

The Anthropocene

A Challenge for the History of Science, Technology, and the Environment

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In 2000, when atmospheric chemist Paul J. Crutzen and limnologist Eugene F. Stoermer proposed to introduce a new geological era, the Anthropocene, they could not have foreseen the remarkable career of the new term. Within a few years, the geological community began to investigate the scientific evidence for the concept and established the Anthropocene Working Group. While the Working Group has started to examine possible markers and periodizations of the new epoch, scholars from numerous other disciplines have taken up the Anthropocene as a cultural concept. In addition, the media have developed a deep interest in the Anthropocene's broader societal ramifications. The article sheds light on the controversial debate about the Anthropocene and discusses its inextricably linked dual careers, first as a geological term and second as a cultural term. Third, it argues that the debate about the "Age of Humans" is a timely opportunity both to rethink the nature-culture relation and to re-assess the narratives that historians of science, technology, and the environment have written until now. Specifically, it examines both the heuristic and analytical power of the concept. It discusses new histories, new ideas to understand historical change, and new temporalities shaped by scholars who have taken up the challenge of the Anthropocene as a cultural concept that has the ability to question established stories and narratives. Fourth, it ends by stressing the potential of the Anthropocene concept to blur established epistemological boundaries and to stimulate cross-disciplinary collaborations between the sciences and the humanities.

Keywords: Anthropocene, Paul J. Crutzen, Geology, Great acceleration, Periodization

Das Anthropozän. Eine Herausforderung für die Geschichte der Wissenschaften, Technik und Umwelt

Als Paul Crutzen und Eugene Stoermer im Jahr den Begriff des Anthropozäns erstmals in die Debatte brachten, konnten sie nicht wissen, welche rasante Karriere dieser machen würden. Nur wenige Jahre später begannen die Geowissenschaften, die wissenschaftliche Evidenz des Konzepts zu erforschen und richteten die *Anthropocene Working Group* ein. Während die Arbeitsgruppe mögliche Marker und Anfänge der neuen geowissenschaftlichen Epoche untersucht, verstehen Vertreter zahlreicher geisteswissenschaftlicher Disziplinen das Anthropozän vor allem als kulturelles Konzept, an dessen gesellschaftlichen Auswirkungen die Medien ein breites Interesse entwickelt haben. Der Beitrag beleuchtet die kontroverse Debatte über das Anthropozän und diskutiert dessen unauf löslich verflochtene Doppelkarriere erstens als geologischer und zweitens als kultureller Begriff. Drittens versteht er die Debatte um das „Zeitalter des Menschen“ als willkommene Gelegenheit, das Verhältnis von Natur und Kultur neu zu bestimmen und etablierte Erzählungen der Wissenschafts-, Technik- und Umweltgeschichte auf den Prüfstand zu stellen, wobei insbesondere das heuristische und analytische Potential des Konzepts geprüft werden soll. Er präsentiert neue Geschichten, neue Ideen zum Verständnis historischen Wandels und neue

Temporalitäten, die aus der Beschäftigung mit dem Anthropozän als kulturelles Konzept, das etablierte Narrative kritisch hinterfragt, entstanden sind. Viertens schließlich diskutiert er das Anthropozän als Katalysator für eine, die Grenzen zwischen Natur- und Geisteswissenschaften sprengende, inter- und transdisziplinäre Forschung.

Schlüsselwörter: Anthropozän, Paul J. Crutzen, Geologie, Great acceleration, Periodisierung

When Paul Crutzen and Eugene Stoermer first introduced the idea of the Anthropocene in the newsletter of the International Geosphere-Biosphere Programme (IGBP) in the year 2000 (Crutzen & Stoermer 2000), they could not have foreseen the meteoric career of the Anthropocene. If they had known, they would surely not have published their proposal in an internal newsletter, but rather in a prominent scientific journal in order to better reach the global scientific community. Two years later, Crutzen rectified this omission when he presented his hypothesis in a precise and succinct one-page article entitled “Geology of Mankind” in the journal *Nature*: Humans, he suggested, have become a powerful geological force, so much so that it is necessary to designate a new geological epoch in order to accurately describe this development—and this new “Age of Humans,” the Anthropocene, started with the Industrial Revolution in the late eighteenth century. Humanity will continue to be a predominant environmental force for thousands of years (Crutzen 2002).

Limnologist Eugene F. Stoermer (1934–2012) had already begun to use the term Anthropocene informally in the 1980s. But it was atmospheric chemist Paul J. Crutzen (*1933), bringing to bear the full weight of his reputation as Nobel Laureate and the discoverer of the ozone hole, who would eventually succeed in popularizing the term. At a conference in Cuernavaca, Mexico, in 2000, Crutzen—“Mr. Anthropocene”—tired of hearing the Holocene mentioned as the current geological epoch, became impatient and spontaneously exclaimed that we are living in the Anthropocene. Crutzen has repeated this story of a sudden flash of insight, a “eureka” moment of our day, on multiple occasions (Schwägerl 2015), and Will Steffen, who was present at the conference, has confirmed it, thus codifying an attractive founding myth about the origins of the term (Steffen 2014: 486).

Crutzen tells an additional story as part of this founding myth: after colleagues suggested that he should claim ownership of the term, he discovered that Stoermer had come up with the term independently. The joint authorship of the article in the IGBP Newsletter that initiated the entire current debate was a reflection of this co-creation. For the atmospheric chemist Crutzen, the neologism was meant to firmly emphasize the anthropogenic causes of climate change, which at the beginning of the twenty-first century were still heavily contested. To him, the new term offers a powerful tool to validate the ongoing process of anthropogenic climate change, which has impacted the Earth in such an enduring manner that it needs a new geological era to depict it properly.

However, the concept of an age marked by far-reaching human influence on the Earth is much older. In fact, the precursors of this concept can be traced

back to the late eighteenth century—precisely the period proposed by Crutzen and Stoermer as the beginning date of the Anthropocene. It is surely no accident that the idea is as old as the phenomenon it describes. As industrialization began to leave a visible mark on the world, scientists started to take heed. In 1775 French naturalist Georges-Louis Leclerc, Comte de Buffon (1707–1788) distinguished between original nature and nature civilized by humans, and observed that “the entire face of the Earth bears the imprint of human power” (Buffon 1778: 237).¹ In 1864 George P. Marsh (1801–1882) described the transformative power of humans, and particularly our influence on the form of the Earth’s surface. The Italian priest and geologist Antonio Stoppani (1824–1891) suggested something very close to today’s word when he wrote about an “antropozoico” in 1873 to stress that the modern era was an age dominated by humankind. In the early twentieth century, as humanity’s impact gathered pace, these comments became more frequent: Vladimir I. Vernadsky (1863–1945) emphasized the role of humans as a “significant geological force” in 1913 and his teacher Alexei P. Pavlov (1854–1929) spoke of an “anthropogenic age.”² Only two years later a young German scientist, Ernst Fischer (1918–2007), published an article with the title *Der Mensch als geologischer Faktor* and in 1922 a book was published in London by R. L. Sherlock with a nearly identical title: *Man as a Geological Agent*. In the late twentieth century numerous researchers anticipated the idea of the Anthropocene, most notably the biologist Hubert Markl (1938–2015), who in the 1980s referred to the “Anthropozoikum” to describe our present age.

Today, less than two decades after it was publicized by Crutzen and Stoermer, the discussion about the “Age of Humans” has long since expanded beyond the realm of the biological and geological sciences. It has, some scholars have complained, become part of “popular culture” (Autin & Holbrook 2012). Scholars from many disciplines—from anthropology and theology, geography and paleology, art and literature—are engaged in intense discussions of the Anthropocene. Furthermore, the Anthropocene is no longer confined to academia and is being widely debated by the media and the general public. To give one example of how far the concept has spread in the public sphere, the *Deutsche Museum*, Germany’s premier museum of science and technology, and the *Rachel Carson Center for Environment and Society* jointly created the world’s first major exhibition on the topic: “Welcome to the Anthropocene: The Earth in Our Hands.” In doing so, they partnered with the *Haus der Kulturen der Welt* in Berlin, an eminent center for arts and cultures, which in 2013 and 2014 devoted all its activities to the “Anthropocene Project” (Möllers et al. 2015; Renn & Scherer 2015; Robin et al. 2014). Meanwhile, many other museums and cultural institutions have followed suit. Today, at least two dozen exhibition projects are underway that refer to the Anthropocene in one way or another.

What is so important in the discussions about the Anthropocene? To understand the current debates, it is crucial to distinguish between the Anthropocene in a narrow sense, as a geological concept, and the Anthropocene as a cultural concept in a wider sense. In this article, I shed light on the controversial debate about the Anthropocene and discuss its dual career as a geological term and as a cultural term. It would be misleading, however, to understand these two careers as separated. On the contrary, they are inextricably interwoven, and can only be fully understood by stressing the linkages between the geological and the cultural layers of the concept. Next, I argue that the debate about the “Age of Humans” is a timely opportunity both to rethink the nature-culture relation and to re-assess the narratives that historians of science, technology, and the environment have written until now. Particularly, the article examines both the heuristic and analytical power of the concept. Moreover, it discusses new histories, new ideas to understand historical change, and new temporalities presented by scholars who have embarked on the challenge of engaging with the Anthropocene as a cultural concept in order to question established stories and narratives. The article ends by stressing the potential of the Anthropocene concept to blur established epistemological boundaries and to stimulate cross-disciplinary collaborations between the sciences and the humanities. Of course, such collaborations often come with controversial debates about conceptual ownership on temporalities and historical change. I do think, however, that history of science, technology, and the environment would greatly benefit from engaging in such border-crossing collaborations and conceptual debates, which are well underway in related fields such as archeology, evolutionary anthropology, and ancient DNA research.

The Anthropocene as a Geological Concept

When Hubert Markl proposed using the term *Anthropozoikum* he was not concerned with the dating of the new era: for him the important thing was that this era, which was particularly marked by a massive loss of biodiversity, had already begun. He underestimated the challenges of defining this era, however. Although the proponents of the Anthropocene are in complete agreement that humanity, with its highly developed technology, is now the dominant geological actor and will continue to be so for a long time to come, there is little agreement about the question of what date marks the beginning of the new era. For Crutzen and Stoermer at the turn of the century, there seemed to be no question that the dating of the Anthropocene should correspond with the beginning of industrialization—specifically with Watt’s development of the steam engine—in the late eighteenth century. Since then nine viable

candidates for possible dates have been proposed, most of which are clustered in the modern era between 1610 and 1964 (Lewis & Maslin 2015). Three of these proposals, in particular, have been prominent in the debate.

The first suggestion focuses on the transition from the nomadic societies of hunters, gatherers, and fishers to the permanent settlements of societies engaged in agriculture, which occurred, according to current knowledge, around 11,700 years ago in the Fertile Crescent in the Near East and is known as the Neolithic Revolution. This process, which took some 5,000 years, was by no means a revolution in the sense of an abrupt change in the social order, but it was a true transformation: humans altered large portions of the landscape and intervened in the natural gene pool by cultivating plants for crops and domesticating animals on a previously unprecedented scale. The “invention” of sedentary societies, agriculture, and animal and plant husbandry was closely connected with new technologies: firing pottery made it possible to store agricultural produce for later use. Improved stone tools and innovations in building methods provided a basis for permanent settlements. The invention of the plow made it possible to break up the soil for cultivation and increased productivity.³

The Neolithic Revolution left detectable traces in the geological record. Countless pieces of evidence from palynology, archaeology, geology, history, and cultural anthropology support the thesis that human alteration of the landscape of Eurasia began during the late Stone Age and gained a new quality during the Bronze and Iron Ages. Only human intervention can explain why the concentration of carbon dioxide and methane in the atmosphere shows an anomalous rise during the Middle Holocene (sixth through third centuries BCE), a rise that is substantially greater than the fluctuations during the previous hundreds of thousands of years (Petit et al. 1999).

Secondly, what is the evidence in support of Crutzen’s proposed dating, which places the start of the Anthropocene in the late eighteenth century? Whole libraries are filled with the debate about whether the industrialization process, which originated in Great Britain and, through technology, completely transformed society over the course of nearly a century, can properly be called a ‘revolution’ at all. However, it resulted in the transformation of the societies affected by industrialization—a transformation that was in fact quite revolutionizing in its effects. The driving force behind it was once again technological innovation. Three main processes worked together: first, the mechanization of manual labor; second, mechanical production and the transformation of energy using the steam engine; and third, the large-scale exploitation, production, and use of coal and iron.

The effects of industrialization on environment and society were even more fundamental, far-reaching, and lasting than those of the Neolithic Revolution. It is no coincidence that discussions about the environment have increased steadily since the 1830s. Contemporaries began to notice that the

new technology was profoundly altering the landscape and the environment, and frequently even their livelihoods. In the environmental discourse of the nineteenth and twentieth centuries, the perception of a change in the relationship between nature and society is a primary concern, as well as more concrete problems such as conflicts about the distribution of natural resources like water, wood, air, and land. Particularly extreme were the effects of the enormous increase in the use of fossil energy sources that resulted from the large-scale use of coal-powered machines. Starting in the nineteenth century, British industrial cities such as Manchester, Glasgow, and even London acquired the dubious honorific “Big Smoke” (Uekötter 2009: 20–65). The development of coal-fired, steam-powered locomotives was only one of many technologies based on the use of fossil fuels. The rapid spread of the railroad provided the iron and steel industry with a huge boost and increased the pace of industrialization. If we look at the carbon dioxide concentrations in the atmosphere as a simple yet significant indicator of change, we see that it rose from pre-industrial levels of 270–275 parts per million (ppm) to 310 ppm in the mid-twentieth century (Petit et al. 1999; Bonneuil & Fressoz 2016: 15–16).

Finally, the third proposed dating, the “Great Acceleration” around the middle of the twentieth century, avoids using the term ‘revolution,’ but in view of the temporal compression of events, it may best be described as such. As shown by an international team of climate and Anthropocene researchers led by Will Steffen, during the course of the 1950s the curves of numerous parameters shifted from linear to an exponential growth (Steffen 2005; Steffen et al. 2015). This characteristic curve, reminiscent of a hockey stick, can be seen on a global scale for such phenomena as the use of resources like crude oil, water, and artificial fertilizers, as well as the construction of dams, automobiles, telephones, and McDonald’s restaurants, and economic indicators such as the increase in international tourism, foreign investments, and gross national product. Even before the Anthropocene discourse started, Christian Pfister, an economic and environmental historian, had already pointed to the middle of the last century as a major turning point, calling it the “1950s syndrome” (Pfister 1995). Rapidly growing energy consumption, together with the mass motorization of large portions of the world, went hand-in-hand with the development of consumer society, and thus a society that is built upon a never-ending stream of technological innovations.

In addition to these primary contenders for the periodization of the Anthropocene there are a number of additional proposals, which have been put forward by individual teams of researchers, often gaining significant visibility due to their reporting in the mass media.

In May 2014, for example, the findings of an international group of scientists at the Desert Research Institute in Reno, Nevada (USA) made headlines in the journal *Nature* and from there quickly found their way into daily news

outlets (McConnell et al. 2014). The scientists had been able to show that when Robert F. Scott (1868–1912) and Roald Amundsen (1872–1928) led their expeditions across Antarctica in 1911 in a competition to be the first to reach the South Pole, the landscape of snow and ice that they struggled to cross was hardly pure and untouched by human activity. On the contrary: even then, at the dawn of World War I, industrialization had left its traces in Antarctica, the one place on Earth that seemed to have been least influenced by human civilization.

Using core samples taken from 16 different locations in the Antarctic ice, the team of scientists measured the annual amount of lead pollution deposited from the atmosphere between the years 1600 and 2010. They demonstrated that by 1889 industrial lead pollution, originally emitted from mining and smelting operations, factory chimneys, and combustion engines, was already present in large quantities—some two decades before the first explorers arrived at the South Pole. At the end of the nineteenth century the levels of lead deposited in the Antarctic were higher than at any time in the twentieth century. The data showed that lead pollution levels reached a maximum around 1900, which continued into the 1920s before starting to fall again.

In spring 2015 another dating proposal received significant attention in the mass media: in an article, again published in *Nature*, British scientists proposed that the starting date for the Anthropocene should be pushed back to the early seventeenth century (Lewis & Maslin 2015). They argued that the consequences of human activity—particularly the colonization of the Americas—were already so widespread that a global effect could be identified even earlier than the Industrial Revolution. Their analysis of ice core samples showed a particularly prominent drop in carbon dioxide levels in the Earth's atmosphere in 1610. Its cause was a delayed effect of the European discovery of the Americas. The colonization of the New World led to the death of some 50 million indigenous Americans as a result of war and diseases introduced by the Europeans such as smallpox. The dramatic drop in population meant that large swathes of land that had previously been cultivated now lay fallow and became rainforest again. This surge in vegetation captured enormous amounts of carbon dioxide from the atmosphere. In 1610 this effect peaked, leaving a distinct trace in the geologic record.⁴ In brief: the early seventeenth century was the last time there was a clear drop in the concentration of greenhouse gases in the atmosphere, and at the same time the last comparatively cool moment on the planet before the beginning of the long-term global warming that has marked the Anthropocene ever since.

Several years ago a panel of experts, the *Anthropocene Working Group*, was entrusted with the task of examining the scientific evidence for each of these suggestions and submitting a formal proposal based on their own stratigraphic investigations to the *Subcommission on Quaternary Stratigraphy*. This organization, in turn, reports to the *International Commission on Stratigraphy*,

which reports to the *International Union of Geological Sciences*. Only after the proposal has successfully passed through all four of these scientific bodies will the existence of a new geological division be considered official. In order to be accepted under this rigorous examination process, a proposal must fulfill three main criteria:

1. A synchronous base, which is the same time everywhere around the globe, representing an event decided in advance of the definition.
2. A specified position in the sedimentary record that defines this synchronous base, that is, a Global Boundary Stratotype Section and Point (GSSP), known as a “golden spike.”
3. A specified rank in the stratigraphic hierarchy (stage, epoch, period, era).

The *Anthropocene Working Group* has announced that they will present their proposal at the end of 2016 or in early 2017 based on the guiding question, “to what extent are human actions recorded as measurable signals in geological strata, and is the Anthropocene world markedly different from the stable Holocene Epoch of the last 11,700 years that allowed human civilization to develop?”⁵ To answer this question, they are examining what are known as stratigraphic signatures, which include a wide variety of possible forms of evidence, in particular:

- new materials, such as elemental aluminum, concrete, plastic, and carbon particles,
- alterations in the processes of sediment creation, for example due to eutrophication from fertilizers, capture of sediment behind dams, erosion from mining or deforestation,
- altered geochemical signals in sediments and ice sheets, for example increases in polycyclic aromatic hydrocarbons, pesticide residues, increases in nitrogen and phosphorus,
- presence in sediments and ice of radionuclides released by nuclear bomb testing,
- changes in the carbon cycle based on data from ice core samples,
- increase in global temperature and rising sea levels, and
- alterations in biodiversity, for example homogenization due to agriculture and animal husbandry, and supplanting of established biota by invasive species introduced by humans.

A recently published article in the leading journal *Science* presents the Anthropocene researchers’ preliminary answer to this question: “The Anthropocene is functionally and stratigraphically distinct from the Holocene,” the article title boldly declares (Waters et al. 2016). The group found stratigraphic signatures that were either completely new, or fell substantially outside the level of variation of the Holocene; all of these changes were occurring in an accelerated fashion. The data collected suggested that the

lower boundary of the Anthropocene should be drawn in the mid-twentieth century. Their preference would be to position it in the stratigraphic hierarchy as an epoch, like the Holocene. Alternatively, the stratigraphers indicated that classifying the Anthropocene as a new age within the Holocene—after the Greenlandian (11,700–8200 years before AD 2000), the Northgrippian (8200–4200), and the Meghalayan (4200–present) (Head & Gibbard 2015)—would also be an option.

It is by no means certain that the *Subcommission on Quaternary Stratigraphy* will approve the suggestion and pass it on to the next highest scientific body, the *International Commission on Stratigraphy*. Its chair, Martin J. Head, has expressed skepticism, suggesting that the many disadvantages of defining a new geological epoch outweigh the few advantages: the Holocene epoch would be cut off, something that had never happened in the 200-year history of geology. The entire geological time scale would be mutilated, rendering a huge quantity of literature on the Holocene obsolete.⁶ Asking the conservatively inclined stratigraphic experts to accept such a proposal is a big demand. The objections of stratigraphers range from purely scientific arguments, such as questioning the long-term duration of potential boundary markers like the radiation layer in the atmosphere resulting from the use and testing of nuclear weapons (which will only linger for 100,000 years), to moral reservations: naming an interval in Earth history for the first time not only after a single species, but after a species that happens to be ourselves, would strengthen the hubris that we ought to overcome if we are to create an ecologically more robust Anthropocene (Gibbard & Walker 2014; Finney & Edwards 2016). Even in the inner workings of the stratigraphic debate, cultural arguments serve as a resource to justify scientific claims.

The proposal can be approved by the *Subcommission on Quaternary Stratigraphy* only if a qualified majority—at least 60 per cent of its members—votes to do so. If this majority is not reached, the stratigraphic debate about the Anthropocene as a distinct phase in the Earth's geological history will be abruptly ended. But it is important to remember that the Anthropocene debate is no longer a topic of interest only to geologists; it has long since been taken up by other disciplines in the natural sciences and beyond. Climate scientists and atmospheric chemists, ecologists and oceanographers, and many more experts in related Earth systems sciences take a broader view on the human-induced changes to the Earth than is implied by the geological search for evidence in rock strata. Indeed, the *Anthropocene Working Group* supports such a wider understanding of the Anthropocene concept that is not only about being able to detect the human influence in stratigraphy, but “reflects a substantial change in the Earth system” (Zalasiewicz et al. 2015b: 197). In this wider, systemic understanding, the Anthropocene connects with the effort to identify “planetary boundaries” and a so-called “safe operating space for humanity” (Rockström et al. 2009; Steffen et al. 2015). If stratigraphers end up voting

against the proposal of a new epoch in Earth history, the term will continue to be used by scientists in a wider, systemic meaning (Hamilton et al. 2015: 3).

The Anthropocene as a Cultural Concept

The wave of attention set in motion by the *Anthropocene Working Group's* article in *Science* rippled through the popular media, highlighting how the Anthropocene debate has long since broken out of the confines of the academy and entered public discourse. Even before the publication of the print version of the article, online articles appeared in news outlets such as the *Guardian*, the *Daily Mail*, the *Washington Post*, the *Frankfurter Allgemeine Zeitung*, the *Züricher Tagesanzeiger*, *New Scientist*, and *Scientific American*. On the same day as the print edition was published, major media sources around the world reported that the scientific community had proposed designating a new geological epoch. The Anthropocene has captured the interest of the media and it is becoming a culturally negotiated matter that dissolves the boundaries between science and society.

This is probably the greatest significance of the Anthropocene as a concept: it blurs established boundaries on many different levels between science and the public as well as between the sciences and the humanities. Equally importantly, it opens up the possibility of freeing ourselves from traditional dichotomies such as ‚nature’ vs. ‚culture’ and redefining the relationship between environment and society as inextricably intertwined. Bruno Latour even goes a step further and challenges not only the modern dichotomy of nature and culture, but their existence as separate categories in the first place:

The point of living in the epoch of the Anthropocene is that all agents share the same shape-changing destiny. A destiny that cannot be followed, documented, told, and represented by using any of the older traits associated with subjectivity or objectivity. Far from trying to ‚reconcile’ or ‚combine’ nature and society, the task, the crucial political task, is on the contrary to distribute agency as far and in as differentiated a way as possible – until, that is, we have thoroughly lost any relation between those two concepts of object and subject that are of no interest any more except patrimonial. (Latour 2014: 17)

Latour draws an interesting parallel between the current debate about the role of humans as a geological force and the controversy about the status of humans in the universe which Galileo Galilei (1564–1642) set into motion 400 years ago when he presented the thesis that the Earth moved around the sun, thereby challenging the established conception of the world, which attracted the attention of the Inquisition. The Anthropocene thesis is not “the Earth is moving,” but rather “the Earth is moved”—by humans (Latour 2014: 3-4). This thesis, too, radically alters our conception of the world, and it, too, summons

the inquisition of our age, which Latour identifies especially as those circles in politics and industry, which deny that humans are the cause of climate change.⁷

The ability of the Anthropocene to challenge established categories and boundaries is evident even within the *Anthropocene Working Group*. For interestingly enough, its scientific debates include not only input from geologists and biologists (that is, experts in stratigraphy and biodiversity), but also from experts in a wide variety of disciplines—another instructive proof that the geological and the cultural debates about the Anthropocene are inextricably linked. The 37 members of the working group include scholars from criminology and anthropology as well as history, the latter represented by global and environmental historian John McNeill and historian of science Naomi Oreskes. For the first time in the history of geology, decisions about geological periodization are being discussed not only among a select group of stratigraphy experts, but in an interdisciplinary setting, to which natural sciences, social sciences, and humanities contribute with their highly diverse concepts of time, space, evidence production, and interpretation. This is in itself a highly interesting setting which invites, nay, even requires historians of science and technology to reflect on the broader epistemological ramifications of such interdisciplinary frameworks of knowledge production.

Critical voices expressing doubt about the analytical value of the Anthropocene are not limited to the geological sciences. As a cultural concept, too, it has been challenged on a wide variety of points. Some critics are dubious about whether, as a way of defining the relationship between nature and culture and environment and society, it offers anything that already established analytic categories cannot. Others have more deep-seated concerns: they fear that naming a new geological epoch after humans would provide massive encouragement for already-rampant anthropocentrism and cause human respect for the intrinsic moral value of nature to diminish even further (Manemann 2014; LeCain 2015: 1–28).⁸ Furthermore, some anthropologists, as experts on ‚anthropos‘ as a cultural entity, are uneasy with the term. For them, it signifies all of humankind when it is only small groups of people in industrialist countries who are truly responsible for the environmental problems of the modern era. Rather than stimulating urgently needed social and political change, the term obscures concrete responsibility by stressing intrinsic human qualities instead of choices resulting from vested capitalist interests (Malm & Hornborg 2014).

Let there be no misunderstanding: the Anthropocene as a cultural concept would benefit from nothing so much as a constructive, critical debate about its potential and effectiveness for redefining the relationship between humans and nature. But the sweeping reproach that it strengthens anthropocentrism fundamentally misunderstands the analytic point of convergence of the concept. The Anthropocene is emphatically not about affirming the dichotomy of

nature and culture that has developed over the course of the modern era, but rather about critically calling into question the anthropocentrism that has resulted from this. It is no coincidence that the Anthropocene as a cultural concept has found particular resonance among advocates of post-humanistic approaches. The blurring of the boundaries between nature and culture in the Anthropocene bestows agency on non-human actants and identifies a wide variety of cyborgs and hybrids in the open space of post-humanist forms of existence. Bruno Latour fiercely insists on a very un-anthropocentric reading of the Anthropocene concept: by attributing agency to non-human factors, the Anthropocene withdraws agency from humankind rather than equipping it with the power to engineer the Earth (Latour 2013, 2014, 2015; also Chakrabarty 2009, 2016).

Understood in such a way, the Anthropocene ultimately allows for a changed perspective on humanity and our supposed uniqueness among the species on the planet. Humanity becomes, in the words of literary scholar and pioneering post-humanist theorist Ursula Heise, just one part of the world's "networks of distributed agencies that include animals, plants, substances, and objects" (Heise 2015: 40). Heise provides an instructive example of this. From a post-humanist perspective, the Anthropocene concept means being aware of:

How even as simple an affirmation of my own agency as ‚I’m going to Berlin tomorrow’ depends on a multitude of objects, substances, processes, and institutions I control only partially or not at all (caffeine, wheat, aspirin, gasoline, rubber, asphalt, highways, car manufacturers, air traffic control, schedules, luggage, and cell phone networks, to name just a few) (Heise 2015: 40).

Donna Haraway, the grande dame of feminist studies, agrees, concluding that, logically, to speak of the "Anthropocene" means speaking of the "Capitalocene" (Haraway 2015: 159–165). In this, Haraway joins the ranks of the numerous political scientists, anthropologists, sociologists, economists, and philosophers who suggest that the Anthropocene, as it has developed since industrialization, is tightly linked with capitalism (Head 2014; Moore 2016).

Political science, anthropology, sociology, and philosophy: along with history, these are the communities within the humanities and social sciences in which the Anthropocene as a cultural concept is being most intensively debated. A short overview such as this cannot adequately discuss all the aspects of such a broad and multi-faceted discourse. As an indication of its importance, there are several new journals dedicated exclusively to the topic: *Elementa: Science of the Anthropocene* and *Anthropocene*, both representing the natural sciences, and *The Anthropocene Review*, which includes humanities and social science perspectives. And, lest we distort the picture, it is necessary to add that many other academic communities are also deeply involved in discussions about the Anthropocene, for example law (Kersten 2013, 2014; Eagle 2016) and religion (Szerszynski 2006; Deane-Drummond et al. 2016; Haber et al. 2016). Nor is it confined to theoretical discussions in the arts,

aesthetics, and cultural theory; artists and architects are beginning to respond to the geological imperative in their practice, and to discuss the significance of the term for their work (Davis & Turpin 2013; Turpin 2015); poets translate the concepts into lyrics and invite literary scholars and ecocritics to reflect on such practices of translation (Bristow 2015; Falb 2015; Clark 2015; Bayer & Seel 2016).

The Anthropocene has also become well established in another practice-based realm, namely education and teaching, where it has been embraced as a powerful instrument for testing out new methods of environmental education (Leinfelder 2013; Möllers 2014; Lloro-Bidart 2015). As institutions dedicated to disseminating knowledge to the public, museums and exhibition centers—often inspired by the groundbreaking exhibition at the *Deutsches Museum*—have discovered that the topic offers a way of expanding their conceptual and thematic repertoire (Robin et al. 2014). At present several dozen exhibitions on the Anthropocene are being prepared around the world. And from one such initiative, the Anthropocene Project of the *Haus der Kulturen der Welt* in Berlin, has sprung an unprecedentedly ambitious endeavor to create an interdisciplinary curriculum for the Anthropocene.⁹ Some humanities scholars, represented prominently by Jürgen Renn, co-organizer of the Anthropocene curriculum and director of the Max Planck Institute for the History of Science, see the Anthropocene debate as an opportunity to restructure our knowledge system so that it is both fundamentally interdisciplinary and reflexive as well as radically oriented towards dialogue with the public (Renn et al. 2015). Its inherent inter- and transdisciplinarity is another way in which the Anthropocene reveals its power to blur boundaries and transcend barriers.

The Anthropocene concept involves more than just an exchange of scientific ideas; rather, it is a site where fundamental ethical positions are being renegotiated. The fierce controversy about the “Good Anthropocene”—initiated by Erle C. Ellis (2011)—encapsulates this like no other topic in the debate. Ellis, a US geographer and landscape ecologist, sees that “the only limits to creating a planet that future generations will be proud of are our imaginations and our social systems.” He continues: “In moving toward a better Anthropocene, the environment will be what we make it” (Ellis 2015: 54).

The idea of the Good Anthropocene has incurred massive criticism from those, who fear that it paves the way for questionable concepts of geo-engineering (Latour 2012, 2013; Hamilton 2015). Critics point out that several years ago, no less a figure than the ‘father’ of the Anthropocene, Paul J. Crutzen, despairing about the effects of anthropogenic climate change, published the suggestion of stopping global warming by injecting 1.5 million tonnes of sulfur dioxide particles into the atmosphere in order to reflect sunlight (Crutzen 2006). Crutzen has been heavily criticized for this. As a

consequence of such talk of technological interventions when the long-term consequences for the climate and the Earth are completely unknown, the idea of the Anthropocene has acquired for many a bitter aftertaste (Hamilton 2013).

Ellis is also one of a group of 18 authors who published *An Ecomodernist Manifesto* in April 2015. It is based on the conviction “that knowledge and technology, applied with wisdom, might allow for a good, or even great, Anthropocene.” A good Anthropocene “demands that humans use their growing social, economic, and technological powers to make life better for people, stabilize the climate, and protect the natural world” (Asafu-Adjaye et al. 2015). The authors of the manifesto include Michael Shellenberger and Ted Nordhaus, founders of the *Breakthrough Institute*, a US think tank with close ties to industry, who have published highly controversial books predicting the end of the environmental movement; are opposed to climate negotiations, and advocate the continued use of nuclear energy in order to protect the climate (Shellenberger & Nordhaus 2004, 2007). Characteristically, the *Breakthrough Institute* also calls for new narratives, which it provides in the form of its own revisionist stories. Particularly controversial is the attempt to recalculate the cumulative costs of nuclear energy over time while relying on highly controversial theses such as “there is no inherent cost escalation trend with nuclear power” and nuclear reactor costs “rise before they fall” which the institute offers as advice for policy makers to justify the construction of new reactors instead of moving away from nuclear power (Lovering et al. 2016: 371, 381).

The cultural debate about the Anthropocene is concerned with nothing less than the most central questions of our society: What will the future look like? How should we conduct business, work, and live? What role will technology have in this? What forms of production and communication of knowledge are suitable for the Anthropocene? Finally, what narratives do we need in order to better understand the planetary role of humans as actors that affect the entire Earth system? This is what makes the discussion so fascinating and so relevant for today—and tomorrow.

New Narratives, New Temporalities

Unsurprisingly, the Anthropocene is being particularly intensely debated among historians. As experts on temporal periods within human history, historians of all types have a direct connection to the topics being discussed in the Anthropocene debate: all of the proposals for defining the temporal boundary of the Anthropocene are concerned with central questions studied by the history of science, the history of technology, and environmental history.

It is therefore particularly relevant for them to be involved in the Anthropocene debate. On the question of the geological definition of the Anthropocene, John McNeill and Naomi Oreskes, as mentioned above, have, as it were, an official mandate to represent their communities and the specific expertise of each. But for historians entering into the discussion of the Anthropocene as a cultural concept, being involved in the Anthropocene debate means nothing less than facing the challenge of critically examining established stories and discourses and scrutinizing the theoretical, methodological, and conceptual foundations of historical research.

Multiple historians have accepted this challenge. For example, John McNeill—with Peter Engelke as co-author—draws on his experience as a member of the *Anthropocene Working Group* to narrate the history of the world since 1945 as a history of the unfolding of the Anthropocene, which resulted from the Great Acceleration in general, and from the massive expansion of fossil fuel use in this era more specifically. This, “more than any other shift,” inaugurated the new epoch (McNeill & Engelke 2014: 367, 2016). As an environmental historian interested in the circulation of resources, McNeill particularly refers to large-scale fossil fuel energy use, carbon dioxide and sulfur dioxide emissions, freshwater use and irrigation, fertilizer use and toxic chemical releases, to name but a few indicators of environmental change during the Great Acceleration. For the geologists in need of a clear-cut golden spike, he proposes examining the bones and teeth of mammals born in the 1940s and 1950s, which for the first time in history include a chemical signature that resulted from nuclear weapons tests. (The test ban treaty of 1963 then weakened the signature of radionuclides.) Some of these bones and teeth will end up in a sediment layer that distinguishes the mid-twentieth century from all that went before and all that came after.

Industrialization had already meant a new stage in the history of human impact. With the Great Acceleration in the mid-twentieth century, however, came a more radical departure. After all, the temporal definition of the Anthropocene is a matter of deciding what constitutes the new epoch. If a slow acceleration of fossil fuel use and of human population growth is the primary indicator, then the eighteenth century is the right choice. If, in addition to a dramatic acceleration of fossil energy use and human numbers, massive deforestation, dramatic loss of biodiversity, and similar environmental changes are also taken into consideration, then the mid-twentieth century makes most sense.

Global historian Paul Dukes frames his world history since the end of the Seven Years’ War as a story of “the Anthropocene era from 1763” (Dukes 2011). In a strict geological sense, the book’s subtitle is misleading since the Anthropocene is set to be defined as a geological epoch rather than an era. Dukes, however, takes the liberty of using the term as an analytical tool to narrate global history over the last 250 years and starts, much in line with Paul

Crutzen's periodization, with the invention of the steam engine. *Minutes to Midnight*, the book's main title, refers to the Doomsday Clock created by atomic scientists in 1947 to point to the perils facing humanity from nuclear weapons. In contrast to the atomic scientists' earlier alarm call, he understands his narrative as a pan-disciplinary response to the ongoing crisis showing that, "after aeons of the development of planet Earth, we have created the mess in no more than two centuries" (Dukes 2013: 5). For him, the Anthropocene concept offers a unique tool to interlink geological time with historical time and to simultaneously focus on "major advances in the natural sciences and their applications" (Dukes 2011: x). Confined to the comparatively recent past, the Anthropocene concept perfectly suits his ambition to narrate environmental change resulting from humanity's scientific creativity and technical inventiveness since the end of the eighteenth century.

While Dukes follows humanity's destiny over the last quarter of a millennium, early modernist Geoffrey Parker focuses on an era that has already concluded: the seventeenth century as a period of crisis and transition. In his brilliant and voluminous book *Global Crisis* Parker traces a "fatal synergy that developed between natural and human factors," the inextricable, but so far under-recognized interlinkages between sociopolitical processes such as wars and political upheaval and environmental processes such as climate change and natural catastrophes (Parker 2013: xxv). The Little Ice Age with its severe cold intervals in the seventeenth century, particularly from 1650 to 1700, led to the rise to political dominance of European powers, known as the "Great Divergence" (Pomeranz 2000), and triggered the emergence of the modern international system. In the seventeenth century "more wars took place around the world than in any other era until the 1940s" (Parker 2008: 1056). In Europe, states answered the climate crisis by creating standing armies and increasing their political power. After all, it was climate change that triggered the emergence of the modern international system.

While Parker himself only indirectly referred to the Anthropocene, others have understood his book as an invaluable contribution to make sense of the concept. Based on Parker's novel interpretation of the seventeenth century, Ji-Hyung Cho for example has stressed another consequence of the enduring cold climates: the transition from renewable organic energy to non-renewable fossil fuels which started in Britain „as an active response to the coldest weather in the last 10,000 years“ and led to „the beginnings of the Anthropocene at the height of the Little Ice Age (Cho 2014: 16). Climate historians in particular have received Parker's work with enthusiasm and read it as an introduction to the Anthropocene (Mauelshagen 2014, 2015). Looking through the analytical lens of the Anthropocene allows for a new history of the seventeenth century that weaves human history and Earth history into a seamless narrative web.

Dipesh Chakrabarty, a leading figure in subaltern studies and postcolonial studies, was one of the first scholars to discuss the challenge of the Anthropocene for narrating history. His much-debated article on the question of how climate change has impacted historiographical practices was informed by the Anthropocene debate (Chakrabarty 2009). To him, taking the Anthropocene seriously means nothing less than overcoming the dominant view of the human condition that was established in modernity. Human history and natural history are no longer independent but interwoven into an integral geohistory. Humanity as a telluric force has inscribed itself into Earth history. In the Anthropocene, cultural, socioeconomic, and sociopolitical orders co-evolve with natural orders, requiring shifting perspectives and novel narratives in the humanities in general and in history in particular (Chakrabarty 2015, 2016). As a recent multi-disciplinary collection examining his theses suggests, they are a particularly powerful and effective appeal for new narratives in the light of the insights of the Anthropocene (Emmett & Lekan 2016).

A couple of years earlier, an interdisciplinary network team of Global Change researchers including leading historians of science and the environment such as Libby Robin (Canberra) and Sverker Sörlin (Stockholm) joined forces to write an “Integrated History and Future of People on Earth” (IHOPE). For them, the challenge of describing changes on the planetary scale over time demands that we understand “the history of the biophysical factors, the human factors and their integration” (Robin & Steffen 2007: 1694). A truly interdisciplinary initiative, the network aims to identify potential common interests between historians and non-historians writing world history at very different scales and for different audiences. The members of the network share the understanding that the Anthropocene concept offers an appealing framework to merge human history and planetary history, resulting in new temporalities and new narratives (Costanza et al. 2012). The network IHOPE holds an impressive record of interdisciplinary publications, which were partly published in science journals, partly in humanities series. The network also pushed the creation of an anthology of commented documents on the long history of global change that provides an overview of the scientific ideas behind environmental prediction and how these ideas have affected both politics and public perception (Robin et al. 2013). It is no coincidence that the anthology’s march through time and space ends with Paul Crutzen’s seminal *Nature* article on the Anthropocene, commented by global change scientist Will Steffen, which kicked off the debate about the need of defining a new era in Earth history (Steffen 2013). The Anthropocene demands thinking in multiple time-scales simultaneously and “calls for expertise on deep time, on futures and on human histories together,” as Libby Robin has pointed out (Robin 2015: 21; also Trischler 2016a, b). The interrelatedness of bio-geological and human times can inform the work of scholars studying the development and change of temporal scales in techno-scientific fields such as weather research,

paleoecology, climate science, or polar research. Studying the history of temporal “scaling” and practices of mediating between different, often at first glance incommensurable frameworks of measurement allows for a “pluralism of perceptions of space and time,” as historian of science Deborah Coen has pointed out (Coen 2016: 305).

Many scholars from the flourishing field of environmental humanities have taken up the task of exploring the analytical and narrative potential of the Anthropocene hypothesis. A particularly instructive example is the brilliant study by historian of technology and the environment Gregory T. Cushman on the career of guano, the phosphate-rich natural fertilizer derived from the excrement of certain bird species. Cushman examines the dramatic, global consequences of the exploitation of the guano reserves on islands near the Pacific coast of Peru starting in the 1840s. If we write a history from the perspective of this resource that so profoundly altered the world, there is much to support dating the beginning of the Anthropocene at around the middle of the nineteenth century. In Cushman’s words: “Nitrogen compounds have turned the Andean legend of El Dorado into reality, down to the nitrogen-based cyanide now used to leach gold from its ore.” And he extends the lines of historical continuity of such materials into the far future. “Our waste nitrogen phosphate is likely to leave a mark that will last until our planet dies in the red blazing fire of our aging sun” (Cushman 2013: 346).

Based on his guano story, Cushman has started to narrate the period between 1820 and 1914 as the first stage of the Anthropocene. In this period of the emerging global capitalist economy, the planet’s human population began to depend on phosphorus—a resource so far surprisingly wildly neglected in historians’ narratives. Phosphorus is essential to the biochemistry of living beings; it is found in DNA and RNA, teeth and bones. In the twentieth century, it has been an indispensable element in both industry and agriculture. Modern industrial farming depends on phosphorus-based fertilizers and pesticides. Accordingly, Cushman conceptualizes the first stage of the Anthropocene as an age of plantation-making and the rise of a new fertility regime. Seen through the lens of phosphorus, the Anthropocene can be traced as a merger of the Capitalocene and the Plantationocene (Cushman 2016a, b).¹⁰

To recognize the potential of the Anthropocene to open up new perspectives by juxtaposing vastly different time scales, it is not necessary to look ahead to the end of the Earth in several billion years, as Cushman does, or backwards to the Big Bang nearly 14 billion years ago that began everything, as proponents of “Big History” advocate (Christian 2005).¹¹ The Anthropocene combines the long history of human alteration of the natural environment starting during the Neolithic Revolution with the “Long Now,” made tangible in the form of the project initiated by California cyber-utopian Steward Brand and his Long Now Foundation, which aims to build a clock that will keep time for 10,000 years or more without the need for maintenance by humans. The

model of this “Clock of the Long Now” displayed in the Anthropocene-exhibition at the *Deutsches Museum* thematizes the dialectical constellation that humans must take responsibility for the consequences of their actions, which will continue into the unimaginably distant future, without knowing how they can adequately fulfill this responsibility (Möllers 2015). This dialectic is also evident, for example, in the law passed by the German government regarding the selection of a long-term repository site for radioactive waste. The law requires that such a storage site must ensure safety for one million years. This desperate attempt borders on hubris, reminding us that high-level radioactive waste is a substance that we cannot control, but rather, as legal scholar Jens Kersten notes, “will control us—at least insofar as we continue to exist in the coming million years” (Kersten 2016: 285).

The problems of safeguarding nuclear waste stress that the temporalities of the Anthropocene stretch far beyond any human experiences and comprehension. As “we appear to have taken control over nature and have become the principal force of its transformation, we also appear ill equipped, and perhaps unable, to govern a world under the influence of these changes,” surmise historians of science Clive Hamilton, Christophe Bonneuil, and Francois Gemenne (Hamilton et al. 2015: 10). This striking paradox of the Anthropocene asks us to reassess the instruments of global—or more accurately: Earth—governance and also for rethinking historians’ temporal frameworks.

In contrast to these studies, which impressively showcase the high heuristic and analytical potential of the concept, a growing number of historians merely link their works to the term without really engaging with its far-reaching, systemic quality. The flip side of the term’s rapid success to rethink historical temporalities is the threat of its degeneration into a fashionable buzzword with very limited explanatory power. For many of its scholarly users, the term has become a mere synonym for the evil side of modernity. For others, the term either signifies a vulnerable present shattered by environmental degradation and loss of biodiversity or an open future in which humanity will suffer from its position as the dominant geological force on Earth. Used as a buzzword, the term will lose much of its explanatory potential and obscure rather than shed light on historical causalities, temporalities, and connections.

While the previous section of this article ended with a discussion of a highly contested manifesto, the *Ecomodernist Manifesto*, this section will also conclude by discussing a widely circulated and contested manifesto, the *History Manifesto*. Its proponents, Jo Guldi and David Armitage, have diagnosed a disease in our culture: “short-termism,” which results from the lack of long-range perspectives. Often, there is a long way from diagnosis to therapy, but Guldi and Armitage have identified a shortcut to effectively treat short-termism: the Anthropocene concept. Writing history at the nexus of past and future makes it possible to showcase “realistic alternative pathways to a world

that we actually want to inhabit.” In addition to narrating these positive future potentialities, a long-term history informed by the Anthropocene concept also depicts “the reality of the obstacles that have historically stood in our way to accomplishing a more just, sustainable, or ecologically attuned civilization” (Guldi & Armitage 2014: 69).

The *History Manifesto* has received much praise, but also severe criticism, in particular for presenting false evidence on the dominance of short-termism in historians’ scholarly production (Cohen & Mandler 2015). The manifesto’s appreciation of the Anthropocene could likewise be lauded and critiqued at the same time. While complementing critical story-telling about humanity’s impact on climate change and Earth systems, its call to “realize our fullest potential as managers of the earth and our future on it” could be read as subscribing to the ecomodernist vision of technological fixes (Guldi & Armitage 2014: 69).

Blurring Boundaries: The Anthropocene as a “Trading Zone” for Cross-disciplinary Collaboration

Within a few years of appearing on the scene, the term Anthropocene has gained wide academic currency and strong societal traction. The term and concept is as contested as it is fertile. It has stimulated a variety of “overlapping and competing narratives and worldviews,” many of them loaded with far reaching claims (Moore 2015: 1). According to Latour, for example, the Anthropocene is no less than “the most decisive philosophical, religious, anthropological and, as we shall see, political concept yet produced as an alternative to the very notions of ,modern’ and ,modernity” (Latour 2013: 77). For his compatriots Christophe Bonneuil and Jean-Baptiste Fressoz the “shock of the Anthropocene” asks for a conceptual “reunion of human (historical) time and Earth (geological) time” to overcome the temporal, ontological, epistemological, and institutional divide between nature and culture, environment and society that has shaped the Western worldview since the nineteenth century—in other words, the “grandiose and impotent narratives about modernity” (Bonneuil & Fressoz 2016: 33, 290). In fact, reintegrating the nonhuman into historical narratives and anthropological ontologies is perhaps the one common denominator that most scholars working on the Anthropocene could agree on.

It will take many years, if not decades, for the Anthropocene concept to unfold its transformative power both for the natural sciences and the humanities. My claim is, however, that it offers an even bigger and perhaps even more promising epistemological potential: it has become a “trading zone” for collaboration across the academic spectrum often stimulating great

interdisciplinarity between scientists and humanists (Moore 2015: 2). The history of science, history of technology, and environmental history are particularly well equipped to serve as academic traders. First, the Anthropocene debate centers on questions about the role of techno-scientific systems of knowledge in relation to other bodies of knowledge, the transformation of environments by human and nonhuman actors, and the breakdown of barriers between science, technology, and nature. Second, the debate questions established master narratives of historical change at the junction of science, technology, and the environment. Third, by calling for a convergence of natural and human temporalities, the Anthropocene debate can build on long established lines of reasoning in these fields, which can now be reassessed through the lens of the Anthropocene.

As shown above, the Anthropocene concept has already catalyzed a flourishing landscape of innovative scholarship on the history of science, technology, and the environment. Yet this is only the beginning of an intellectual trajectory that will probe the heuristic and analytical potential of the concept. There is much more to gain by venturing out of established narratives and exploring new ways of both interdisciplinary and transdisciplinary collaboration.

In knowledge production collaboration is inextricably intertwined with competition (Nickelsen 2014; Nickelsen & Krämer 2016). The debate on the Anthropocene concept exemplifies this productive tension. Disciplinary and interdisciplinary groups alike argue over practices of evidence, different temporalities, and normative implications of the concept. They dispute about the cognitive power to define the concept and its temporal dimensions. They question intrusions from scholars outside of their disciplinary realms and, worse, from media and the interested public. Along with these disputes and contentions come, however, opportunities to break away from established academic confinements and epistemic containers.

What we can already observe today after only a couple of years of intensive debate over the Anthropocene is the opening up of a new trading zone for cross-disciplinary discourse and collaboration. The trading mingles historians of science, technology, and the environment not only with scholars from many others fields of the humanities and social sciences, but also with geologists, earth systems scientists, and biologists, to name but a few cross-disciplinary constellations. This is a great challenge, but also a most welcome opportunity to rethink the modes of knowledge production in our fields. We should not shy away from tackling this challenge, cautiously insisting on the grounded theoretical and methodological, and conceptual foundations of our fields, but remaining open to venturing out to new temporal concepts and epistemologies of historical change. Historians working at the intersection of their field with archeology have experienced, and profited from, similar challenges in recent years (Samida & Eggert 2013). The same holds true for the burgeoning field of

research in ancient DNA, which has experienced a contentious, yet productive encounter of deep time and historical temporalities.¹²

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Endnotes

- 1 See for the following with detailed references Steffen et al. (2011: 842), and Schwägerl (2015: 128–129). An in-depth analysis of the term's conceptual origins is provided by Mauelshagen (2016), while the idea of an intellectual prehistory of the term is furiously criticized by Hamilton and Grinevald (2015).
- 2 Vernadsky as a conceptual forerunner of the Anthropocene is discussed by Guillaume (2014).
- 3 For more on these three proposals and additional references, see Trischler (2015: 26–27).
- 4 The argument has received strong criticism in Zalasiewicz et al. (2015a).
- 5 University of Leicester, press release from Jan. 7, 2016, <https://www2.le.ac.uk/offices/press/press-releases/2016/january/the-anthropocene-hard-evidence-for-a-human-driven-earth> (30.3.2016).
- 6 Martin J. Head: The Anthropocene: A Cultural Revolution or Legitimate Unit of Geological Time? Paper for the conference “Museums and the Anthropocene” at the National Museum of Nature and Science in Tokyo, 27–29 January 2016. The present author had a discussion with Head on that occasion in which Head expressed significant doubts about the Anthropocene as a geological period but predicted it would have a splendid career as a cultural concept.
- 7 See also the lecture on YouTube by Bruno Latour, “The Anthropocene and the Destruction of the Image of the Globe,” <https://www.youtube.com/watch?v=4-l6FQN4P1c> (23.3.2016).
- 8 A thoughtful rebuttal of common objections to the Anthropocene concept can be found in Schwägerl (2013: 29–37).
- 9 <http://www.anthropocene-curriculum.org>; see also Renn and Scherer (2015).
- 10 Cushman is in line here with anthropologists Donna Haraway (2015: 159–165) and Anna Tsing (2012: 95–97).
- 11 See also the Big History Project sponsored by Bill Gates: <https://school.bighistoryproject.com/bhplive>, and Dukes (2013): 4–5.
- 12 I'm very grateful to Désirée Schauz for pointing me to these similarities and to Elsbeth Bösl for her insights into the debates on aDNA research.

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