄRDLE W., UNWIN A. (edited by), *Handbook of data visualization*, Springer Verlag, Berlin, pp. 15-56.
- FUNKHOUSER H. G. (1937), "Historical Development of the Graphical Representation of Statistical Data", in *Osiris*, 3, pp. 269-404.
- GARRARD M. D., BROUDE N. (edited by) (2021), *Diane Burko: Seeing Climate Change, 2002-2021*, American University Museum, Washington DC.
- GOULD S. J. (1987), *Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*, Harvard University Press, Cambridge MA.
- GRINEVALD J. (2008), *La Biosphère de l'Anthropocène: Climat et pétrole, la double menace*, Georg Editeur, Genève.
- HANNAH D. (edited by) (2021), *Julian Charrière: Towards No Earthly Pole*, Mousse Publishing, Milan.
- HARAWAY D. (2016), *Staying with the Trouble: Making Kin in the Chthulucene*, Duke University Press, Durham.
- HECHT G. (2018), "Interscalar Vehicles for an African Anthropocene: On Waste, Temporality, and Violence", in *Cultural Anthropology*, 1, pp. 109-141.
- HORN E. (2019), "The Anthropocene Sublime: Justin Guariglia's Art-work", in REISS J. H. (edited by), *Art, Theory and Practice in the Anthropocene*, Vernon Press, Wilmington.
- HORNBY L. (2017), "Appropriating the Weather: Olafur Eliasson and Climate Control", in *Environmental Humanities*, 9, pp. 60-83.
- IOVINO S., OPPERMANN S. (2014), "Introduction: Stories Come to Matter", in IOVINO S., OPPERMANN S. (edited by), *Material Ecocriticism*, Indiana University Press, Bloomington.
- ISBERG E. (2018), *Drilling for Time: Ice Cores and the Synchronization of Temporalities in Glaciology, 1935-1978*, Master Thesis, Lund University, <http://lup.lub.lu.se/student-papers/record/8953992>.
- JACKSON M. (2015), "Glaciers and Climate Change: Narratives of Ruined Futures", in *WIREs Climate Change*, 5, pp. 479-492.
- JORDHEIM H. (2014), "Introduction: Multiple Times and the Work of Synchronization", in *History and Theory*, 4, pp. 498-518.
- Id. (2022), "Stratigraphies of Time and History: Beyond the Outrages upon Humanity's Self-Love", in EKSTRÖM A., BERGWIK S. (edited by), *Times of History, Times of Nature. Temporalization and the Limits of Modern Knowledge*, Berghahn Books, New York-Oxford.
- KLINGAN K. (edited by) (2022), *Earth Indices. Processing the Anthropocene*. Giulia Bruno and Armin Linke, HKW, Berlin.
- KOSELLECK R. (2018), *Sediments of Time: On Possible Histories*, trans. by Sean Franzel and Stefan-Ludwig Hoffman, Stanford University Press, Stanford.
- KOTHE E. L., MAUTE M. J., BREWER C. (2015), "Vanishing Ice: Art as a Tool for Documenting Climate Change", in *Art Education*, 2, pp. 48-54.
- LATOUR B. (1987), *Science in Action: How to Follow Scientists and Engineers Through Society*, Harvard University Press, Cambridge MA.
- Id. (1991), *We have never been modern*. Translated by Catherine Porter, Harvard University Press, Cambridge MA.
- Id. (2004a), *Politics of Nature: How to Bring the Sciences into Democracy*, Harvard University Press, Cambridge MA.
- Id. (2004b), "Why has critique run out of steam? From Matters of Fact to Matters of Concern", in *Critical Inquiry*, 2, pp. 225-248.
- Id. (2017), "Anthropology at the Time of the Anthropocene: A Personal View of What Is to Be Studied" in BRIGHTMAN M., LEWIS J. (edited by), *The Anthropology of Sustainability*, Palgrave Macmillan, New York, pp. 35-49.
- LUISSETTI F. (2019), "Geopower: On the states of nature of late capitalism", in *European Journal of Social Theory*, 3, pp. 342-363.
- MARAN T. (2014), "Semiotization of Matter. A Hybrid Zone between Bi-semiotics and Material Ecocriticism", in IOVINO S., OPPERMANN S. (edited by), *Material Ecocriticism*, Indiana University Press, Bloomington.
- MATILSKY B. (2013), *Vanishing Ice. Alpine and Polar Landscapes in Art, 1775-2012*, The Whatcom Museum, Bellingham WA.
- MOORE J. W., ALTVATER E., CRIST E. (2016), *Anthropocene or Capitalocene?*, PM Press, Oakland.
- NOWAK Z. (2022), "Theorising the Natural Archive" in *Environment & History*, 1, pp. 105-127.
- OFFENHUBER D. (2020), "What We Talk about When We Talk about Data Physicality", in *ArXiv:2006.04631 [Cs]*, June.
- OPPERMAN S. (2018), "Storied Matter", BRAIDOTTI R., HLAVAJOVA M. (edited by), *Posthuman Glossary*, Bloomsbury, London.
- PALMER D., MACFERLANE R. (edited by) (2020), *Strata: William Smith's geological maps*, The University of Chicago Press, Chicago.
- PAOLUCCI C. (2020), *Persona. Soggettività nel linguaggio e semiotica dell'enunciazione*, Bompiani, Milano.
- POMIAN K. (1984), *L'ordre du temps*, Editions Gallimard, Paris.
- PUIG DE LA BELLACASA M. (2017), *Matters of Care: Speculative Ethics in More Than Human Worlds*, University of Minnesota Press, Minneapolis.
- REISS J. (2019), "Terra Incognita: Exhibiting Ice in the Anthropocene", in REISS J. (edited by), *Art, Theory and Practice in the Anthropocene*, Vernon Press, Wilmington.
- RICOEUR P. (1985), *Temps et récit. Le temps raconté*, tome 3, Seuil, Paris.
- ROSENBERG D., GRAFTON A. (2010), *Cartographies of Time. A history of the Timeline*, Princeton Architectural Press, New York.
- RUDWICK M. J. S. (2005), *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution*, University of Chicago Press, Chicago.
- SALAZAR J. F. (2018), "Ice Cores as Temporal Probes", in *Journal of*

- Contemporary Archaeology*, 1, pp. 32-43.
- SCHUPPLI S. (2020), *Material Witness: Media, Forensics, Evidence*, The MIT Press, Boston.
- SCHWÄGERL C., CRUTZEN P. (2014), *The Anthropocene: The Human Era and How It Shapes Our Planet*, Synergetic Press, Santa Fe.
- SCOTT E. (2015), "Narrating the Anthropocene", in *ETH Zukunftsblog*, July 2, 2015, <https://www.ethz.ch/en/news-and-events/eth-news/news/2015/07/narrating-the-anthropocene.html>.
- SEPKOSKY D., TAMBORINI M. (2018), "An Image of Science": Cameralism, Statistics and the Visual Language of Natural History in the Nineteenth Century", in *Historical Studies in the Natural Sciences*, 1, pp. 56-109.
- SERRES M. (2018), *The Incandescent*. Translated by Randolph Burks, Bloomsbury, London.
- SIMONETTI C. (2015), "Feeling Forward into the Past: Depths and Surfaces in Archaeology", in *Time and Mind*, 1, pp. 69-89.
- SMITH A. (1805), *An Inquiry Into the Nature and Causes of the Wealth of Nations*, vol. 3, Cadell and Davies, London.
- STEFFEN W., GRINEVALD J., CRUTZEN P., MCNEILL J. (2011), "The Anthropocene: Conceptual and Historical Perspectives" in *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 369 (1938), pp. 842-867.
- STEFFEN W., SANDERSON A., TYSON P., JÄGER J., MATSON P., MOORE B. III, OLDFIELD F., et al. (2005), *Global Change and the Earth System: A Planet Under Pressure*, Springer Berlin, Heidelberg.
- STIEGLER B. (2018), *The Neganthropocene*. Open Humanities Press, London.
- TAYLOR J. O. (2014), "Auras and Ice Cores: Atmospheric Archives and the Anthropocene", *The Minnesota Review: A Journal of Creative and Critical Writing*, 83, pp. 73-82.
- TSING A. (2018), "Holocene Resurgence against Anthropocene Planation" in *Multitudes*, 3, pp. 77-85.
- UHRQVIST O., LINNÉR B. O. (2015), "Narratives of the Past for Future Earth: The Historiography of Global Environmental Change Research", in *The Anthropocene Review*, 2, pp. 159-173.
- WATERS C. N., ZALASIEWICZ J. A., WILLIAMS M., ELLIS M. A., SNELLING A. M. (2014), *A Stratigraphical Basis for the Anthropocene*, Geological Society of London, London.
- WOLLENSAK A., GOLDMAN J., BAIRD B. (2015), "Ice Core Modulations: Performative Digital Poetics", XVIII Generative Art Conference, pp. 148-157, Venice.
- YUSOFF K. (2016), "Anthropogenesis: Origins and Endings in the Anthropocene", in *Theory, Culture & Society*, 2, pp. 3-28.